Cerulean Winds Aspen Project Limited

# Aspen Offshore Wind Farm

Offshore Environmental Impact Assessment Report

Volume 2, Chapter 11: Marine Mammals and Other Megafauna

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## Defined Terms

| Term | Definition |
|---|---|
| Applicant | Cerulean Winds Aspen Project Limited. |
| Aspen Array Area | The area in which the generation infrastructure for Aspen Offshore Wind Farm (OWF), including Wind Turbine Generators (WTGs) and Offshore Substation Platforms (OSPs) will be located. |
| Cumulative Effects | The combined effect of the Proposed Development in combination with the effects from a number of different Projects, on the same single receptor/resource. |
| Design Envelope | A description of the range of possible elements that make up the Proposed Development's design options under consideration, as set out in detail in the project description. This envelope is used to define the Proposed Development for Environmental Impact Assessment (EIA) and Habitats Regulation Appraisal (HRA) purposes when the exact engineering parameters are not yet known. This is also known as the "Rochdale Envelope" approach. |
| EIA Regulations | The collective term used to refer to the following:<br>▪ The Electricity Works (Environmental Impact Assessment)(Scotland) Regulations 2017;<br>▪ The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017; and<br>▪ The Marine Works (Environmental Impact Assessment) Regulations 2007. |
| Environmental Impact Assessment (EIA) | A statutory process whereby planned projects must be assessed before a formal decision to proceed can be made. It involves assessment requirements outlined in the EIA Regulations, including the collection and consideration of environmental information, which fulfils the publication of an Environmental Impact Assessment Report (EIAR). |
| European Protected Species (EPS) | Licence granted under the Conservation (Natural Habitats, &c.) Regulations 1994 and/or the Conservation of Offshore Marine Habitats and Species Regulations 2017. |
| European Site | Protected sites, originally established under EU legislation, including Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSACs), Special Protection Areas (SPAs), proposed Special Protection Areas (pSPAs) and Ramsar sites. |
| High Voltage Alternating Current (HVAC) | Refers to where the flow of electric current reverses direction in a regular frequency. HVAC supports bulk power flow over short to medium transmission distances. |
| High Voltage Direct Current (HVDC) | Refers to high voltage electricity in direct current form where current flows in one direction only. HVDC supports longer transmission infrastructure due to not experiencing reactive losses. |
| Inter-array Cables (IACs) | Cables which link the Wind Turbine Generators (WTGs) to each other and to the Offshore Substation Platforms (OSPs) within the Aspen Array Area. |
| Inter-link Cables | Cables that will link Offshore Substation Platforms (OSPs) within the Aspen Array Area. |

| Term | Definition |
|---|---|
| Landfall | The area between Mean Low Water Spring (MLWS) and Mean High Water Spring (MHWS) where the Offshore Transmission Cables (OTCs) will connect onshore to offshore. |
| Likely Significant Effect (LSE) | In the context of Environmental Impact Assessment (EIA), a Likely Significant Effect (LSE) refers to a predicted environmental impact of a proposed development that, by its nature, magnitude, duration or likelihood, has the potential to be significant in the context of the EIA Regulations. This determination is made during the EIA screening and scoping stages and helps establish whether a full EIA is required and what topics should be assessed in detail. |
| Marine Directorate - Licensing Operations Team (MD-LOT) | The Marine Directorate responsible for Section 36 Consents, and marine licensing within the Scottish inshore region (between 0 and 12 nautical miles (nm)) and in the Scottish offshore region (between 12 and 200 nm). MD-LOT acts on behalf of the Scottish Ministers. |
| Marine Scotland (MS) | The Directorate responsible for the integrated management of Scottish waters. Acts on behalf of the Scottish Ministers. |
| Non-statutory Consultee | Organisations that the Local Authorities and/or Marine Directorate may choose to engage (if, for example, there are planning policy reasons to do so) who are not designated in law but are likely to have an interest in the Proposed Development. |
| North Sea Transition Deal (NSTD) | A UK government framework supporting the transition of the offshore energy sector from oil and gas to low-carbon energy, including offshore wind, while promoting investment, reducing emissions, and safeguarding jobs in the industry. |
| Offshore Scoping Opinion | The document issued by MD-LOT on 12 May 2025 to the Applicant under the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2007 and the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017, setting out the Scottish Ministers' opinion on the content of the Offshore Environmental Impact Assessment Report (Offshore EIAR) including those issues that will or will not need to be addressed in the Offshore EIAR. |
| Offshore Scoping Report | The document submitted by the Applicant on 31 January 2025 setting out the proposed contents of the Offshore Environmental Impact Assessment Report (Offshore EIAR) and provided to MD-LOT to support the request for an Offshore Scoping Opinion. |
| Offshore Substation Platform (OSP) | Offshore platform consisting of High Voltage Alternating Current (HVAC) substations or High Voltage Direct Current (HVDC) substations. |
| Offshore Transmission Cable Corridor (OTC Corridor) | The area within which the Offshore Transmission Cables (OTCs) will be installed. |
| Offshore Transmission Cables (OTCs) | The subsea electricity cables running from Landfall in the region of Stonehaven to the Offshore Substation Platform(s) (OSP(s)) in Aspen Array Area. The OTCs will act as both a demand and supply cable. The OTCs will provide both traditional supply of power to grid but also ensures robust secure power supply to oil and gas assets when the Aspen Array Area is not generating sufficient renewable power to support their demand. |

| Term | Definition |
| --- | --- |
| Offshore Wind Farm (OWF) | The proposed generation infrastructure comprising of Wind Turbine Generators (WTGs) and associated, Offshore Substation Platform(s) (OSP(s)), foundations and substructures and Inter-array Cables (IACs). |
| Project | Aspen Offshore Wind Farm (OWF) - comprises the wind farm and all associated offshore and onshore components. |
| Proposed Development | The offshore components of the Project (Aspen Offshore Wind Farm) which include all offshore infrastructure associated with Aspen Array Area and the Offshore Transmission Cables (OTCs). |
| Section 36 Consent | Consent under Section 36 of the Electricity Act 1989 for the construction, or extension, and operation of electricity generating stations. |
| Wind Turbine Generator (WTG) | The wind turbine that generates electricity consisting of tubular towers and blades attached to a nacelle housing mechanical and electrical generating equipment. |
| Worst-case Design Scenario | The maximum design parameters of each offshore asset of the Proposed Development considered to be a worst-case for any given assessment. |

# Abbreviations

| Abbreviation | Definition |
|---|---|
| AA | Appropriate Assessment |
| ADD | Acoustic Deterrent Device |
| AfL | Agreement for Lease |
| ASCOBANS | Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas |
| BEIS | Department of Business, Energy, and Industrial Strategy (now DESNZ) |
| BERR | Business Enterprise and Regulatory Reform |
| CaP | Cable Plan |
| CBRA | Cable Burial Risk Assessment |
| CEA | Cumulative Effects Assessment |
| CES | Coastal East Scotland |
| CGNS | Celtic and Greater North Seas |
| CI | Confidence Intervals |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CMS | Construction Method Statement |
| CoP | Construction Programme |
| CSIP | Cetacean Strandings Investigation Programme |
| DAS | Digital Aerial Surveys |
| DESNZ | Department for Energy Security and Net Zero |
| DP | Decommissioning Programme |
| DTAGs | Digital Acoustic Recording Tags |
| EDR | Effective Deterrence Range |
| EEA | European Economic Areas |
| EIA | Environmental Impact Assessment |
| EIAR | Environmental Impact Assessment Report |
| EMF | Electromagnetic Field |
| EMP | Entanglement Management Plan |
| EPS | European Protected Species |
| EU | European Union |
| FCS | Favourable Conservation Status |
| FHG | Functional Hearing Group |

| Abbreviation | Definition |
|---|---|
| GBF | Global Biodiversity Framework |
| GES | Good Environmental Status |
| GNS | Greater North Sea |
| HF | High Frequency |
| HRA | Habitat Regulations Appraisal |
| HVAC | High Voltage Alternating Current |
| HVDC | High Voltage Direct Current |
| IAMMWG | Inter Agency Marine Mammal Working Group |
| IEEM | Institute of Ecology and Environmental Management |
| INNS | Invasive Non-Native Species |
| IEMA | Institute of Environmental Management and Assessment |
| INSPIRE | Impulse Noise Sound Propagation and Impact Range Estimator |
| iPCoD | Interim Population Consequences of Disturbance |
| IUCN | International Union for Conservation of Nature |
| JNCC | Joint Nature Conservation Committee |
| LF | Low Frequency |
| LSE | Likely Significant Effects |
| MAG | Magnetometer |
| MBES | Multibeam Echo Sounder |
| MD-LOT | Marine Directorate - Licensing Operations Team |
| MHWS | Mean High Water Springs |
| MLWS | Mean Low Water Springs |
| MMMP | Marine Mammal Mitigation Plan |
| MMO | Marine Management Organisation |
| MMOb | Marine Mammal Observer |
| MPA | Marine Protected Area |
| MPCP | Marine Pollution Contingency Plan |
| MU | Management Unit |
| NCMPA | Nature Conservation Marine Protected Area |
| NERC | Natural Environment Research Council |
| NMFS | National Marine Fisheries Service |
| NS | North Sea |

| Abbreviation | Definition |
|---|---|
| O&M | Operation and Maintenance |
| OMP | Operation and Maintenance Programme |
| OSP | Offshore Substation Platform |
| OSPAR | Oslo and Paris Convention for the Protection of the Marine Environment |
| OTC | Offshore Transmission Cable |
| OWF | Offshore Wind Farm |
| PAM | Passive Acoustic Monitoring |
| PCW | Phocid Carnivores in Water |
| PEMP | Project Environmental Management Plan |
| PMFs | Priority Marine Features |
| PS | Piling Strategy |
| PTS | Permanent Threshold Shift |
| RIAA | Report to Inform Assessment |
| RMS | Root Mean Square |
| ROV | Remotely Operated Vehicle |
| SAC | Special Area of Conservation |
| SBP | Sub-bottom Profiling |
| SCOS | Special Committee on Seals |
| SEL | Sound Exposure Level |
| SMASS | Scottish Marine Animal Stranding Scheme |
| SMRU | Sea Mammal Research Unit |
| SMU | Seal Management Unit |
| SNCBs | Statutory Nature Conservation Bodies |
| SPL | Sound Pressure Level |
| SSS | Sidescan Sonar |
| TTS | Temporary Threshold Shift |
| UHRS | Ultra-High Resolution Seismic |
| UWN | Underwater Noise |
| UK | United Kingdom |
| US | United States |
| USBL | Ultra-short Baseline |
| UXO | Unexploded Ordnance |

| Abbreviation | Definition |
| --- | --- |
| VER | Valued Ecological Receptor |
| VHF | Very High Frequency |
| VMP | Vessel Management Plan |
| WTG | Wind Turbine Generator |
| ZOI | Zone of Influence |

## Units

| Unit | Definition |
| --- | --- |
| dB | Decibel (sound pressure) |
| Hz | Hertz (frequency) |
| kHz | Kilohertz (frequency) |
| km | Kilometre |
| $km^2$ | Kilometre squared |
| m | Metre |
| $m^2$ | Metre squared |
| mm | Milimetre |
| nm | Nautical mile |
| m/s | Metres per second |
| MW | Megawatt |
| Pa | Pascal |
| $Pa^2s$ | Pascal squared seconds |
| µV/m | Microvolt per metre |
| µPa | Micropascal |
| $\mu Pa^2s$ | Micropascal squared seconds |

# 11 Marine Mammals and Other Megafauna

## 11.1 Introduction

11.1.1 Cerulean Winds Aspen Project Limited (hereafter referred to as the 'Applicant') is proposing to develop the Aspen Offshore Wind Farm (hereafter referred to as 'the Project'). The Project is made up of both offshore and onshore components. The subject of the Offshore Environmental Impact Assessment Report (Offshore EIAR) is the offshore infrastructure of the Project seaward of Mean High Water Springs (MHWS) which is hereafter referred to as 'the Proposed Development'.

11.1.2 The Aspen Array Area covers an area of approximately 333 km2 and is located approximately 84 km east of Peterhead on the east coast of Scotland. The offshore infrastructure of the Proposed Development includes Wind Turbine Generators (WTGs) and associated floating foundations, Offshore Substation Platform(s) (OSP(s)) and associated foundations, the Inter-array Cables (IACs), Inter-link Cables, Offshore Transmission Cables (OTCs) and Landfall.

11.1.3 This Chapter of the Offshore EIAR presents an assessment of the potential impacts and associated Likely Significant Effects (LSE) on marine mammals and other megafauna receptors from the Proposed Development and discusses appropriate mitigation and monitoring as required to address any significant effects. As per the Environmental Impact Assessment (EIA) Regulations, this Chapter specifically refers to the assessment of LSE on marine mammals and other megafauna receptors, seaward of MHWS, during pre-construction, construction, operation and maintenance (O&M), and decommissioning phases.

11.1.4 The term 'Likely Significant Effect' is used in both the EIA Regulations and the Habitat Regulations. The Offshore EIAR is accompanied by an Offshore Report to Inform Assessment (Offshore RIAA) (Cerulean Winds Aspen Project Limited, 2025) which uses the term as defined by the Habitat Regulations Appraisal (HRA) Regulations. The Offshore EIAR uses the term as defined in the 'EIA Regulations'.

11.1.5 This Chapter should be read alongside the following other Chapters and technical appendices:

- **Volume 1, Chapter 3: Project Description**;
- **Volume 1, Chapter 4: Environmental Impact Assessment Methodology**;
- **Volume 2, Chapter 10: Fish and Shellfish Ecology**;
- **Volume 2, Chapter 14: Shipping and Navigation**;
- **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**;
- **Volume 3, Appendix 3.1: Underwater Noise Technical Report;** and
- **Volume 3, Appendix 11.2: iPCoD Modelling Report**.

11.1.6 This Chapter includes a summary of information contained in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**, which provides a detailed characterisation of marine mammals and other megafauna relevant to the Proposed Development, including cetaceans (whales, dolphins and porpoises), pinnipeds (seals), basking sharks and sea turtles.

11.1.7 This Chapter refers to the design of the Proposed Development as described in **Volume 1, Chapter 3: Project Description** of the Offshore EIAR.

11.1.8 This Chapter has been prepared by GoBe Consultants Limited on behalf of the Applicant.

## 11.2 Purpose of the Chapter

11.2.1 The primary purpose of the Offshore EIAR is defined in **Volume 1, Chapter 1: Introduction**.

11.2.2 The key objective of this Chapter is to provide Scottish Ministers, statutory and non-statutory stakeholders the information required to assess for LSE upon marine mammals and other megafauna due to the Proposed Development.

11.2.3 The topic of marine mammals includes the following elements:

- Detailed description of baseline environment conditions relevant to marine mammals and other megafauna, based on data gathered from literature review and site-specific Digital Aerial Surveys (DAS) conducted between March 2023[1] and February 2025.
- Discussion of assumptions and limitations with respect to the information used in the baseline.
- Assessment of potential impacts and any resulting LSE on marine mammals related to the Proposed Development.
- Identification of monitoring measures to support proposed mitigation.

11.2.4 This Chapter presents the following:

- A detailed description of current environmental baseline conditions relevant to marine mammals and other megafauna. These have been established from a combination of literature reviews and data obtained from site specific surveys conducted between April 2023 and March 2025;
- Assumptions and limitations of the data used to define the baseline;
- Assessment of LSE on marine mammals and basking sharks from the Proposed Development activities, taking into account the embedded commitments;
- Consideration of the need for secondary mitigation and any residual effects following the application of these;
- Identification of monitoring measures to support the mitigation measures proposed.

[1] The first DAS survey was flown at the start of April 2023, due to logistical challenges not enabling the first survey to be flown in March 2023. This first April survey has been used as a proxy for the March 2023 survey, with a second survey also flown during April 2023 to be used for the "April" survey.

## 11.3 Legislation and Policy Context

11.3.1 Overarching legislation, policy, and guidance in relation to the Offshore EIAR for the Proposed Development is provided in **Volume 1, Chapter 2: Policy and Legislative Context** of the Offshore EIAR. A summary of policy (Table 11.1), legislation (Table 11.2), and guidance directly relevant to marine mammals and other megafauna is provided in the following sections.

### Legislation and Policy

11.3.2 A summary of any relevant legislation is provided below within Table 11.1 below. All policy directly applicable to marine mammals and other megafauna is presented in Table 11.2.

Table 11.1 Table of Relevant Legislation for Marine Mammals

| Legislation | Summary | How/Where Chapter has Considered This |
|---|---|---|
| Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973. | CITES is a global agreement among governments to regulate or ban the international trade in species under threat. This prohibits the trade of species listed under Appendix 1 of the agreement (including baleen whales) and controls the trade of all other cetacean species. | The protection of cetaceans (including baleen whales) has been considered throughout the assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| Convention on the Conservation of Migratory Species of Wild Animals (The Bonn Convention) 1979 | The Bonn Convention is an environmental treaty of the United Nations that aims to protect migratory wild animals (including all cetacean species, grey and harbour seals, and basking sharks) worldwide across all, or part of their natural range. It relates particularly to those species in danger of extinction. | The protection of all cetacean species, grey and harbour seals, and basking sharks has been considered throughout the assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention) 1992 | OSPAR Convention is a collaboration between 15 Western European governments dedicated to safeguarding the marine environment in the North East Atlantic region. The convention established a list of threatened and/or declining species in the north-east Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V. The UK has committed to the OSPAR MPA commitment in 2023, to establish a well-managed and ecologically coherent network of MPAs. As part of the UK's contribution, Marine Special Areas of Conservation (SACs) designated under the European Habitats Directive have been submitted. | Details of the relevant designated sites have been outlined in Table 11.7. The Offshore EIAR is accompanied by the RIAA which assesses LSE on designated European Sites. |

| Legislation | Summary | How/Where Chapter has Considered This |
|---|---|---|
| Convention on Biological Diversity 1993 | The Convention on Biological Diversity has three primary objectives: conserving biological diversity, promoting the sustainable use of its components, and ensuring the fair and equitable sharing of benefits derived from the use of genetic resources. It mandates signatories to identify activities that could impact the conservation and sustainable use of biological diversity, including the implementation of procedures for conducting an EIA and mitigation measures. | The conservation of biological diversity and the sustainable use of its components has been considered throughout the assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, 2008 (ASCOBANS) | ASCOBANS came into force in 1994 under the Convention on Migratory Species (Bonn Convention), with additional areas (including the north-east Atlantic and Irish Sea) included into the convention in 2008. The aim is to promote international cooperation with a view of achieving and maintaining the Favourable Conservation Status (FCS) of small cetaceans throughout the agreement area. | The aim of maintaining the FCS of small cetaceans has been considered throughout the assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| The Wildlife and Countryside Act 1981 (as amended) | The act makes it an offence to intentionally (or recklessly) kill, injure or take any wild animal listed on Schedule 5 of the Act, and prohibits interference with places used for shelter or protection, or intentionally disturbing or harassing animals occupying such places (either intentionally or recklessly). All cetacean species are protected within the 12 nm territorial waters under Schedule 5 of the Act. The Act also enacts requirements under the Convention on the Conservation of European Wildlife and Natural Habitats (The Bern Convention) 1979 which conveys special protection to vulnerable or endangered species and their habitats, including all cetaceans, grey and harbour seals, and basking sharks. | The protection conferred to the relevant species under the act have been accounted for throughout the assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |

| Legislation | Summary | How/Where Chapter has Considered This |
|---|---|---|
| Nature Conservation (Scotland) Act 2004 | The Nature Conservation (Scotland) Act 2004 sets out measures designed to conserve biodiversity, and to protect and enhance the natural heritage. It establishes measures to protect wildlife, providing amendments to the Wildlife and Countryside Act 1981 specifically for Scottish waters, by further improving protection of cetaceans from intentional disturbance. This further protection incorporates risk from reckless disturbance. The Act also enacts requirements under the Bern Convention 1979. | The conservation of biodiversity and the protection of natural heritage has been considered throughout this assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| Marine (Scotland) Act 2010 | The Marine (Scotland) Act 2010 provides a framework for the sustainable management of Scotland's seas to balance competing demands on Scotland's marine environment. While protecting Scotland's seas, it also promotes economic investment and growth in sectors such as marine renewable energy. One of the aims is to create more simplified marine planning and licensing system. The Act also provides improved protection for seals from intentional or reckless harassment, where certain haul-out sites have been designated as SACs. | Details of the relevant designated SACs, MPAs and haul-out sites have been outlined in Table 11.7. Further information on relevant seal haul-out sites is provided in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Technical Baseline Report.** |
| The Conservation (Natural Habitats, &c.) Regulations 1994<br><br>The Conservation of Habitats and Species Regulations 2017<br><br>The Conservation of Offshore Marine | All cetacean species in UK waters are listed in Annex IV of the Habitats Directive as European Protected Species (EPS), which is enacted in the UK through 'The Conservation of Habitats and Species Regulations 2017' and 'The Conservation of Offshore Marine Habitats and Species Regulations 2017'. They are therefore protected from deliberate killing (or injury), capture or disturbance throughout their range. They are also considered species of community interest in need of strict protection, as directed by Article 12 of the Directive.<br>The Habitats Regulations aim to ensure that habitats and species of European importance are effectively conserved and protected. The Regulations classify all cetacean species as EPS and include all seal species in Schedule 3, which prohibits certain methods of capture or killing. They also provide for the selection, designation, registration and notification of protected European Sites. | All relevant EPS species and designated sites are summarised in section 11.5.<br><br>EPS consideration has been given to all noise related impacts in Section 11.7, which has considered the conservation status and sensitivity of the receptor species when concluding the significance of effect and proposed mitigation. An EPS license will be applied for if any activity has the potential to result in such an offence. The application would be informed by the assessments presented. |

| Legislation | Summary | How/Where Chapter has Considered This |
|---|---|---|
| Habitats and Species Regulations 2017<br><br>(referred to collectively as the Habitats Regulations) | They implement the Council Directive 92/43/EEC, requiring 'competent authorities' to conduct an Appropriate Assessment (AA) for any proposed activity or development that may significantly impact a European Site. Authorities must consult with Statutory Nature Conservation Bodies (SNCBs) and reject any proposal that would harm the integrity of a European Site, except in very limited circumstances. These Regulations apply both onshore and within territorial seas, while the Offshore Marine Regulations govern marine areas beyond 12 nautical miles (nm). | Details of the relevant designated sites have been outlined in Table 11.7. The Offshore EIAR is accompanied by the RIAA which assesses LSE on designated European Sites. |
| Marine and Coastal Access Act 2009 | The Marine and Coastal Access Act 2009 established provisions for the management and protection of the marine environment. In relation to Scotland, the Act applies to offshore waters, beyond 12 nm. Along with the Marine (Scotland) Act 2010, the Act introduced a new marine licensing system, designed to achieve a consistent approach across a range of activities, and simplify the process of getting approval for a Project. | The management and protection of the marine environment has been considered throughout this assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| Wildlife and Natural Environment (Scotland) Act 2011 | The Wildlife and Natural Environment (Scotland) Act 2011 is an amendment of the Wildlife and Countryside Act 1981. The act has introduced new wildlife offences into Scotland and established a Biodiversity Duty, requiring public bodies to report on their compliance with biodiversity objectives every three years. | All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| Marine Strategy Regulations 2010 | The Marine Strategy Regulations 2010, transposes into UK law the Marine Strategy Framework Directive 2008. It requires action to be taken to achieve or maintain Good Environmental Status (GES) in UK waters. It requires a Marine Strategy for all UK waters in cooperation with other countries sharing the same | All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The |

| Legislation | Summary | How/Where Chapter has Considered This |
|---|---|---|
| | seas. The Marine Strategy which considers 11 descriptors and must reviewed and updated every 6 years.<br>Descriptor 1 relates to biological diversity (cetaceans, seals, amongst others). Descriptor 4 relates to food webs (cetaceans, seals, amongst others). Descriptor 6 relates to seafloor integrity (benthic habitats). Descriptor 7 relates to hydrographical conditions. Descriptor 11 relates to underwater noise. | significance of the effect has been concluded, and mitigation measures have been proposed.<br>All impacts relate to Descriptor 1 and 4. Impacts 11, 14 and 15 relates to Descriptor 6. Impacts 1,2,3,4,5,8,12,16 and 17 relate to Descriptor 11. |
| Protection of Seals (Designated Sea Haul-out sites) (Scotland) Order 2014 | The Protection of Seals (Designated Sea Haul-out Sites) (Scotland) Order 2014 introduced additional protection for seals at 194 designated haul-out sites. The sites were selected using a methodology developed by Sea Mammal Research Unit (SMRU) based on patterns of seal usage over recent years as recorded by aerial surveys. | Relevant designated haul-out sites have been summarised in section 11.5. Further information on relevant seal haul-out sites is provided in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Technical Baseline Report.** |

Table 11.2 Table of Relevant Policy for Marine Mammals

| Policy | Summary | How/Where Chapter has Considered This |
| --- | --- | --- |
| Scotland's National Marine Plan (Scottish Government, 2015) | The Plan covers both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm) and aims to promote the sustainable development of marine areas and sustainable use of marine resources. This policy builds on implementing the Marine (Scotland) Act 2010. The plan outlines descriptors of GES which must be met. The GES descriptors relevant to the Project and marine mammal species are GES 1, GES 4, GES 6, GES 7 and GES 11. | All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. All impacts relate to GES 1 and GES 4. Impacts 1,2,3,4,5,8,12,16 and 17 relate to GES 11. Impacts 7,10, 15 and 19 relate to GES 6 and GES 7. Impacts |
| Scottish Planning Policy 2014 (Scottish Government, 2014) | The Policy sets out national planning policies which reflect the Scottish Ministers' priorities of the planning system and for the development and use of land. | All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| UK Marine Policy Statement (HM Government, 2011) | The Policy Statement provides the framework for preparing Marine Plans and taking decisions affecting the marine environment. It contributes to the achievement of sustainable development in the UK marine area. | The sustainable development in the UK marine area has been considered throughout this assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |

| Policy | Summary | How/Where Chapter has Considered This |
|---|---|---|
| Sectoral Marine Plan for Offshore Wind Energy 2020 (Scottish Government, 2020) | The Plan covers both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm). It aims to identify sustainable plan options for the future development of commercial-scale offshore wind energy in Scotland. | The sustainable development of commercial-scale offshore wind energy in Scotland has been considered throughout this assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. The cumulative effects of the Proposed Development alongside other Scottish OWF Projects are assessed in section 11.8. |
| Scottish Biodiversity Strategy to 2045 – Tackling the Nature Emergency in Scotland (The Environment and Forestry Directorate, 2023) | This policy outlines Scottish Government's plans for restoring and regenerating biodiversity across the country by 2045. As of the most recent report, it highlights the stable abundance of some offshore whales, dolphins and porpoise, and increasing abundance and distribution of coastal bottlenose dolphins on the east coast. | The restoration and regeneration of biodiversity in Scotland have been accounted for throughout the assessment process. All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |
| The UK Biodiversity Framework. JNCC behalf of Four Countries' Biodiversity Group (4CBG) (JNCC, 2024) | The UK Biodiversity Framework supersedes the previous Framework (the UK Post-2010 UK Biodiversity Framework), which was developed following agreement of the CBD's Strategic Plan for Biodiversity 2011-2020 and the 'Aichi targets'. The framework aims to coordinate efforts across the four UK countries to meet obligations set out under the *Kunming-Montreal Global Biodiversity Framework* (GBF). As a key initial activity, the UK National Biodiversity Strategy and Action Plan has been developed and published summarising how the UK will deliver/implement the GBF. | All relevant species and designated sites are summarised in section 11.5. An assessment of the potential injury and disturbance to marine mammals and basking sharks from the Project have been discussed in section 11.7. The significance of the effect has been concluded, and mitigation measures have been proposed. |

## Guidance

11.3.3 All guidance directly applicable to marine mammals and other megafauna includes the following documents:

- Institute of Ecology and Environmental Management (IEEM) guidelines for marine and coastal ecological impact assessment in Britain and Ireland (IEEM, 2010);
- European Union Guidance on wind energy developments on Natura 2000 legislation (European Commission, 2021);
- OSPAR Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008);
- Marine mammal PTS-onset noise exposure criteria (Southall *et al.,* 2019);
- Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010);
- Scottish Marine Wildlife Watching Code (SNH, 2017);
- JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines) (JNCC, 2017);
- JNCC guidelines or minimising the risk of injury to marine mammals from unexploded ordnance (UXO) clearance in the marine environment (JNCC, 2025);
- JNCC guidance for the use of Passive Acoustic Monitoring in UK waters for minimising the risk of injury to marine mammals from offshore activities (JNCC, 2023a);
- Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation (Version 4: October 2022) (McGarry *et al.,* 2022);
- UK Government Policy paper: Marine environment: unexploded ordnance clearance joint position statement (UK Government, 2025);
- Guidance on the Offence of Harassment at Seal Haul-Out Sites (Marine Scotland, 2014);
- The protection of Marine European Protected Species (EPS) from injury and disturbance: Guidance for Inshore Waters (July 2020 Version) (Marine Scotland, 2020); and
- Description of Scottish Priority Marine Features (PMFs), commissioned Report (2016) (Tyler-Walters *et al.,* 2016).

## 11.4 Consultation

11.4.1 Continuous consultation (statutory and non-statutory) and incorporation of feedback is critical in developing a robust Offshore EIAR. The Offshore Scoping Report for the Proposed Development (**Volume 3, Appendix 6.1: Offshore Scoping Report**) was submitted to the Marine Directorate – Licensing Operations Team (MD-LOT) in January 2025. MD-LOT issued a detailed response to the Offshore Scoping Report in the May 2025 Offshore Scoping Opinion (**Volume 3, Appendix 6.2: Offshore Scoping Opinion**), covering its own opinion on the Offshore Scoping Report as well as the statutory and Non-statutory Consultees' advice on each topic.

11.4.2 A summary of the stakeholder consultation activities specific to marine mammals is provided in Table 11.3 in which the issues are raised and the actions to address them are incorporated throughout the Offshore EIAR.

11.4.3 Further detail on the Proposed Development's overall EIA stakeholder consultation process is presented in **Volume 1, Chapter 6: Consultation** of the Offshore EIAR.

Table 11.3 Consultation Relevant to Marine Mammals

| Date | Consultee and Type of Consultation | Description/Issues Raised | How This has Been Considered in This Chapter |
|---|---|---|---|
| May, 2025 | Nature Scot - Consultation and Response Advice (Appendix D) | NatureScot are content with the proposed study areas, which are considered at two spatial scales: site-specific and a broader regional scale. | Noted. |
| | | NatureScot are content with the proposed data sources, with the following comments. Seal data, note that Carter *et al*. 2022 has been updated to Carter *et al*. 2025. Moreover, the most recent bottlenose dolphin coastal east Scotland population estimate is 226 individuals (Cheney *et al.* 2024). | Noted. The new Carter *et al*. 2025 data has been used to undertake the assessment. The most recent population estimate for bottlenose dolphins has been considered as part of the baseline environment (Section 11.5) and in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**. |
| | | NatureScot noted that DAS data was not yet available and that any further species recorded in the DAS should be included within the report. | Noted. The full 24 month DAS has been included in this chapter (Paragraph 11.5.11) and in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**. |
| | | NatureScot recommends using the UK portion of MUs for the assessment as this better reflects the likely size of populations affected by the potential impact pathways, alongside the full MU population estimates. For seals and bottlenose dolphin in the Coastal East Scotland (CES) MU the entire MU should be used in the assessment. | Noted. Both the full and the UK MU population estimates have been used in the assessment conducted in Section 11.7 Assessment of Likely Significant Effects. |
| | | NatureScot states that no information is provided on which density estimates will be used and advises that the most up-to-date and precautionary estimates should be used. Usually this would be either site-specific data or SCANS-IV, depending on which is more precautionary. For species where site-specific data is not available, SCANS-IV should be used. If there is no SCANS-IV estimate, then SCANS-III and for | The densities used in the assessment are summarized in Table 11.5. The recommended order of priority for density selection has been followed, with the worse-case scenario for each species being used in the assessment. Risso's dolphin was the only species where there was no SCANS data available. Due to the known limitations of the Waggit *et al*. (2019) data, the |

| Date | Consultee and Type of Consultation | Description/Issues Raised | How This has Been Considered in This Chapter |
|---|---|---|---|
| | | species not recorded in SCANS, Waggit *et al*. (2019) may be acceptable. | impact assessment has also considered the SCANS density for the neighbouring block. |
| | | NatureScot is content with list of species included in the assessment, noting that basking sharks is considered within this chapter also. | Noted. |
| | | NatureScot is content with the designated sites identified in Table 11.3 (Table 11.7 of this document). NatureScot advise that the Southern Trench Nature Conservation Marine Protected Area (NCMPA) should be considered and addressed in more detail in the EIA Report and included as part of a separate MPA assessment. | The NCMPA is addressed in more detail in paragraph11.5.55 and included in **Volume 3, Appendix 10.2 Marine Protected Area Assessment Report.** |
| | | NatureScot is content with the impacts scoped in (Table 11.5) and out (Table 11.6). It is proposed that operational noise will be assessed qualitatively. Currently this is acceptable.<br>However, if/when more information becomes available (i.e. through the monitoring at other developments), then this should be taken into account where possible. | Noted. All publicly available information on operational noise has been included in the assessment of operational noise in section Impact 12 (paragraph 11.7.477 onwards). |
| | | NatureScot notes that paragraph 11.8.4 states "The need for inclusion of interim Population Consequences of Disturbance (iPCoD) modelling as part of the CEA will be reviewed and discussed with stakeholders at the appropriate stage of the EIA". NatureScot welcomes the opportunity for further discussion on this but advise that is likely that iPCoD modelling will be required for certain species. | iPCoD modelling has been undertaken for the alone and in-combination disturbance assessment and is provided as a separate document (see **Volume 3, Appendix 11.2: iPCoD Modelling Report)**. The modelling results have been integrated in section 11.7 and 11.8. |
| | | NatureScot agrees with use of Southall *et al*. (2019) thresholds for injury, but notes NMFS (2024) revised auditory injury thresholds may soon be adopted by NatureScot in the near future. | Noted. At the time of conducting this Offshore EIA chapter NatureScot had not adopted the NMFS (2024) injury thresholds. |

| Date | Consultee and Type of Consultation | Description/Issues Raised | How This has Been Considered in This Chapter |
|---|---|---|---|
| | | NatureScot advises that Table 11.7 includes definitions for sensitivity, however these are qualitative and very brief. Scoring should take their ability to tolerate, recover and adapt behaviour to maintain vital rates in response to assessed pressures into account, as well as considering their conservation value. Value is consistently considered within the sensitivity criteria across other ecological receptors. Not including value/importance within the sensitivity criteria disregards the inherent reason why cetaceans and seals are given a high level of legislative protection through the Habitats Regulations and fails to fully acknowledge the potential risks to individuals and populations. | The Applicant notes NatureScot comment on sensitivity definitions and has updated them in Table 11.10. |
| | | NatureScot is content with approach outlined for cumulative impacts, noting their comment above regarding iPCoD. | Noted. |
| | | NatureScot is content with approach outlined for Transboundary impacts. | Noted. |
| | | NatureScot welcomes the identification of embedded mitigation described in Section 11.6. | Noted. |
| | | NatureScot notes the need to consider impacts to cetaceans within an EPS context as far as reasonably practicable. Whilst NatureScot do not expect a full EPS risk assessment at this stage but an understanding of the implications for cetaceans from the proposal under inshore regulations, together with mitigation options. This will provide confidence, should the proposal be consented, that any impact is able to be addressed through a subsequent derogation under EPS licensing. In our experience, leaving this entirely to the post-consent stage can lead to difficulties and delays. | An EPS consideration sub-section is included for each of the impacts assessed in Section 11.7. |

| Date | Consultee and Type of Consultation | Description/Issues Raised | How This has Been Considered in This Chapter |
|---|---|---|---|
| May, 2025 | Scottish Ministers - Offshore Scoping Opinion (via MD-LOT) Section 5.6 Marine Mammals and other Megafauna | The Scottish Ministers are content with the approach on the study area, which is considered at two spatial scales: site-specific and a broader regional scale which will vary with the receptor due to differences in range and movement of Management Units (MUs). | Noted. |
| | | The Scottish Ministers are content with the current key data sources used to characterise the baseline environment and commitment to ongoing review. MD-LOT refers to the updated papers on seals data and bottlenose dolphin population estimates as per NatureScot and Natural England's paper on seals appended to their representation. | Noted. The new Carter *et al*. 2025 data has been used to undertake the assessment. The most recent population estimate for bottlenose dolphins has been considered as part of the baseline environment (Section 11.5) and in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**. |
| | | The Scottish Ministers are broadly in agreement with the description of baseline environment, including how it relates to a number of different species and various designated sites but direct the Applicant to the information provided by NatureScot representation regarding use of MUs for different species and on the use of density estimates. | Noted. The Applicant has followed NatureScot advice on the use of MUs and density estimates. |
| | | The Scottish Ministers are content with the receptors and impacts scoped into to the EIA and direct the Applicant to NatureScot recommendation that should appropriate quantitative data become available for operational noise, this should be taken into account in the assessment. | Noted. All publicly available information on operational noise has been included in the assessment of operational noise in section Impact 12 (paragraph 11.7.477 onwards). |
| | | The Scottish Ministers agree with NatureScot advice considering assessment methodology being 'high level and lacking in detail'. They refers to NatureScot advice on modelling of impacts, auditory injury and consideration of sensitivity. The Scottish Ministers are supportive of the | NatureScot comments on modelling and auditory injury have been integrated into this chapter in section 11.7, with sensitivity definitions being updated in Table 11.10. |

| Date | Consultee and Type of Consultation | Description/Issues Raised | How This has Been Considered in This Chapter |
|---|---|---|---|
| | | Applicant's commitment to engage with a wide variety of guidance documents, as detailed in Section 11.10.2. | |
| | | The Scottish Ministers are content and agree with NatureScot advice considering embedded mitigation measures detailed in Table 11.4. | Noted. |
| | | The Scottish Ministers are broadly content with the proposed approach to the assessment of cumulative effects. This aligns with NatureScot advice that iPCoD modelling would be applicable. | iPCoD modelling has been undertaking as part of the assessment with the results presented in **Volume 3, Appendix 11.2: iPCoD Modelling Report** and integrated in section 11.7 and 11.8. |
| | | The Scottish Ministers agrees with that transboundary effects should be scoped in for further assessment within the EIA. | Transboundary effects are considered in section 11.9. |
| July, 2025 | Nature Scot – virtual meeting | Points discussed included:<br>▪ Updated sensitivity criteria table presented and confirmation that all marine mammals will be classed as very high value;<br>▪ Bottlenose dolphin densities will be based on the Cheney *et al* (2024) values for the 2 km from the coast area and SCANS uniform densities will be used for the remainder of the MU;<br>▪ Use of Risso's dolphin densities from Waggit *et al* (2019) and adjacent block;<br>▪ iPCoD modelling for alone and in-combination assessments; and<br>▪ UXO disturbance assessment to include TTS as a proxy in addition to EDRs<br>NatureScot indicated agreement with the above proposed approaches. | The updated sensitivity table (Table 11.10 ) has been implemented throughout the assessment.<br><br>Densities used for all species are presented in Table 11.5.<br><br>iPCoD modelling has been undertaking as part of the assessment with the results presented in **Volume 3, Appendix 11.2: iPCoD Modelling Report** and integrated in section 11.7 and 11.8.<br><br>Impact 2: Injury and Disturbance From Underwater Noise From UXO Clearance includes TTS as a proxy and EDRs to calculate the number of animals potentially impacted. |

## 11.5 Baseline Environment

11.5.1 This section provides a summary of the marine mammal baseline environment study area, the methodology, baseline conditions and limitations and assumptions of the data used. The supporting analysis undertaken to develop this baseline is provided in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**.

### Study Area

11.5.2 For all species, the study area covers the Aspen Array Area and OTC Corridor to shore, which is then extended over a wider area to account for the scale of movement and population structure for each species as appropriate.

11.5.3 As marine mammal and other megafauna are all typically highly mobile and wide-ranging species, the study area is considered at two separate scales: a broader regional scale (Figure 11.1) and a site-specific scale (Figure 11.2).

11.5.4 For each cetacean species (whales, dolphins and porpoises), the broader regional scale study area is largely defined by the appropriate species Management Unit (MU) defined by the Inter Agency Marine Mammal Working Group (IAMMWG, 2023). A MU typically refers to a geographical area in which the animals of a particular cetacean species are found, to which management of human activities is applied. It may be smaller than what is believed to be a 'population[2]', to reflect spatial differences in human activities and their management (IAMMWG, 2023). Using MUs in the assessment of cetacean species allows consideration of the scale of movement of a species and its respective populations, whilst taking account of jurisdictional boundaries and the management of human activities.

11.5.5 At the broad MU scale, the Proposed Development is located within the following species specific MUs:

- Harbour porpoise: North Sea (NS) MU;
- White-beaked dolphin: Celtic and Greater North Seas (CGNS) MU;
- Bottlenose dolphin: Coastal East Scotland (CES) and Greater North Sea (GNS) MU;
- Risso's dolphin: CGNS MU;
- Atlantic white-sided dolphin: CGNS MU;
- Minke whale: CGNS MU; and
- Humpback whale: no MU defined for UK waters.

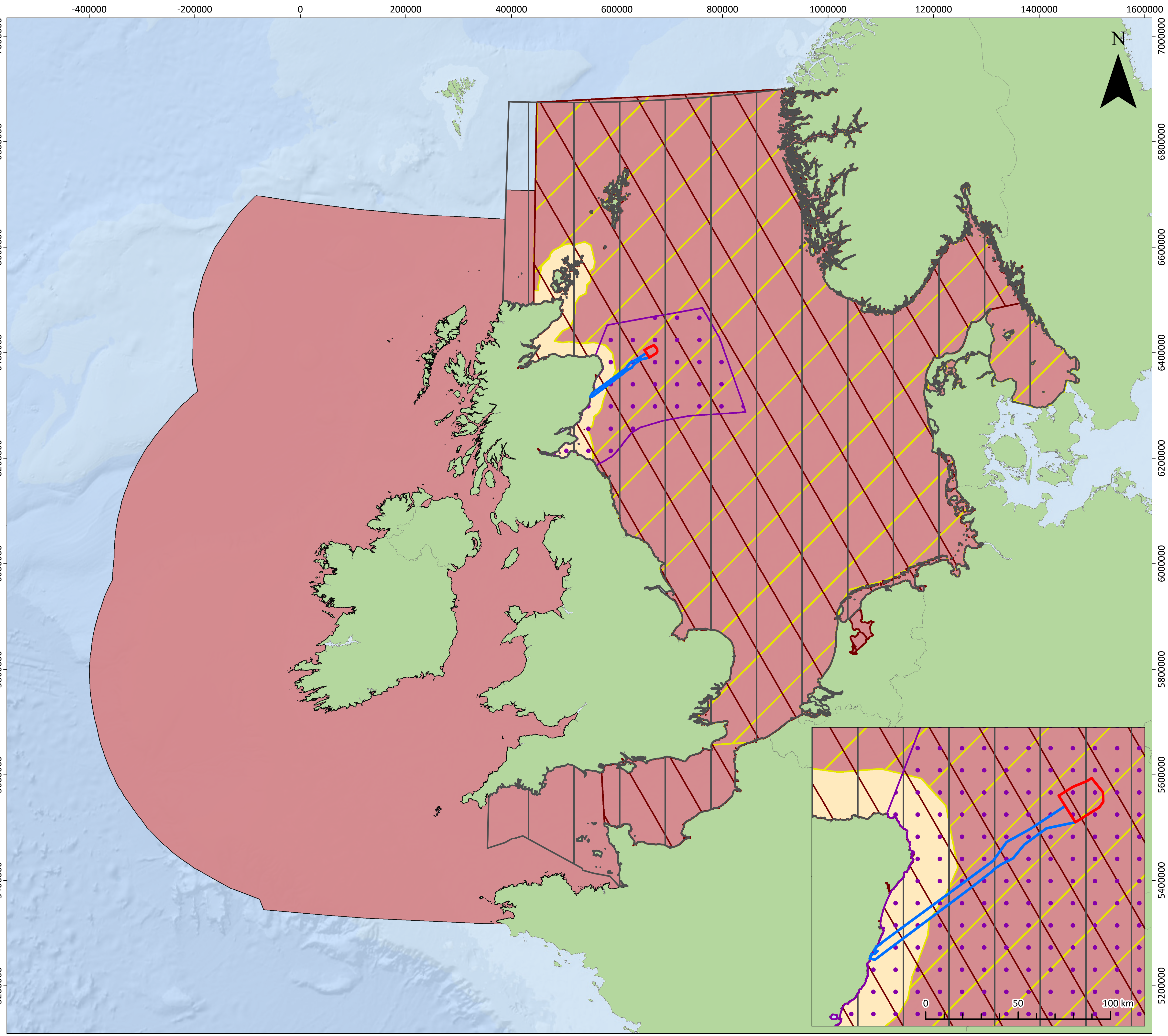
11.5.6 For seals, Seal Management Units (SMU) also refer to a geographical area which are defined based on the distribution of seal haul-out sites, for pragmatic reasons such as the ability to survey a SMU within one season, and the locations of jurisdictional boundaries (SCOS, 2022). SMUs are not explicit management divisions and should be combined appropriately when management is considered. The broad scale study area for seals is:

2 Defined as a collection of individuals of the same species found in the same area, where genetic variation occurs within the population and between other populations

- Grey seal: East Scotland (ES) and North Coast & Orkney (NC&O) SMU;
- Harbour seal: ES and NC&O SMU.

11.5.7 The broad scale study area for basking sharks is based upon the OSPAR Region II: Greater North Sea (OSPAR, 2021), in view of the wide-ranging distribution of basking sharks throughout the region.

11.5.8 The site-specific study area for all marine mammals and other megafauna is defined as the area which covers the Aspen Array Area plus a 4 km buffer, which is the survey area for the DAS conducted by the Proposed Development to provide an indication of the local densities of each species across the Aspen Array Area.




CERULEAN WINDS

## Aspen Offshore Wind Farm
Environmental Impact Assessment

### Regional Marine Mammal Study Area

**Legend**

Aspen Array Area
Offshore Transmission Cable Corridor

**Sea Turtles and Basking Sharks**
OSPAR Region II: Greater North Sea

**Grey Seal and Harbour Seal**
Eastern Scotland

**Harbour Porpoise**
North Sea

**Bottlenose Dolphin**
Coastal East Scotland
Greater North Sea

**White-beaked Dolphin**
Celtic and Greater North Sea

**Minke Whale**
Celtic and Greater North Sea

**Risso Dolphin**
Celtic and Greater North Sea

**Notes**
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Contains Ordnance Survey data © Crown copyright and database rights (2024). OS OpenData.

Coordinate System:
WGS 1984 UTM Zone 30N

0 100 200 km
0 100 200 nm

| Scale | Date | Drawn by | Checked by | Approved by |
|---|---|---|---|---|
| 1:7,000,000@A3 | 06/05/2025 | EV | GB | SB |

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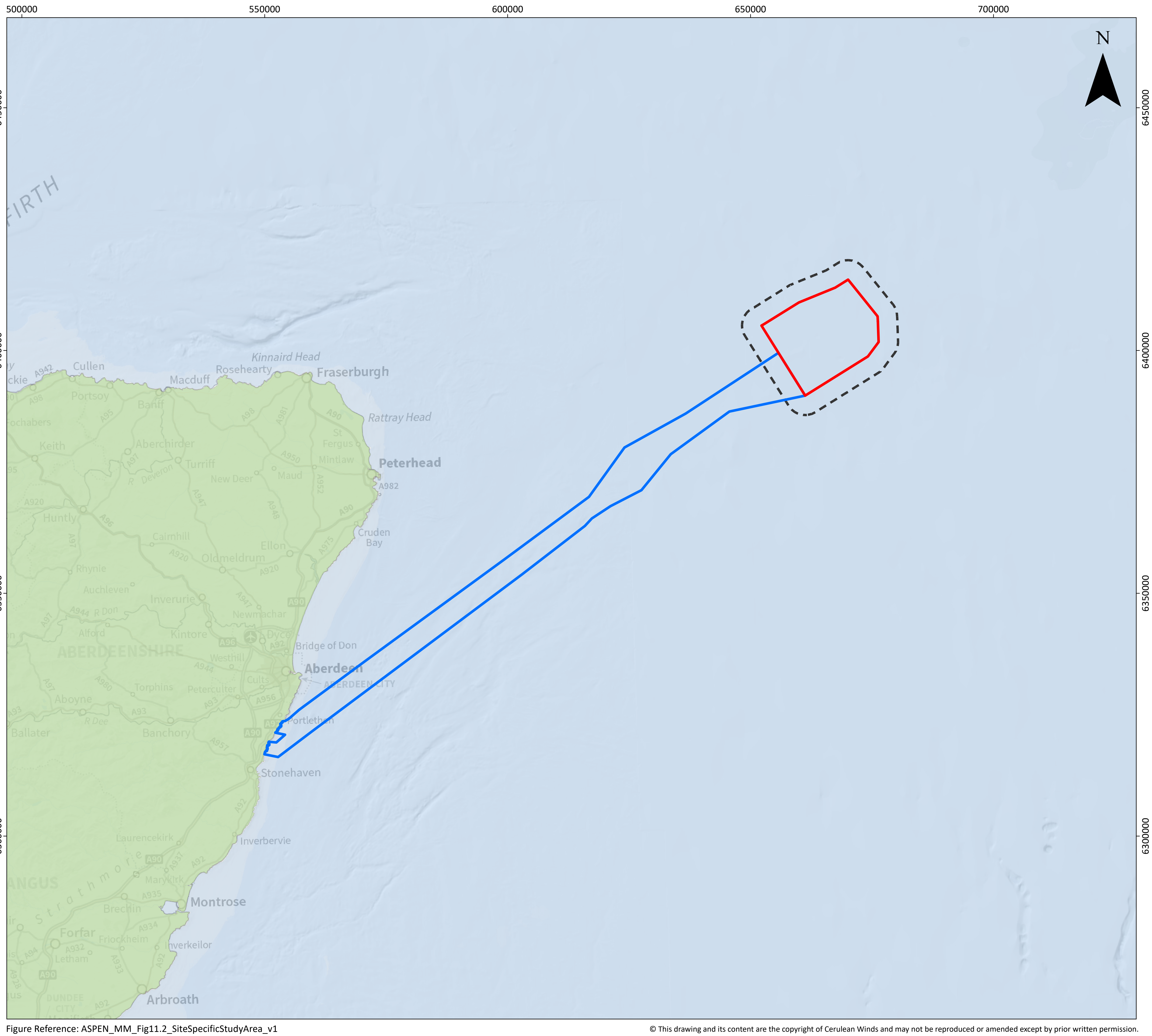
GoBe APEM Group

**Figure 11.1**

Figure Reference: ASPEN_MM_Fig11.1_RegionalStudyArea_v1




CERULEAN WINDS

## Aspen Offshore Wind Farm
Environmental Impact Assessment

### Site-specific Marine Mammal Study Area

**Legend**
- Aspen Array Area
- Offshore Transmission Cable Corridor
- Aspen Array Area 4km Buffer

**Notes**
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Coordinate System:
WGS 1984 UTM Zone 30N

0 20 40 km
0 10 20 nm

| Scale | Date | Drawn by | Checked by | Approved by |
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**Figure 11.2**

Figure Reference: ASPEN_MM_Fig11.2_SiteSpecificStudyArea_v1

## Methodology

11.5.9 Baseline data to inform the marine mammal and other megafauna assessment was collected using a desktop study and data from site specific surveys.

### Desktop Study

11.5.10 For the purpose of this marine mammal and other megafauna chapter, a desk-based review was undertaken using relevant spatial and scientific data sources. These existing data sets and literature are presented in Table 11.4.

### Site Specific Surveys

11.5.11 Site specific DAS were conducted monthly across a two-year period by HiDef Aerial Surveying Limited between March 2023 and February 2025[3]. Each survey comprises of 17 survey transects with 2 kilometres (km) spacing within the Aspen Array Area plus a 6 km buffer. For data analysis purposes a 4 km buffer has been used.

[3] The first DAS survey was flown at the start of April 2023, due to logistical challenges not enabling the first survey to be flown in March 2023. This first April survey has been used as a proxy for the March 2023 survey, with a second survey also flown during April 2023 to be used for the "April" survey.

Table 11.4 Key Sources of Marine Mammal and Other Megafauna Baseline Data

| Source | Summary | Coverage of the Aspen Array Area and OTC Corridor Study Area | Data Quality |
|---|---|---|---|
| Sightings of Marine Mammals and Other Animals Recorded from Offshore Installations in the North Sea (Weir, 2001) | Report collates records of observations of cetaceans, pinnipeds, turtle and shark species made by observers on offshore installations in the North Sea, with the sighting predominantly occurring between 1987 and 1999. | Full – Sightings are from offshore installations across the North Sea, which, in turn covers the Proposed Development. | Variable (sightings are reported by specialists and non-specialists so identification might not be accurate) |
| Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resource JNCC Report (Paxton *et al.*, 2016) | Effort-linked sightings data from the Joint Cetacean Protocol data resource were used to estimate spatio-temporal patterns of abundance for seven cetacean species across the UK and Ireland between 1994 and 2010. | Full – Cetacean trends in the North Sea, which covers the Proposed Development. | Good |
| Distribution Maps of Cetacean and Seabird Populations in the North-East Atlantic, Marine Ecosystems Research Programme (Waggitt *et al.*, 2019) | Distributional maps for 12 cetacean species were produced at 10 km resolution. The data is collated between 1980 and 2018 from both aerial and vessel surveys. The data provides the largest ever collation and standardisation of survey data for cetaceans and seabirds in the North-East Atlantic. | Full – The modelled density spans the North-East Atlantic, and therefore covers the Proposed Development. | Variable (several limitations identified regarding outputs) |
| Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters. Scottish Marine and Freshwater Science Vol | Report collates information on marine mammal abundance in the Scottish Northern North Sea region and Scottish Atlantic waters with a focus on Draft Plan Option sites which may be leased for commercial scale offshore renewable development. | Full – study area covers all Scottish waters which, in turn, covers the Proposed Development. | Good |

| Source | Summary | Coverage of the Aspen Array Area and OTC Corridor Study Area | Data Quality |
|---|---|---|---|
| 11 No 12 (Hague *et al.*, 2020) | | | |
| Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (1910–2018). (Botterell *et al.*, 2020) | Analysis of spatial and temporal occurrence of marine turtle sightings and strandings in the UK and Ireland between 1910 and 2018. | Full – Sightings and strandings are across UK and Irish waters, which, in turn covers the Proposed Development. | Variable (sightings and strandings are reported by specialists and non-specialists so identification might not be accurate) |
| Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys (Hammond *et al.*, 2021) | Report provides estimates of cetacean abundance in European Atlantic waters in summer 2016 using the SCANS-III aerial and shipboard surveys. | Full – Study area covers most of the European Atlantic waters. The Proposed Development is fully covered by this report. | Good |
| Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys (Gilles *et al.*, 2023) | Report provides estimates of cetacean abundance in European Atlantic waters in summer 2022 using the SCANS-IV aerial and shipboard surveys. | Full – Study area covers most of the European Atlantic waters. The Proposed Development is fully covered by this report. | Good |
| Review of Management Unit boundaries for cetaceans in UK waters | Report provides abundance estimates for the seven most common cetacean species found in UK waters. MUs were | Full - The relevant MUs for the Proposed Development are as follows – harbour porpoise: NS MU; white-beaked dolphin: | Good |

| Source | Summary | Coverage of the Aspen Array Area and OTC Corridor Study Area | Data Quality |
|---|---|---|---|
| (2023). JNCC Report 734, JNCC, Peterborough, ISSN 0963-8091. (IAMMWG, 2023) | defined across UK waters and abundance estimates were calculated for each species within their respective MU. | CGNS MU; bottlenose dolphin: CES and GNS MUs; Risso's dolphin: CGNS MU; Atlantic white-sided dolphin: CGNS MU and minke whale: CGNS MU. | |
| British & Irish Marine Turtle Strandings & Sightings Annual Report 2022 (Penrose and Westfield, 2023) | Report collates all sightings and strandings of marine turtles in UK and Irish waters during 2022. | Full – Sightings and strandings are across UK and Irish waters, which, in turn covers the Proposed Development. | Variable (sightings and strandings are reported by specialists and non-specialists so identification might not be accurate) |
| Marine Turtles (NBN Trust, 2023) | Sightings and strandings of both dead and alive marine turtles in UK and Irish waters between 1748 and 2017. | Full – Sightings and strandings are across UK and Irish waters, which, in turn covers the Proposed Development. | Variable (sightings and strandings are reported by specialists and non-specialists so identification might not be accurate) |
| Green Volt OWF DAS (Green Volt, 2023) | DAS were conducted monthly between May 2020 and April 2022 across the Green Volt array area plus a 4 km buffer. | No coverage - The survey area covers Green Volt array area plus a 4 km buffer. Green Volt lies within the same region as | Good |

| Source | Summary | Coverage of the Aspen Array Area and OTC Corridor Study Area | Data Quality |
|---|---|---|---|
| | | the Proposed Development and is a neighbouring wind farm. | |
| Muir Mhòr OWF DAS (Muir Mhòr, 2023) | DAS were conducted monthly between April 2021 and March 2023 across the Muir Mhòr array area plus a 4 km buffer. | No coverage - The survey area covers the Muir Mhòr array area plus a 4 km buffer. Muir Mhòr lies within the same region as the Proposed Development and is a neighbouring wind farm. | Good |
| Scientific advice on matters related to the management of seal populations: 2024. NERC: Special Committee on Seals (SCOS). (SCOS, 2024) | Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) has a duty to provide scientific advice to the government on matters related to the management of UK seals. This advice is based on the latest scientific research conducted and collated by the Sea Mammal Research Unit, University of St Andrews. NERC appointed a Special Committee on Seals (SCOS) to review and formally issue this advice. | Full - Advice covers seal populations across the UK which, in turn, covers the Proposed Development. | Good |
| ORCA Whale and dolphin sightings (ORCA, 2024) | Database of all the sighting records of whale and dolphin species made by ORCA's citizen scientists over nearly 30 years. Sightings were originally focused in the North-East Atlantic but data is now global. | Partial - ORCA provides data of sightings globally. Most sightings within the Proposed Development were collected on ferry routes from Aberdeen. | Variable (sightings are reported by specialists and non-specialists so identification might not be accurate) |
| Sea Watch Foundation Recent Sightings (Sea Watch Foundation, 2024) | Database of the latest sightings records of marine mammal species collected by citizen scientists across UK and Irish waters. | Full – The Proposed Development area covers both the 'NE Scotland' and 'South Grampian and SE Scotland' regions of the database. | Variable (sightings and strandings are reported by |

| Source | Summary | Coverage of the Aspen Array Area and OTC Corridor Study Area | Data Quality |
|---|---|---|---|
| | | | specialists and non-specialists so identification might not be accurate) |
| Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins *Tursiops truncatus* in Scottish waters (Cheney *et al.*, 2024) | A comprehensive assessment of the abundance of bottlenose dolphins in the inshore waters of Scotland through a combination of photo-identification studies and opportunistic sightings. | Partial – The assessment covers the CES MU for bottlenose dolphins and the Moray Firth SAC which partially covers the Proposed Development. | Good |
| Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management (Carter *et al.*, 2022; 2025) | Study models the at-sea distribution of all grey and harbour seals hauling out in the UK and Ireland, calculated using satellite tracking and abundance data (haul out counts). | Full - Study area is comprised of UK and Irish waters which, in turn, covers the Proposed Development. | Good |
| Site-specific DAS for the Aspen Array Area | DAS are being conducted monthly between April 2023 and March 2025 across the Aspen Array Area plus a 6 km buffer. For data analysis purposes a 4 km buffer has been used. | Full – The survey area covers the Aspen Array Area plus a 4 km buffer. | Good |

## Description of Baseline Environment

11.5.12 A summary of the marine mammal and other megafauna baseline environment is provided in the following sections. Full details of the analysis undertaken to develop the marine mammal and other megafauna baseline is provided in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Technical Baseline Report**.

11.5.13 A review of the data available have confirmed the likely presence of the following marine mammals and other megafauna in the vicinity of the Proposed Development:

- Harbour porpoise (*Phocoena Phocoena*);
- Bottlenose dolphin (*Tursiops truncatus*);
- White-beaked dolphin (*Lagenorhynchus albirostris*);
- Risso's dolphin (*Grampus griseus*);
- Atlantic white-sided dolphins (*Lagenorhynchus acutus*);
- Minke whale (*Balaenoptera acutorostrata*);
- Humpback whale (*Megaptera novaeangliae*);
- Grey seal (*Haliochoerus grypus*);
- Harbour seal (*Phoca vitulina*) and
- Basking sharks (*Cetorhinus maximus*);

11.5.14 Therefore, the above species will be considered within the quantitative impact assessment in the Offshore EIAR. The exceptions are the humpback whale and basking shark for which a qualitative impact assessment will be undertaken due to the absence of a defined MU and a lack of reliable density estimates needed to support robust quantitative impact assessment.

11.5.15 The most robust and relevant density estimates within each MU were determined for each receptor with a justification of density estimates used included in the **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Technical Baseline Report**. Density estimates and population assessments for the marine mammal species in the Marine Mammal Study Areas are presented in Table 11.5. These values provide a measure to quantify the scale of effect of given impacts within the impact assessment. Where possible, site-specific estimates from the DAS are provided for a species and have been used in the impact assessment. However, it is important to note that the site-specific density estimates are not representative of animal densities across the wider scale for large-scale impacts such as disturbance from piling.

Table 11.5 Marine Mammal and Megafauna Density Estimates and Reference Populations Used in Quantitative Impact Assessment

| Species | MU | MU Reference Population | UK MU Reference Population | MU Source | Density (#/km$^2$) | Density Source |
|---|---|---|---|---|---|---|
| Harbour porpoise | NS | 346,601 | 159,632 | IAMMWG (2023) | 0.5444 | Derived from SCANS-IV density surfaces (Gilles *et al.*, 2025) |
| | | | | | 0.2510 | Site-specific DAS |
| | | | | | 0.5985 | SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023) |
| White-beaked dolphin | CGNS | 43,951 | 34,025 | IAMMWG (2023) | 0.2047 | Derived from SCANS-IV density surfaces (Gilles *et al.*, 2025) |
| | | | | | 0.009 | Site-specific DAS |
| | | | | | 0.0799 | SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023) |
| Bottlenose dolphin | GNS | 2,022 | 1,885 | IAMMWG (2023) | 0.001 | Derived from SCANS-IV density surfaces (Gilles *et al.*, 2025) |
| | | | | | 0.0023 | SCANS-III Survey Block NS-D (Hammond *et al.*, 2021) |
| | CES | 226 | | Cheney *et al.* (2024) | 0.116 (within 2 km of the coast), | Calculated from Cheney *et al.* (2024) |
| | | | | | 0.0023 (beyond) | SCANS-III Survey Block NS-D (Hammond *et al.*, 2021) |
| Risso's dolphin | CGNS | 12,262 | 8,687 | IAMMWG (2023) | 0.0702 | SCANS-IV Survey Block NS-E (Gilles *et al.*, 2023) |
| | | | | | 0.0013 | Calculated Aspen Array Area (Waggitt *et al.*, 2019) |
| Atlantic white-sided dolphin | CGNS | 18,128 | 12,293 | IAMMWG (2023) | 0.0100 | SCANS-III Survey Block R (Hammond *et al.*, 2021) |

| Species | MU | MU Reference Population | UK MU Reference Population | MU Source | Density (#/km$^2$) | Density Source |
|---|---|---|---|---|---|---|
| Minke whale | CGNS | 20,118 | 10,288 | IAMMWG (2023) | 0.0769 | Derived from SCANS-IV density surfaces (Gilles *et al.*, 2025) |
| | | | | | 0.0419 | SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023) |
| Humpback whale | Qualitative assessment | | | | | |
| Harbour seal | East Scotland SMU | 383 | | Harbour seal count 2023 (SCOS, 2024) | 0.000008 (Grid-cell specific) | Carter *et al.* (2022) |
| | NC&O SMU | 1,951 | | | 0.00000014 (Grid-cell specific) | |
| Grey seal | East Scotland SMU | 6,298 | | Scaled grey seal count 2023 (SCOS, 2024) | 0.004 | Site-specific DAS |
| | | | | | 0.0195 (Grid-cell specific) | Carter *et al.* (2025) |
| | NC&O SMU | 34,266 | | | 0.03292 (Grid-cell specific) | |
| Basking shark | Qualitative assessment | | | | | |

### Harbour Porpoise

11.5.16 The harbour porpoise is the most widespread and frequently recorded species in the North Sea (Evans *et al.,* 2003). They are listed as a species of Least Concern on the International Union for Conservation of Nature (IUCN) Red List (Braulik *et al.,* 2023). The conservation status of the harbour porpoise in the UK is currently unknown due to insufficient data (JNCC, 2019a).

11.5.17 Estimates provided from the SCANS-IV surveys gave a density of 0.5985 individuals/km$^2$ and an abundance of 38,577 individuals for block NS-D (Gilles *et al.,* 2023). This is similar to the estimates from the SCANS-III surveys of 0.599 individuals/km$^2$ and 38,646 individuals for block R (Hammond *et al.,* 2021). Density estimates have been modelled for harbour porpoise using the SCANS-III (Lacey *et al.,* 2022) and IV (Gilles *et al.,* 2025) data. Within the site-specific area using SCANS-IV predictive surface density models, a density of 0.5444 harbour porpoise/km$^2$ is estimated (Gilles *et al.,* 2025).

11.5.18 The Proposed Development is located within the North Sea MU for harbour porpoise. This MU encompasses a much larger region than the SCANS-III and IV survey blocks. The abundance estimate within the UK portion of this MU is 159,632 individuals (CV=0.12; 95% CI=127,442-199,954) (IAMMWG, 2023).

11.5.19 Harbour porpoise is the most frequently sighted species in the site-specific DAS (Table 11.6). Considering the two closest wind farms for which DAS results are available, harbour porpoises were also the most frequently sighted species during the Green Volt OWF (Green Volt, 2023) and Muir Mhòr OWF (Muir Mhòr, 2023) site-specific surveys. Frequent sightings of this species across the region have also been reported in the citizen science data collated by both ORCA and the Sea Watch Foundation (ORCA, 2024; Sea Watch Foundation, 2024). Both DAS results and the ORCA database also had several sightings of unidentified dolphin and/or cetacean species, some of which might have been harbour porpoise.

Table 11.6 Marine Mammal Sightings During Site-specific DAS

| Species | Submerged | Surfacing | Unknown Behaviour | Total |
|---|---|---|---|---|
| White-beaked dolphin | 14 | 3 | 0 | 17 |
| Grey seal | 3 | 4 | 0 | 7 |
| Harbour porpoise | 103 | 33 | 0 | 136 |
| Minke whale | 1 | 0 | 0 | 1 |
| Risso's dolphin | 0 | 1 | 0 | 1 |
| No Identification | | | | |
| Cetacean species | 1 | 0 | 0 | 1 |
| Dolphin species | 1 | 0 | 0 | 1 |
| Seal species | 0 | 6 | 1 | 7 |
| **Total** | **123** | **47** | **1** | **171** |

### *White-beaked Dolphin*

11.5.20 White-beaked dolphins are present in Scottish offshore waters year-round, with increased sightings during the summer months (Hague *et al.,* 2020). They are one of the most abundant cetacean species in Scottish shelf waters. The SCANS-IV surveys estimated the species to have a density of 0.0799 individuals/km² and an abundance estimate of 5,149 within block NS-D (Gilles *et al.,* 2023). This is considerably lower than the previous SCANS-III surveys, which provided a density estimate of 0.243 individuals/km² and an abundance estimate of 15,694 within survey block R (Hammond *et al.,* 2021). Within the site-specific area using SCANS-IV predictive surface density models, a density of 0.2047 white-beaked dolphin/km² is estimated (Gilles *et al.,* 2025). The site of the Proposed Development is located within the CGNS MU, which has an estimated abundance of 34,025 (CV=0.28; 95% CI=20,026-57,807) white-beaked dolphins within the UK portion of the MU (IAMMWG, 2023). The white-beaked dolphin is listed as a species of Least Concern on the IUCN Red List (Kiszka & Braulik, 2018a). The UK conservation status of the white-beaked dolphin is currently unknown due to insufficient data (JNCC, 2019b).

11.5.21 White-beaked dolphins were sighted a total of 17 times in the site-specific DAS, with the highest number of sightings (of 11 individuals) in July 2023. Considering the two closest wind farms for which DAS results are available, white-beaked dolphins were also sighted during the Green Volt OWF (Green Volt, 2023) and Muir Mhòr OWF (Muir Mhòr, 2023) site-specific surveys. There were four sightings of the species on a ferry route close to the local study area reported to ORCA (ORCA, 2024). However, no recent sightings of white-beaked dolphins have been reported to the Sea Watch Foundation (Sea Watch Foundation, 2024). Both the Muir Mhòr and Green Volt DAS surveys, and the ORCA database reported several sightings of unidentified dolphin and/or cetacean species, some of which might have been white-beaked dolphins.

### *Bottlenose Dolphin*

11.5.22 There are two ecotypes of bottlenose dolphin present in UK waters, a coastal and offshore ecotype (Cheney *et al.,* 2013). With respect to the coastal ecotype, movement of individuals through prospective corridors between designated SACs in the Moray Firth (Scotland), Cardigan Bay (Wales) and Shannon Estuary (Ireland) have been confirmed (Robinson *et al.,* 2012). Bottlenose dolphins off the east coast of Scotland are regularly observed with calves and juveniles, indicating a breeding population (Arso Civil *et al.,* 2021). The OTC Corridor of the Proposed Development would intersect an area of the coastline known to be used by the Moray Firth SAC population of bottlenose dolphins. Therefore, bottlenose dolphins travelling to or from the Moray Firth SAC may therefore be present in the OTC Corridor. This population has an estimated abundance of 226 (CV=0.028, 95% CI=214-239) individuals within the CES MU (Cheney *et al.*, 2024).

11.5.23 Relative to the wider and offshore region, the estimated abundance of bottlenose dolphins is 1,885 (CV=0.8; 95% CI = 476 – 7461), encompassing the UK portion of the GNS MU (IAMMWG, 2023). The SCANS-III surveys (Hammond *et al.,* 2021) estimated bottlenose dolphin density to be 0.0298 individuals/km$^2$ with an abundance estimate of 1,924 individuals within survey block R. There were no density or abundance estimates provided for bottlenose dolphin from the SCANS-IV surveys of block NS-D, due to little or no sightings (Gilles *et al.,* 2023). Bottlenose dolphins are listed as a species of Least Concern on the IUCN Red List (Wells *et al.,* 2019). The UK conservation status for the bottlenose dolphin is currently unknown due to insufficient data (JNCC, 2019c).

11.5.24 Bottlenose dolphins have not been sighted during the site-specific DAS (Table 11.6) and were not sighted during the site-specific DAS for the Muir Mhòr OWF (Muir Mhòr, 2023). There was one sighting reported on the Green Volt OWF site-specific DAS (Green Volt, 2023). The ORCA and the Sea Watch Foundation reported frequent sightings of bottlenose dolphins in the region (ORCA, 2024; Sea Watch Foundation, 2024). The site-specific DAS, Muir Mhòr and Green Volt DAS surveys, and the ORCA database reported several sightings of unidentified dolphin and/or cetacean species, some of which might have been bottlenose dolphins.

11.5.25 The bottlenose dolphin density estimates used in the EIA have been derived using uniform density values. These estimates were calculated for the GNS MU, which exhibited a uniform density of 0.0003 bottlenose dolphins/km$^2$. Additionally, a uniform density of 0.116 bottlenose dolphins/km$^2$ was applied within 2 km of the Scottish coastline in the CES MU, with the rest of the MU considered to have a density of 0.0003 bottlenose dolphins/km$^2$. The methodology used to derive these uniform density estimates, along with the rationale for their application, is detailed in **Volume 3, Appendix 11.1: Marine Mammals and Other Megafauna Baseline Technical Report**.

### *Risso's Dolphin*

11.5.26 Risso's dolphins are present within Scottish waters with sightings occurring most commonly in the coastal waters of Western Scotland (JNCC, 2019d). Risso's dolphins are recorded in the coastal waters around northeast Scotland, and these waters have been suggested as critical habitats for the species (Hodgins *et al.,* 2024). Frequent sightings of mothers with dependant calves indicate that these shallow coastal waters provide nursery grounds for the population.

11.5.27 The abundance estimate for Risso's dolphins within the UK portion of the MU for CGNS is 8,687 individuals (CV=0.63; 95% CI=2,810-26,852) (IAMMWG, 2023). There are no density or abundance estimates available for Risso's dolphin from the SCANS-IV surveys of block NS-D or the SCANS-III surveys of block R, due to little or no sightings (Hammond *et al.,* 2021; Gilles *et al.,* 2023), hence density estimates provided by Waggitt *et al.* (2019) will be used, 0.0013 individuals/km$^2$. The Risso's dolphin is listed as a species of Least Concern on the IUCN Red List (Kiszka & Braulik, 2018b). The conservation status for the Risso's dolphin in the UK is currently unknown due to insufficient data (JNCC, 2019d).

11.5.28 Risso's dolphins were sighted once during the site-specific DAS (Table 11.6). There was one sighting during the Green Volt OWF DAS (Green Volt, 2023) and four during the Muir Mhòr OWF DAS (Muir Mhòr, 2023). No sightings of Risso's dolphins have been reported by ORCA (ORCA, 2024) or in the 'South Grampian and SE Scotland' region of the Sea Watch Foundation database (Sea Watch Foundation, 2024). However, nine sightings of Risso's dolphins have been reported in the 'NE Scotland' region (Sea Watch Foundation, 2024). Both the Muir Mhòr and Green Volt DAS surveys, and the ORCA database reported several sightings of unidentified dolphin and/or cetacean species, some of which might have been Risso's dolphins.

### *Atlantic White-sided Dolphin*

11.5.29 Atlantic white-sided dolphins are sighted throughout the year across UK waters, particularly in the north and northwest coasts of Scotland during the summer months (Paxton *et al.,* 2016). Their main habitat is offshore along the outer continental shelf and slope. The Scottish Marine Atlas shows that some sightings have been reported in the east and northeast (Scottish Government, 2011).

11.5.30 SCANS-III surveys reported an estimated density of 0.010 individuals/km² and an abundance estimate of 644 within block R (Hammond *et al.,* 2021). There were no density or abundance estimates available for white-sided dolphin from the SCANS-IV surveys of block NS-D, due to little or no sightings (Gilles *et al.,* 2023). The abundance estimate for white-sided dolphin across the UK portion of the MU for CGNS is 12,293 (CV=0.64; 95% CI=3,891-38,841) individuals (IAMMWG, 2023). The Atlantic white-sided dolphin is listed as a species of Least Concern on the IUCN Red List (Braulik, 2019). The conservation status for the Atlantic white-sided dolphin in the UK is currently unknown due to insufficient data (JNCC, 2019e).

11.5.31 Atlantic white-sided dolphins were not sighted during the site-specific DAS (Table 11.6), nor during the Muir Mhòr OWF DAS (Muir Mhòr, 2023) or the Green Volt OWF DAS (Green Volt, 2023). No sightings of this species have been reported by either ORCA or the Sea Watch Foundation (ORCA, 2024; Sea Watch Foundation, 2024). Both the Muir Mhòr and Green Volt DAS surveys, and the ORCA database reported several sightings of unidentified dolphin and/or cetacean species, some of which might have been Atlantic white-sided dolphins.

11.5.32 Despite Atlantic white-sided dolphins being present in low numbers in Scottish waters, as a precautionary measure and to reflect advice given by NatureScot to nearby developments, they have been included in the assessment.

### *Minke Whale*

11.5.33 Minke whales are the most abundant baleen whale species within Scottish waters and occur throughout the northeast of Scotland (Robinson *et al.,* 2009), although there is currently no evidence of minke whales calving in Scottish waters. The minke whale is listed as a species of Least Concern on the IUCN Red List (Cooke, 2018a) and is a feature of the Southern Trench NCMPA. The UK conservation status for the minke whale is currently unknown due to insufficient data (JNCC, 2019f).

11.5.34 Density and abundance estimates from the SCANS-IV surveys of block NS-D were 0.0419 individuals/km$^2$ and 2,702 individuals (Gilles *et al.,* 2023). These are slightly higher than estimates from the prior SCANS-III surveys of block R which were 0.0387 individuals/km$^2$ and 2,498 individuals (Hammond *et al.,* 2021). Within the site-specific area using SCANS-IV predictive surface density models, a density of 0.0769 minke whale/km$^2$ is estimated (Gilles *et al.,* 2025). The abundance estimate of minke whales across the UK portion of the MU for the CGNS is 10,288 (CV=0.26; 95% CI=6,210-17,042) individuals (IAMMWG, 2023).

11.5.35 Minke whales were sighted once during the site-specific DAS (Table 11.6). Minke whales were also sighted during Muir Mhòr OWF DAS, with 12 sightings between April and September (Muir Mhòr, 2023). They were not sighted during the Green Volt OWF DAS (Green Volt, 2023). The Sea Watch Foundation has reported eight sightings of minke whales throughout the 'South Grampian and SE Scotland' region and 22 sightings in the 'NE Scotland' region (Sea Watch Foundation, 2024), whilst ORCA reported sightings of eight individuals across the region (ORCA, 2024). Several sightings of unidentified whale species were also reported by ORCA, some of which may be minke whales.

### *Humpback Whale*

11.5.36 Humpback whales are occasionally sighted in UK waters as they migrate between winter breeding grounds off the coast of Africa and feeding grounds around Iceland (Sea Watch Foundation, 2012). Since the mid-1980s, sightings of humpback whales in UK waters have been steadily increasing, likely due to their population's recovery following the ban on commercial whaling (JNCC, 2019g).

11.5.37 In Scottish waters, humpback whales are most common off the Shetland Isles and Hebrides but are increasingly present in the Northern North Sea (Hague *et al.,* 2020). At least four individual humpback whales were observed in the Firth of Forth, Scotland during the winter months of 2017 and 2018 (O'Neil *et al.,* 2019).

11.5.38 The UK conservation status of humpback whales is currently unknown due to insufficient data (JNCC, 2019g) and no humpback whales were sighted in the SCANS-III or VI surveys (Hammond *et al.,* 2021; Gilles *et al.,* 2023). The humpback whale is listed as a species of Least Concern on the IUCN Red List (Cooke, 2018b).

11.5.39 Humpback whales were not sighted during the site-specific DAS (Table 11.6), nor during the Muir Mhòr OWF DAS (Muir Mhòr, 2023) or the Green Volt OWF DAS (Green Volt, 2023). No sightings of humpback whales within this region have been reported by either ORCA or the Sea Watch Foundation (ORCA, 2024; Sea Watch Foundation, 2024).

11.5.40 Despite humpback whales being present in low numbers in east-coast Scottish waters there has been a recent increase in sightings in the North Sea from the Firth of Forth north to Shetland. As a precautionary measure and to reflect advice given by NatureScot to Green Volt OWF (Marine Scotland, 2022), they have been included in the assessment.

### *Harbour Seal*

11.5.41 Harbour seals will haul-out to give birth to their pup in June and July and will moult in August. Outside these times they will haul-out regularly to rest. The August count of harbour seals at haul-out sites within the ES SMU was 276 (2016-2023), with the latest population estimate being 383 individuals (95% CI=314-511), and the NC&O SMU August count was 1,405 (2016-2019), with the latest population estimate being 1,951 individuals (95% CI=1,597-2,602; SCOS, 2024). Foraging ranges of up to 273 km from a haul-out site have been reported (Carter *et al.,* 2022). However, typically, harbour seals will forage within 50 km of their haul-out site and show high site fidelity. Harbour seals have been assessed as having an unfavourable-inadequate conservation status in the UK (JNCC, 2019h), with the ES and NC&O SMU both considered depleted and still declining (SCOS, 2024).

11.5.42 Harbour seals were not sighted during the site-specific DAS (Table 11.6), nor were they recorded during Green Volt OWF DAS (Green Volt, 2023). Both DAS did report several sightings of unidentified seals, some of which could have been harbour seals. There were four confirmed sightings of harbour seals during the Muir Mhòr OWF DAS (Muir Mhòr, 2023). Two sightings of harbour seals were reported in the 'South Grampian and SE Scotland' region in the Sea Watch Foundation database (Sea Watch Foundation, 2024).

### *Grey Seal*

11.5.43 Grey seals are present year-round on the east coast of Scotland and are the more abundant seal species in this region. Foraging ranges of up to 448 km from haul-out sites have been reported (Carter *et al.,* 2022). However, typically, foraging distances tend to be shorter, with McConnell *et al.* (1999) reporting that 88% of trips undertaken by grey seals were within 65 km of the haul-out site and Carter *et al.* (2022) reporting an average foraging distance of 100 km. Grey seals regularly haul-out to rest, breed, and moult. The breeding season for grey seals occurs between August and December, while the annual moult occurs between December and April (SCOS, 2022). The most recent August counts of grey seals at haul-outs within the ES SMU was 1,584 (with a scaled population of 6,298 individuals) in 2021 to 2023, and for the NC&O SMU the August count was 8,618 (with a scaled population of 34,266) in 2016 to 2019 (SCOS, 2024). In the ES SMU, this estimation is lower than the 2016-2019 annually averaged count of 3,683 (with a scaled population of 14,644 individuals), however NC&O SMU remains similar at 8,599 (with a scaled population of 34,191 individuals). The UK conservation status for grey seals has been assessed as favourable with an improving overall trend (JNCC, 2019i).

11.5.44 Grey seals were sighted seven times in the site-specific DAS, alongside seven unidentified seal species (Table 11.6). They were also sighted during Muir Mhòr OWF DAS (Muir Mhòr, 2023) and Green Volt OWF DAS (Green Volt, 2023). The Sea Watch Foundation database reported one sighting of a grey seal in the 'South Grampian and SE Scotland' region and seven sightings in the 'NE Scotland' region (Sea Watch Foundation, 2024).

### *Basking Shark*

11.5.45 Basking sharks have been recorded around the UK, primarily in the Sea of the Hebrides on the Scottish west coast (NatureScot, 2019; Witt *et al.,* 2016, 2019), and off Devon and Cornwall in south-west England (Fugro, 2021). In Scottish waters, peak numbers of basking shark sightings are during the summer months, between June and August (Drewery, 2012). This highly mobile species is distributed globally and considered endangered by the IUCN Red List (Rigby *et al.,* 2021). In 2023, a total of nine basking shark sightings (accounting for 14 individuals) were reported around the UK, however, none of which were in eastern Scotland with the closest sighting reported in Orkney (Shark Trust, 2024). There are currently no population estimates for basking sharks within UK or Scottish waters due to insufficient data (Drewery, 2012).

11.5.46 Nicholson *et al.* (2000) reported infrequent sightings of basking sharks on the north-east coast of Scotland. Sightings in this region have also been reported by The National Biodiversity Network Atlas (NBN Trust, 2024). NatureScot's open dataset does not hold records of basking sharks in the vicinity of the Proposed Development (NatureScot, 2024).

11.5.47 Modelled density estimates by Paxton *et al.* (2014) and Pikesley *et al.* (2024) estimated basking shark density on the east coast of Scotland to be much lower than on the west coast. Paxton *et al.* (2014) estimated the relative density for most of the east coast to be approximately between 0 and 0.1 animals/km$^2$ between 2000-2012. More recent estimates by Pikesley *et al.* (2024) using data collected between 2014 and 2020 estimates a density of 0.01 animals/km$^2$ for the majority of the east coast.

11.5.48 Despite basking sharks being present in low numbers in Scottish waters, sightings on the north-east coast of Scotland have been reported (Paxton *et al.* 2014; Pikesley *et al.* 2024). As a precautionary measure they have been included in the assessment.

### *Designated Sites*

11.5.49 The protected sites to be considered within this assessment are summarised in Table 11.7. All marine mammal and other megafauna Marine Protected Areas (MPAs) and SACs within the regional study area have been considered. There are no SACs or MPAs that overlap with the Proposed Development (Figure 11.3). The nearest designated SAC for cetaceans to the Proposed Development is the Moray Firth SAC, which is designated for bottlenose dolphins (Table 11.7) and is located 102.4 km (at the closest point) from the Proposed Development.

11.5.50 The closest domestic MPA for cetaceans to the Proposed Development is the Southern Trench Nature Conservation MPA (NCMPA), which is designated for minke whales (Table 11.7) and is located 6.4 km (at the closest point) from the Proposed Development.

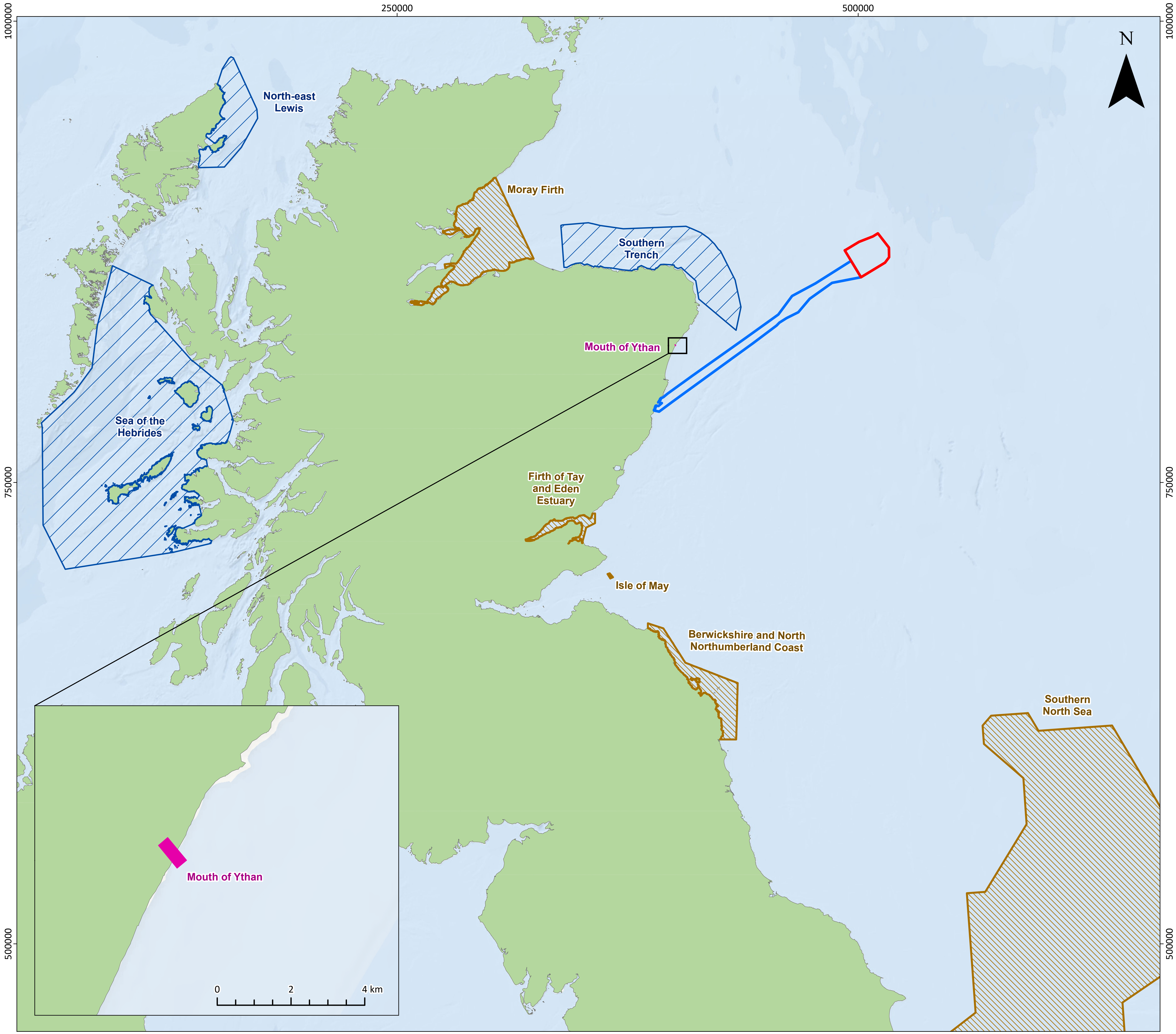
11.5.51 The closest SAC to the Proposed Development for grey seals is the Isle of May SAC (Figure 11.3), which is located 91.4 km (at the closest point) from the Proposed Development (Table 11.7). The closest SAC to the Proposed Development for harbour seals is the Firth of Tay and Eden Estuary SAC (Figure 11.3), which is located 64.3 km (at the closest point) from the Proposed Development (Table 11.7).

11.5.52 The closest designated seal haul out is Ythan River Mouth (Figure 11.3), located 18.5 km (at the closest point) from the Proposed Development (Table 11.7).

11.5.53 The closest domestic MPA for basking sharks to the Proposed Development is the Sea of the Hebrides MPA (Table 11.7, Figure 11.3) and is located 228.2 km (at the closest point) from the Proposed Development.

11.5.54 Potential impacts to designated sites within the UK site network, which includes SACs designated under various regulations transposing the Habitats Directive into domestic law, are assessed as part of the HRA. Therefore, impacts relating to marine mammal SACs are provided in the RIAA (Aspen Offshore Wind Farm, 2025) accompanying the Offshore EIAR.

11.5.55 NCMPAs are designated under The Marine (Scotland) Act 2010, '2010 Act' hereafter, and subsequent Orders. Under the 2010 Act, public authorities have general duties in relation to NCMPAs that need to be met when issuing authorisations (e.g. granting Section 36 Consent and Marine Licences). Particularly, the authority must not grant authorisation for an activity unless it can be demonstrated that there is no significant risk of the activity hindering the achievement of the conservation objectives for the NCMPA (see s83(4) of the 2010 Act). Considering this, the Offshore EIAR includes **Volume 3, Appendix 10.2 Marine Protected Area Assessment Report** which assesses the impacts on the Southern Trench NCMPA.




CERULEAN WINDS

**Aspen Offshore Wind Farm**
Environmental Impact Assessment

**Designated Sites**

**Legend**
- Aspen Array Area
- Offshore Transmission Cable Corridor
- SAC
- MPA
- Mouth of Ythan Seal Haul-out

**Notes**
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Contains Ordnance Survey data © Crown copyright and database rights (2024). OS OpenData.

Coordinate System:
WGS 1984 UTM Zone 30N

0 50 100 km
0 25 50 nm

| Scale | Date | Drawn by | Checked by | Approved by |
|---|---|---|---|---|
| 1:2,000,000@A3 | 06/05/2025 | EV | GB | SB |

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GoBe APEM Group

**Figure 11.3**

Figure Reference: ASPEN_MM_Fig11.3_DesignatedSites_v1

Table 11.7 Relevant Nature Conservation Sites Designated for the Protection of Marine Mammal Receptors

| Designated Site Name | Distances from the Aspen Array Area (km) | Distance from OTC Corridor (km) | Reason for Designation (Specifically Related to Marine Mammals) |
|---|---|---|---|
| Mouth of Ythan Designated Seal Haul-out | 105.2 | 18.5 | Grey seal and harbour seal |
| Southern Trench NCMPA | 61.6 | 6.4 | Minke whale |
| Moray Firth SAC | 168.9 | 102.4 | Bottlenose dolphin |
| Firth of Tay and Eden Estuary SAC | 192.9 | 64.3 | Harbour seal |
| Isle of May SAC | 210.6 | 91.4 | Grey seal |
| Berwickshire and North Northumberland Coast SAC | 218.5 | 114.9 | Grey seal |
| North-east Lewis MPA | 326.4 | 264.6 | Risso's dolphin |
| Sea of the Hebrides MPA | 344.3 | 228.2 | Minke whale and Basking sharks |
| Southern North Sea SAC | 248.0 | 239.3 | Harbour porpoise |

## Future Baseline Conditions

11.5.56 In line with the EIA Regulations, the Offshore EIAR requires "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge". This reflects how the baseline relevant to marine mammals is expected to evolve without the Proposed Development.

11.5.57 There is some inherent uncertainty associated with the baseline environment over the proposed 35-year operational lifetime of the Project. However, given the natural variability and limited long-term data sets for marine mammals and basking sharks, the current baseline characterisation is considered sufficient to assess potential operational impacts.

11.5.58 Broadly speaking, any future baseline will include consideration of new MPA designations and longer-term environmental changes including those driven by climate change.

11.5.59 Climate change is expected to affect marine mammal populations over time, although specific responses are not yet well understood (Evans and Bjørge, 2013). Likely pressures include alterations in prey availability, reductions in habitat suitability, increased mortality and disease susceptibility, and greater exposure to pollution (Boyd and Hanson, 2021; Martay *et al.,* 2023). For example, Townhill *et al.* (2024) suggests a decline in central North Sea harbour porpoise biomass linked to reduced sand eel availability (a key prey species) following reduced phytoplankton production rates.

11.5.60 Around the UK, evidence of range shift is increasing, with a shift north by some warmer water species (Martin *et al.,* 2023), trying to remain within preferred thermal habitats and/or in response to changes in prey abundance and distribution because of increasing sea temperatures (Simmonds and Elliott, 2008; MacLeod, 2009; Lambert *et al.,* 2011). Marine mammal species most likely to be affected in the future are those that have relatively narrow habitat requirements, including shelf species such as harbour porpoise and minke whale. If a northward range shift were to occur, these species may experience increased pressure because of reduced available habitat (Evans and Bjørge, 2013).

11.5.61 There is no clear evidence that climate change has directly affected grey seal to date, although it is likely to be a key driver of seal population declines in the future (Evans and Bjørge, 2013). Further Townhill *et al*. (2024) predicts declines in grey and harbour seal biomass on the western side of the North Sea (the UK coast) based on increased temperatures and declines in both salinity and primary production of phytoplankton. Resident grey seals at the Cornish Seal Sanctuary underwent an early moult in August 2023 (compared to December-April) suspectedly due to seasonal weather changes resulting from climate change (Cornish Seal Sanctuary, 2023). In addition, sea level rise and increase in storm frequency and associated wave surges could result in changes to physical habitats. This could affect the availability of seal haul-out sites and breeding locations in caves or low-lying coasts which may be modified or lost as a result, in turn this could lead to increased pup mortality (Gazo *et al.,* 2000; Lea *et al.,* 2009).

11.5.62 Changes in the population and distribution of basking sharks are likely to occur due to climate change, as a result of changes in environmental suitability and prey distribution. The key environmental factors thought to determine basking shark distribution are sea surface temperatures, salinity, sea surface chlorophyll concentrations, bathymetry and substrate properties (Townhill *et al.,* 2024; Cotton *et al.,* 2005; Sun *et al.,* 2024). These environmental factors have been used to predict the potential changes of suitable habitats for basking sharks (Townhill *et al*, 2024; Sun *et al.,* 2024). Projections of a number of future climate scenarios have revealed a trend of habitat contraction in lower latitudes, leading to the migration of basking sharks towards higher latitudes in search of more suitable conditions. This, in turn, may lead to an increase in habitat suitability in UK waters. Townhill *et al.* (2024) predicted a general increase of 15 to 30% in habitat suitability for basking sharks throughout their study area within the UK, with exception of the very southern region of North Sea. However, it is important to note that prey availability and interactions with other marine species were not considered within these distribution models. Changes in the distribution of key prey species, such as zooplankton, may also alter the basking shark distribution. In the northeast Atlantic, basking shark distribution was observed shifting northward in response to long-term zooplankton declines (Sims and Reid, 2002). However, Cotton *et al.* (2005) found that zooplankton density was only very weakly corrected to basking shark abundance, with sea surface temperature being the primary influence of the species distribution.

11.5.63 Species responses to climate change are complex and sensitivities are likely exacerbated by anthropogenic pressures such as construction, pollution, and fishing (Poloczanska *et al.,* 2016), which also influences the distribution and abundance of marine mammal populations. The future population trajectories of marine mammal and basking shark species are difficult to predict because monitoring at the appropriate temporal and spatial scales does not exist at present. It is also difficult to predict at what timescale any of these additional climate change influences will take place.

11.5.64 Furthermore, the impacts on marine mammals and basking sharks that may arise from climate change induced pressures will occur irrespective of the Proposed Development. Given the predicted scale of operational and decommissioning effects (as assessed against the current baseline), there is unlikely to be any significant change in the associated future impact significance (from minor or negligible) of climate change effects, arising from the Proposed Development.

## In Combination Climate Impacts

11.5.65 As outlined in paragraphs 11.5.53 to 11.5.60, climate change is anticipated to result in changes to the marine environment, including shifts in species distribution, prey availability, and habitat suitability. However, the direction, magnitude, and timescales of these changes remain uncertain, and many are expected to occur over periods longer than the operational lifetime of the Proposed Development.

11.5.66 Climate change may act as a background pressure that increases the sensitivity of some marine receptors to disturbance, displacement, or habitat modification. For example, projected reductions in suitable habitat or prey for species such as harbour porpoise and minke whale, or the potential loss of seal haul-out sites, could reduce ecological resilience. Similarly, changes in basking shark distribution may alter their presence in the development area over time.

11.5.67 However, based on current evidence and predicted timescales, there is no indication that climate change will amplify the potential effects of the Proposed Development to a level that would be considered significant in EIA terms. The conclusions of the technical assessments remain valid under future baseline conditions that include climate-related change.

11.5.68 Climate change is not predicted to introduce any new impact pathways or contribute to significant cumulative or in-combination effects when considered alongside the Proposed Development.

11.5.69 Therefore, while climate change is an important contextual factor in the long-term evolution of the marine environment, it is not considered to materially alter the assessment outcomes presented in this chapter. The proposed mitigation and monitoring measures remain appropriate.

### Data Limitations and Assumptions

11.5.70 The data assumptions and limitations in this section are typical of difficulties encountered with undertaking field surveys of marine mammals and other megafauna using aerial survey methods and are outlined in Table 11.8.

Table 11.8 Identified Data Limitations Associated With Data to Inform the Baseline

| Limitation | Description |
|---|---|
| Bias in data | DAS were carried out and provided estimates which were used to inform the underwater noise assessment. During these DAS, animals are only available for detection when they are at or just below the surface, resulting in availability bias (where an animal is underwater and therefore not available for detection). When considering population estimates calculated for species without data on time spent underwater, it should be noted that population estimates for these species are likely to be underestimated when availability bias is not corrected for.<br>Availability bias of harbour porpoise was corrected for by HiDef (2025). The resulting correction factor was then used to estimate the total number of animals that may be present within the site-specific study area.<br>In the absence of data for porpoises in the site-specific study area, to estimate absolute abundance, HiDef used published correction factors from a North Sea telemetry tagging study by Teilmann *et al.* (2013) (HiDef, 2025). Although, the tagging study of Teilmann *et al.* (2013) did not extend to the area of the North Sea surrounding this Project, no other data are available on surfacing behaviour for this species in the relevant area. For the analysis HiDef assume that diving behaviour in the survey area was comparable to that of the North Sea data collection area of Teilmann *et al.* (2013). Based on this, HiDef were able to derive the estimates of absolute density and abundance.<br>Availability bias is likely to be influenced by extrinsic factors that combine to produce a situation that is unique to each survey: factors such as light conditions, water clarity (turbidity), and animal behaviour can influence whether an animal will be detected on or near the surface. Therefore, species correction factors derived from one aerial survey are unlikely to be a true representation of availability bias for a different aerial survey in a different location, due to the potential spatial and temporal differences in environmental conditions.<br>Despite this limitation, the DAS data add to the baseline assessment, which provides an informative account of the marine mammals and other megafauna within the study areas. As such, the site-specific data has contributed to the detailed desktop review incorporating many other sources of data, and therefore this data limitation is not expected to constrain the ability to draw conclusions within this assessment. |
| Survey timings | The DAS data represents a snapshot over a short time period each month. Therefore, it was not possible to understand if changes in sighting rates were influenced by environmental conditions. Differences in sighting rates between months may be due to seasonal changes, but environmental conditions (such as weather) also have the potential to influence how and when animals use the area, and the detectability of animals present.<br>Despite this limitation, the DAS data add to the baseline assessment, which provides an informative account of the marine mammals and other megafauna within the study areas. As such, the site-specific data has contributed to the detailed desktop review incorporating many other sources of data, and therefore this data limitation is not expected to constrain the ability to draw conclusions within this assessment. |

| | |
|---|---|
| SCANS surveys and associated modelled surface densities | One of the key knowledge gaps relates to the diurnal and seasonal variability in cetacean presence. Most available data, including surveys such as SCANS-III and SCANS-IV are collected during daylight hours and are primarily limited to the summer months. As a result, changes in cetacean occurrence throughout the day and across different seasons remain largely undocumented at both regional and site-specific scales.<br>While the SCANS surveys provide valuable information on sightings, density and abundance at broad spatial scales, they lack fine-scale spatial and temporal resolution. Since these surveys are conducted periodically and only during the summer, relying solely on their data may lead to overestimations of average annual abundances for species with seasonal distribution patterns.<br>Furthermore, studies by Gilles *et al.* (2025) and Lacey *et al.* (2022) used data from SCANS-III and SCANS-IV to develop density surface models for cetaceans in European Atlantic Waters. Although these surveys yielded sufficient data to model distribution of certain key marine mammal, the temporal limitations of the data still constrain a comprehensive understanding of their year-round presence and behaviour. |

## 11.6 Marine Mammals and Other Megafauna Assessment Methodology

11.6.1 Assessment of effects in this Chapter will follow the general approach outlined in **Volume 1, Chapter 4: Environmental Impact Assessment Methodology** of the Offshore EIAR.

11.6.2 The specific assessment criteria and recognised guidance on relevant to assessing marine mammals and other megafauna are provided below.

### Guidance

11.6.3 In addition to the general approach and guidance outlined in **Volume 1, Chapter 4: Environmental Impact Assessment Methodology**, the marine mammals and other megafauna assessment also considers the guidance documents presented in paragraph 11.3.3.

### Criteria for Assessment

11.6.4 The process for determining the significance of effects is a two-stage process that involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors.

11.6.5 The terms used to define impact magnitude and receptor sensitivity for marine mammals and other megafauna are based on those described in further detail in **Volume 1, Chapter 4: Environmental Impact Assessment Methodology** of the Offshore EIAR.

11.6.6 Assessment of impacts on marine mammals and other megafauna will utilise both the site-specific DAS and public available data.

#### Magnitude

11.6.7 The magnitude criteria for marine mammals and other megafauna are provided in Table 11.9 and are based upon the technical expert's experience and judgement. In determining magnitude, each assessment considered the spatial extent, duration, frequency, and reversibility of impact and these are outlined within the magnitude section of each assessment of impact (e.g., a duration of hours or days would be considered for most receptors to be of short-term duration, which is likely to result in a low magnitude of impact).

Table 11.9 Impact Magnitude Criteria for Marine Mammal and Other Megafauna Receptors

| Magnitude | Definition |
|---|---|
| Negligible | A very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Recovery to baseline levels from that change predicted to be rapid (i.e. no more than circa six months) following cessation of the Proposed Development. |
| Low | A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature/population. Recovery to baseline levels from that change predicted to be achieved in the short term (i.e. no more than one year) following cessation of the Proposed Development. |
| Medium | A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long term, but which is not predicted to alter the long-term viability of the population and/or the integrity of the protected site. Recovery to baseline levels from that change predicted to be achieved in the medium term (i.e. no more than five years) following cessation of the Proposed Development. |
| High | A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short-to-long term and to alter the long-term viability of the population and/or the integrity of the protected site. Recovery to baseline levels from that change predicted to be achieved in the long term (i.e. more than five years) following cessation of the Proposed Development. |

### Sensitivity

11.6.8 The sensitivity criteria for marine mammals and other megafauna receptors are provided in Table 11.10.

11.6.9 The value of the receptor is not included in the definitions of criteria used to determine the sensitivity of marine mammals and other megafauna. All marine mammals are considered to have a very high value given that all are either listed under Annex II of the Habitats Directive as species of Community Interest and/or are listed under Annex IV of the Habitats Directive as EPS of Community Interest and in need of strict protection.

11.6.10 Basking shark is the only other megafauna receptor considered in this Chapter, and this species is afforded a high degree of legislative protection and is currently listed as a priority marine feature in Scotland and as endangered conservation status on the IUCN Red List (Rigby *et al.*, 2021). Therefore, they are also considered to have a very high value.

11.6.11 The sensitivity of marine mammals and basking sharks to potential impacts will be assessed using evidence of the responses of marine mammals and basking sharks to stimuli. Professional judgement will be applied to consider the information available on the responses of various marine mammal species and basking sharks to different stimuli (for example, underwater noise) and whether their ecology makes them vulnerable to potential impacts.

Table 11.10 Receptor Sensitivity Criteria for Marine Mammals and Other Megafauna Receptors

| Sensitivity | Description |
|---|---|
| Negligible | Adaptability: The receptor is able to avoid or adapt to an impact.<br>Tolerance: The receptor is able to tolerate the proposed form of change.<br>Recoverability: The effect on the receptor is anticipated to be temporary and the receptor will have the ability to fully recover from an impact. |
| Low | Adaptability: The receptor has reasonable ability to avoid or adapt to an impact.<br>Tolerance: The receptor has reasonable tolerance to accommodate the proposed form of change.<br>Recoverability: The effect on the receptor is anticipated to be medium to short-term and the receptor will have the ability to fully recover from an impact. |
| Medium | Adaptability: The receptor has limited ability to avoid or adapt to an impact.<br>Tolerance: The receptor has limited tolerance to accommodate the proposed form of change.<br>Recoverability: The effect on the receptor is anticipated to be long-term and the receptor will have limited ability to recover from an impact. |
| High | Adaptability: The receptor cannot avoid or adapt to an impact.<br>Tolerance: The receptor has no tolerance to accommodate the proposed form of change.<br>Recoverability: The effect on the receptor is anticipated to be permanent and the receptor will not have any ability to recover from an impact. |

## Significance

11.6.12 By assigning and combining magnitude and sensitivity criteria, overall effect significance upon marine mammals and other megafauna receptors can be determined (Table 11.11).

Table 11.11 Matrix Used for the Assessment of Significance of the Effect

| | | Magnitude of Impact | | | |
|---|---|---|---|---|---|
| | | Negligible | Low | Medium | High |
| Sensitivity of Receptor | Negligible | Negligible | Negligible | Negligible | Negligible |
| | Low | Negligible | Minor | Minor | Minor |
| | Medium | Negligible | Minor | Moderate | Moderate |
| | High | Minor | Minor | Moderate | Major |

11.6.13 A level of effect of moderate or more will be considered a 'significant' effect for the purpose of the EIA. A level of effect of minor or less will be considered 'not significant'.

## Assessment Methodology of Injury From Underwater Noise

11.6.14 It is widely documented that marine mammals are sensitive to underwater noise (Hildebrand, 2009; Nowacek *et al.,* 2007; OSPAR 2009; Richardson *et al.,* 1995; Southall *et al.,* 2019; 2021). Underwater noise has the potential to impact marine mammals if the frequency of the noise is within their hearing range. Marine mammal species have different hearing sensitivity thresholds resulting in different species detecting underwater noise at varying frequency bands (NMFS, 2018, Southall *et al.,* 2019).

11.6.15 To assess impacts of underwater noise, marine mammal species are separated into functional hearing groups (FHGs), which reflect the broad differences in hearing capabilities between taxa (e.g., Southall *et al.,* 2019) (Table 11.12). The classifications by Southall *et al.* (2019) have used the most recent data on marine mammal hearing. This is considered current best practice and supersedes previous works (i.e., Southall *et al.* (2007)).

Table 11.12 Marine Mammal Hearing Ranges as Described in Southall *et al.* (2019)

| Functional Hearing Group (FHG) | Species | Generalised Hearing Ranges | Estimated Region of Peak Sensitivity |
|---|---|---|---|
| Very high frequency cetaceans (VHF) | Harbour Porpoise | 275 hertz (Hz) – 160 kilohertz (kHz) | 12 kHz – 140 kHz |
| High frequency cetaceans (HF) | Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin | 150 Hz – 160 kHz | 8.8 kHz – 110 kHz |
| Low frequency cetaceans (LF) | Minke whale and humpback whale | 7 Hz – 35 kHz | 200 Hz – 19 kHz |
| Phocid carnivores in water (PCW) | Grey seal and harbour seal | 50 Hz – 86 kHz | 1.9 kHz – 30 kHz |

11.6.16 Impacts to marine mammals from underwater noise range from changes in behaviour and masking that affect communication and listening space, and/or locating prey (Basran *et al.,* 2020; Dunlop, 2016; Erbe *et al.,* 2016; Heiler *et al.,* 2016; Pine *et al.,* 2019; Pirotta *et al.,* 2012; Wisniewska *et al.,* 2018), displacement and disturbance (Brandt *et al.,* 2011; Culloch *et al.,* 2016; Graham *et al.,* 2019; Pirotta *et al.,* 2014; Stone *et al.,* 2017), or injury and mortality (Reichmuth *et al.,* 2019; Schaffeld *et al.,* 2019).

11.6.17 Auditory injury in marine mammals occurs at permanent threshold shift (PTS) onset, where the hearing sensitivity is reduced after noise exposure with no hearing recovery in the impacted frequencies (Tougaard, 2021). PTS can occur instantaneously (via impulsive noise sources such as pile-driving) or cumulatively (i.e. exposed to the sound source over an extended period). The level of injury depends on the duration, frequency and intensity of the sound source and received level. Whilst PTS is considered a permanent effect, the most likely response of an animal exposed to noise levels that could induce PTS is to flee the ensonified area. Therefore, animals exposed to these noise levels are likely to actively avoid hearing damage by moving away from the area.

11.6.18 Another auditory effect is described as temporary threshold shift (TTS) in hearing where an individual experiences a temporary increase in the threshold of hearing (i.e. the minimum intensity needed for a sound to be audible) at a specific frequency that returns to its pre-exposure baseline over time (Tougaard, 2021).

11.6.19 The current set of TTS-onset thresholds presented by Southall *et al.* (2019) define a TTS-onset as the exposure required to produce a 6 decibel (dB) shift in the hearing threshold. However, data upon which these thresholds are based for TTS-onset in marine mammals from impulsive or non-impulsive noise is extremely limited. It is therefore necessary to determine exposure functions for TTS in order to estimate the levels at which the onset of PTS could occur, as experiments inducing PTS in animals are considered unethical. Southall *et al.* (2007) predict an exposure of 40 dB of TTS would result in PTS onset in marine mammals. Southall *et al.* (2007) define TTS in marine mammals as 'the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject's normal hearing ability' for the purposes of developing these thresholds, and that it was 'typically the minimum amount of threshold shift that can be differentiated in most experimental conditions'. Thus, the adoption of this TTS-onset threshold would typically result in overestimates of potential impact ranges at which ecologically significant effects could occur in marine mammals. In addition, as TTS-onset is defined primarily as a means of predicting PTS-onset, there is currently no threshold for TTS-onset that would indicate a biologically significant amount of TTS in marine mammals.

11.6.20 Basking sharks lack a swim bladder and detect sound using inner ear end organs primarily (Casper *et al.,* 2012). Fish with no swim bladder are not as vulnerable to trauma from extreme sound pressure changes as fish with a swim bladder and primarily detect particle motion (Popper *et al.,* 2014).

11.6.21 Popper *et al.* (2014) grouped animals into different categories and proposed the adoption of different underwater noise thresholds depending on the source in order to analyse the effects of sound on them. Basking sharks are included in Group 1 "Fishes with no swim bladder or other gas chamber", which are considered the least sensitive. These species are less sensitive to barotrauma as they do not detect sound pressure but might experience barotrauma from exposure to it.

11.6.22 Auditory injury to marine mammals and basking sharks occurs when the sound levels are greater than the threshold for the species. The risk of injury is based on both the cumulative sound exposure level ($SEL_{cum}$) and instantaneous sound pressure level ($SPL_{peak}$). The $SEL_{cum}$ criterion predicts frequency-weighted received sound levels across a 24-hour period and is used to calculate the occurrence of 'cumulative' PTS. The $SPL_{peak}$ criterion uses unweighted sound levels, typically used to assess impulsive noise sources such as impact pile driving, and is used to calculate the occurrence of 'instantaneous' PTS.

The latest literature on noise exposure criteria for marine mammals (Southall *et al.* 2019) has been used within this assessment to determine where thresholds for auditory injury (in the form of PTS) are surpassed. With respect to auditory injury, marine mammals have a greater sensitivity to impulsive noise. Therefore, PTS-onset from impulsive noise is predicted to occur at lower weighted $SEL_{cum}$ than for non-impulsive noise (Southall *et al.,* 2019). These thresholds are presented in Table 11.13 and

11.6.23 Table 11.14.

Table 11.13 PTS-onset Thresholds for Marine Mammals Exposed to Impulse Noise as Described by Southall *et al.* (2019)

| FHG | Instantaneous PTS ($SPL_{peak}$ dB re 1µPa Unweighted) | Cumulative PTS ($SEL_{cum}$ dB re 1µPa$^2$s Weighted) | Instantaneous TTS ($SPL_{peak}$ dB re 1µPa Unweighted) | Cumulative TTS ($SEL_{cum}$ dB re 1µPa$^2$s Weighted) |
|---|---|---|---|---|
| VHF | 202 | 155 | 196 | 140 |
| HF | 230 | 185 | 224 | 170 |
| LF | 219 | 183 | 213 | 168 |
| PCW | 218 | 185 | 212 | 170 |

Table 11.14 PTS-onset Thresholds for Marine Mammals Exposed to Non-impulse Noise as Described by Southall *et al.* (2019)

| FHG | Cumulative PTS ($SEL_{cum}$ dB re 1µPa$^2$s Weighted) | Cumulative TTS ($SEL_{cum}$ dB re 1µPa$^2$s Weighted) |
|---|---|---|
| VHF | 173 | 153 |
| HF | 198 | 178 |
| LF | 199 | 179 |
| PCW | 201 | 181 |

11.6.24 When calculating the noise levels that individuals are likely to receive the following flee speeds have been used:

- 2.1 metres per second (m/s) for LF cetaceans (Scottish Natural Heritage, 2016)
- 1.52 m/s for HF cetaceans (Bailey and Thompson, 2006)
- 1.4 m/s for VHF cetaceans (Scottish Natural Heritage, 2016)
- 1.8 m/s for PCWs (Scottish Natural Heritage, 2016)

11.6.25 However, it is important to note that the swim speeds in this context are more typical swimming speeds rather than fleeing speeds. This is precautionary to account for the fact that marine mammals are unlikely to flee from the noise source in a straight line, as modelled. The calculated PTS-onset impact ranges therefore represent the minimum starting distances from the piling location for individuals to escape and prevent them from receiving a dose higher than the threshold.

11.6.26 Southall *et al.* (2019) proposes the $SPL_{peak}$ is either unweighted or flat weighted across the entire frequency band of a FHG. This is because the direct mechanical damage to the auditory system that is associated with high peak sound pressures is not frequency dependent (i.e. restricted to the audible frequency range of a species).

11.6.27 The physiological damage that sound energy can cause is mainly restricted to energy occurring in the frequency range of a species' hearing range. Therefore, for the $SEL_{cum}$, sound has been weighted based on the species hearing group specific weighting curves given in Southall *et al.* (2019).

11.6.28 For basking sharks underwater noise can result in mortality and potential mortal injury, recoverable injury, TTS and behavioural effects (Popper *et al.,* 2014). Further details on the criteria and swim speeds used for the different activities are included in **Volume 2, Chapter 10: Fish and Shellfish Ecology Chapter** and **Volume 3, Appendix 3.1: Underwater Noise Technical Report**.

### Injury From Pile Driving

11.6.29 Underwater noise from pile driving is classified as impulsive noise, having the ability to cause both instantaneous and cumulative PTS. However, it is important to note that this sound source loses its impulsive characteristics as a result of propagation effects and therefore, could be characterised as non-impulsive beyond a certain distance (Southall *et al.,* 2019).

11.6.30 Impulsive sound sources, such as pile driving, have high peak sound pressure, short duration, fast rise-time, and broad frequency content at source.

11.6.31 To quantify the impact of underwater noise on marine mammals with regards to PTS and TTS, the instantaneous and cumulative PTS and TTS-onset impact ranges (the area around the piling location within which the noise levels exceed the PTS or TTS-onset threshold for the relevant FHG) were determined using the thresholds described by Southall *et al.* (2019). Further information on the modelling approach and the methods used to calculate PTS and TTS-onset impact ranges is provided in **Volume 3, Appendix 3.1: Underwater Noise Technical Report**.

11.6.32 The number of individuals that may be affected by PTS relative to the reference population was quantified by multiplying the onset impact ranges by the density estimates for each species and calculating the proportion of the reference population.

### Injury From UXO Clearance

11.6.33 UXO clearance will be licensed under a separate Marine Licence but it has been included in this Offshore EIA chapter for illustrative purposes. A detailed UXO survey will be completed prior to construction to determine the maximum size of the UXO, number of UXOs to be cleared and clearance methods.

11.6.34 The noise levels generated from UXO clearance were predicted by Subacoustech Environmental Ltd. Full details of the underwater noise modelling and resulting impact ranges are detailed in **Volume 3, Appendix 3.1: Underwater Noise Technical Report**.

11.6.35 A selection of explosive sizes has been considered based on what might be present, and in each case, it has been assumed that the maximum explosive charge in each device is present and detonates with the clearance. The range of charge weights (TNT equivalent) for the potential UXO devices that have been modelled are 25, 55, 120, 240, 525, 698, 750 and 907 kg. In each case, an additional donor weight of 0.5 kg has been included to initiate detonation. Low-order deflagration has also been assessed, which assumes that the donor or shaped charge (charge weight of 0.25 kg) detonates fully to initiate a burnout of the explosive but without the follow-up detonation of the UXO. No mitigation has been considered within the modelling.

11.6.36 Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014). Unweighted UXO clearance source levels for each charge weight are presented in Table 11.15.

11.6.37 For basking sharks, Group 1 fish thresholds criteria for explosions from Popper *et al.* (2014) was used.

11.6.38 As previously mentioned, there is currently no threshold for TTS-onset that would indicate a biologically significant impact as a result of TTS. Therefore, it was not possible to carry out a quantitative assessment of the sensitivity, magnitude, or significance of the impact of TTS on marine mammals. Any impacts relating to the effects of TTS are considered to be captured in the quantitative assessment of disturbance.

Table 11.15 Unweighted $SPL_{peak}$ and $SEL_{ss}$ Source Levels Used for UXO Modelling

| Charge Weight (kg) | $SPL_{peak}$ Source Level (dB re 1µPa @1 m) | $SEL_{ss}$ Source Level (dB re 1µPa$^2$s @1 m) |
|---|---|---|
| Low order (0.25 kg) | 269.8 | 215.2 |
| 25 kg (+donor) | 284.9 | 228.0 |
| 55 kg (+donor) | 287.5 | 230.1 |
| 120 kg (+donor) | 290.0 | 232.3 |
| 240 kg (+donor) | 292.3 | 234.2 |
| 525 kg (+donor) | 294.8 | 236.4 |
| 698 kg (+donor) | 295.7 | 237.1 |
| 750 kg (+donor) | 296.0 | 237.3 |
| 907 kg (+donor) | 296.0 | 237.9 |

## Assessment Methodology of Disturbance From Underwater Noise

### Disturbance From Pile Driving

11.6.39 A species-specific dose-response approach was used for the assessment of disturbance of marine mammals to underwater noise from pile driving. This approach is based on current best practice methodology to provide evidence-based estimates rather than using the fixed behavioural threshold approach.

11.6.40 The latest guidance provided in Southall *et al.* (2019) states that: "Apparent patterns in response as a function of received noise level (Sound Pressure Level (SPL)) highlighted a number of potential errors in using all-or-nothing "thresholds" to predict whether individuals will respond. Tyack and Thomas (2019) subsequently and substantially expanded upon these observations. The clearly evident variability in response is likely attributable to a host of contextual factors, which emphasizes the importance of estimating not only a dose-response function but also characterizing response variability at any dosage".

11.6.41 The application of a dose-response curve allows for more realistic assumptions about individual response varying with dose, which is supported by a growing number of studies. A dose-response function is used to quantify the probability of a response from an individual to a certain stimulus or stressor, which will vary according to the dose received (Dunlop *et al.,* 2017). This assumes that not all individuals in an impact zone will respond, unlike traditional methods of threshold assessment. The dose can either be determined using the distance from the sound source or the received weighted or unweighted sound level at the receiver (Sinclair *et al.,* 2021).

11.6.42 For the purpose of this assessment, the dose is the received single-strike $SEL_{SS}$ which is considered to be best practice for this type of assessment (Southall *et al.,* 2021). $SEL_{SS}$ contours at 5 dB intervals generated by noise modelling have been overlain on species density surfaces to quantify the number of animals receiving each $SEL_{SS}$, and subsequently the number of animals likely to be disturbed based on the dose-response curve.

#### *Dose-Response Curve*

11.6.43 This assessment for cetaceans uses the harbour porpoise dose-response curve that was developed by Graham *et al.* (2017b) for harbour porpoise using data collected during the first six weeks of pile driving during Phase 1 of the Beatrice OWF.

11.6.44 Following the development of this dose-response curve, additional data from the remaining piling events were processed and it was found that the responses of harbour porpoises to piling noise diminishes over the construction period (Graham *et al.,* 2019) (Figure 11.4). Therefore, the use of the dose-response curve in this assessment can be considered conservative.

11.6.45 In the absence of species-specific data for dolphin species, minke whales or humpback whales, the harbour porpoise dose-response curve has been adopted for all cetacean species. However, the application of this method for other cetaceans is considered highly over-precautionary and should be interpreted with a large degree of caution.

11.6.46 This is because harbour porpoise are considered to be particularly sensitive to anthropogenic noise in comparison to other cetacean species. Studies have shown avoidance reactions from harbour porpoise to very low levels of noise (Tyack, 2009), as well as behavioural responses (avoidance and reduced vocalisations) to a variety of anthropogenic noise sources to distances up to multiple kilometres (Brandt *et al.,* 2013; Thompson *et al.,* 2013; Tougaard *et al.,* 2013; Brandt *et al.,* 2018; Sarnocinska *et al.,* 2019; Thompson *et al.,* 2020; Benhemma-Le Gall *et al.,* 2021). In comparison, multiple studies have shown that other cetacean species show less of a disturbance response, and consequently are considered less sensitive to anthropogenic noise than harbour porpoise (Kastelein *et al.,* 2006; Culloch *et al.,* 2016; Stone *et al.,* 2017; Fernandez-Betelu *et al.,* 2021).

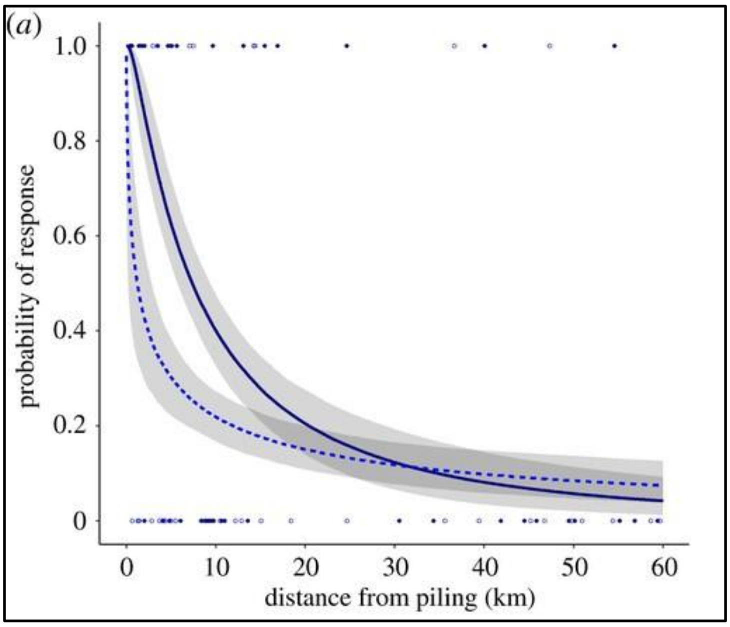



Figure 11.4 The Probability of Harbour Porpoise Response (24 h) in Relation to the Partial Contribution of Distance From Piling (solid navy line) and the Final Location Piled (dashed blue line) (Graham *et al.,* 2019).

11.6.47 The seal dose-response function is based on the data presented in Whyte *et al.* (2020) for harbour seals during piling activities at Lincs OWF. It provides an update to the dose-response function described in Russell *et al.* (2016) and Russell and Hastie (2017).

11.6.48 The seal dose-response function developed by Whyte *et al.* (2020) assumes that all seals are displaced when $SEL_{cum}$ exceeds 180 dB re 1 $\mu Pa^2s$. This assumption is precautionary as no data was presented for harbour seals at this noise level. It is also important to note that the percentage decrease in response in the 170 ≤ 175 and 175 ≤ 180 dB re 1 $\mu Pa^2s$ categories is slightly anomalous (a higher response is observed at a lower sound exposure level (SEL)) due to the small number of spatial cells included in the analysis for these categories (n = 2 and 3 respectively). Given the large confidence intervals (CI) on the data, this assessment presents the mean number of seals predicted to be disturbed alongside the 95% CI.

11.6.49 While the seal dose-response function is based on data for harbour seals, it can be applied to both harbour and greys seals, as both species belong to the same FHG. However, grey seals are considered to be less sensitive to behavioural disturbance from anthropogenic noise (Booth *et al.,* 2019), and vast individual variation has been observed in this species in response to pile driving, with some individuals showing no evidence of a behavioural response (Aarts *et al.,* 2018). Therefore, the seal dose-response function is considered to be highly precautionary for grey seals and is likely an over-estimate of the potential impact.

### *Level B Harassment Thresholds*

11.6.50 As a result of the limitations described when applying the harbour porpoise dose-response curve to other cetaceans, an alternative method for assessing disturbance to dolphin species, minke whales and humpback whales has also been applied in this assessment.

11.6.51 The number of animals predicted to experience behavioural disturbance using the United States (US) National Marine Fisheries Service (NMFS) Level B harassment threshold for strong disturbance (NMFS, 2024) are presented alongside the dose-response assessment methodology to provide context on the potential extent of disturbance.

11.6.52 The threshold predicts that Level B harassment will occur when an animal is exposed to received levels above 160 dB re 1µPa (rms) for non-explosive impulsive (e.g., impact pile driving and seismic airguns) or intermittent (e.g. scientific, non-tactical sonar) sound sources (Guan and Brookens, 2021, NMFS, 2024). The Level B harassment threshold originates from a study by Malme *et al.* (1984) on a grey whale mother and calf pair responses to playback signals. Avoidance responses were exhibited by the pair when they were exposed to air gun playback signals above 160 dB re 1µPa rms. Beyond the 160 dB re 1 µPa (rms) threshold, the behavioural responses are likely to become less severe, for example, minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al.,* 2007). However, it is important to note that marine mammal responses to disturbance will, depend on the individual and the context. For example, previous experience and acclimatisation will affect whether an individual exhibits an aversive response to noise, particularly in a historically noisy area.

## Population Modelling

11.6.53 Population modelling was completed using the interim Population Consequences of Disturbance (iPCoD) framework for the Proposed Development to assess whether disturbance resulting from pile driving is predicted to result in population level impacts to five marine mammal species that were identified in the baseline as key receptors. The species assessed are harbour porpoise, bottlenose dolphin, minke whale, grey seal, and harbour seal, noting that iPCoD is not available for Risso's dolphin, white-beaked dolphin and Atlantic white-sided dolphin. The assessment was based on the maximum number of animals predicted to be disturbed per piling day.

11.6.54 iPCoD uses a stage structured model of population dynamics with nine age classes and one stage class (adults 10 years and older). The model is used to run a number of 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.

11.6.55 Further details are presented in **Volume 3, Appendix 11.2: iPCoD Modelling Report.**

## Disturbance From UXO Clearance

11.6.56 Unlike pile driving, there are no dose-response functions available that describe the magnitude and short-term nature of the behavioural impact on marine mammals from UXO clearance.

11.6.57 Explosive sound sources, like piling, are categorised as 'impulsive', however the number of pulses and overall duration of noise emission which drive the behavioural response are significantly different. Behavioural responses to a single UXO detonation are expected to be a one-off startle response or aversive behaviour; while during pile driving the series of pulses that are emitted are expected to continuously drive animals out the impacted area, enabling a dose-response to be quantified. Therefore, the empirically-derived dose-response curves used for assessment of behavioural disturbance for pile driving are not applicable to the assessment of UXO clearance.

11.6.58 Given that there are no appropriate dose-response functions available for behavioural disturbance from UXO detonation, other disturbance thresholds have been considered and are summarised in the sections below.

11.6.59 It should be noted that the understanding of the effect of behavioural disturbance from UXO detonation is very limited, and therefore the assessment provides an indication of the number of animals potentially at risk of disturbance given the limited evidence available.

### *Effective Deterrence Ranges (EDR)*

#### High Order Clearance

11.6.60 There is guidance for assessing the significance of noise disturbance against the Conservation Objectives of harbour porpoise SAC in England, Wales & Northern Ireland (JNCC, 2020), which advises the use of a 26 km EDR around the source location to determine the impact from a high order UXO detonation.

11.6.61 The recommended 26 km EDR is presented in a paper by Tougaard *et al.* (2013) where the EDR was calculated using data from Dähne *et al.* (2013). This study was conducted at the first OWF in German waters where the piles of 12 jacket foundations with 2.4 to 2.6 m diameter were installed up to a penetration depth of 30 m using a hydraulic hammer with up to 500 kJ hammer energy (Dähne *et al.,* 2013).

11.6.62 While the guidance acknowledges that there is no empirical evidence of harbour porpoise avoidance from UXO clearance (i.e. this guidance is based on pile driving), the guidance also states that the 26 km EDR is also to be used for the high order detonation of UXOs (JNCC, 2020), therefore it has been used in this assessment.

11.6.63 The 26 km EDR assumes that all animals are disturbed within this radius (2,123.72 km$^2$) and has been applied to all marine mammal species for high order detonations given that agreed metrics of disturbance for other marine mammal species are not available and there is a lack of empirical data on the likelihood of response to explosives.

11.6.64 However, it is important to note that the behavioural disturbance from a single UXO detonation would probably only cause a startle response and would not result in the same widespread and prolonged displacement that pile driving does (JNCC, 2020). Furthermore, there is no direct evidence to support the assumption that all marine mammal species will respond in the same way to a high order UXO clearance as harbour porpoise do to pile driving of jacket foundations (Dähne *et al.,* 2013).

**Low Order Clearance**

11.6.65 There is currently no formal guidance for disturbance from low order detonations, however a 5 km EDR has been frequently assumed for low order detonations and has therefore been adopted within this assessment (JNCC, 2023b). This EDR is based on data obtained during low order detonations using deflagration which measured the underwater noise produced at over 20 dB lower than high order detonation (Robinson *et al.,* 2020; Cheong *et al.,* 2020). As such, it is anticipated that there will be a corresponding reduction in the area over which sound may result in disturbance to marine mammals. Although the potential impacts in relation to disturbance relating to low order UXO clearance are yet to be verified empirically, an EDR of 5 km should be considered as precautionary.

### *TTS as a Proxy for Disturbance*

11.6.66 Southall *et al*. (2007) states that in the absence of empirical data on behavioural responses, the use of TTS-onset threshold may be appropriate for single pulses (like UXO detonation) until better measures are identified. In addition, strong behavioural responses to single pulses are expected to dissipate rapidly enough and have limited long-term consequences and lesser exposure are not expected to cause significant disturbance.

11.6.67 Considering the above, recent assessments of UXO clearance activities (such as Salamander, Caledonia and Muir Mhor) have used the TTS-onset threshold for the different functional hearing groups stated by Southall *et al*. 2019 to indicate the level at which a "fleeing" response might be expected to occur in marine mammals.

## Embedded Commitments

11.6.68 As part of the Project design process, several designed-in measures have been proposed to reduce the potential for impacts on environmental receptors. As there is a commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development and have therefore been considered in the assessment (i.e., the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development. The embedded commitments relevant to marine mammals and other megafauna are presented in Table 11.16. **Volume 3, Appendix 4.2: Commitments Register**, provides additional information on how these commitments are secured.

11.6.69 In accordance with the Institute of Environmental Management and Assessment Guide to Delivering Quality Development (IEMA 2016), embedded commitments are described using the following classifications:

- Primary mitigation – embedded commitments built into the design of the Proposed Development which reduce or avoid the likelihood or magnitude of an adverse environmental effect, including location or design (also referred to Embedded Mitigation);
- Secondary mitigation – additional measures implemented to further reduce environmental effects to 'not significant' levels (where appropriate) and do not form part of the fundamental design of the Proposed Development; and
- Tertiary mitigation – commitments that are required through standard practice or to meet legislative requirements and are independent of any EIA assessment.

11.6.70 The embedded commitments collectively aim to mitigate the impact of offshore infrastructure on marine mammals and other megafauna.

Table 11.16 Embedded Commitment Measures of Relevance to Marine Mammals and Other Megafauna

| Code | Embedded Commitment | Commitment Type | How Commitment is Secured |
|---|---|---|---|
| C-OFF-04 | Development of, and adherence to a Cable Plan (CaP). The CaP will confirm planned cable routing, burial and any additional protection and will set out methods for post-installation cable monitoring as secured by Section 36 and Marine Licence consent conditions. The CaP is likely to be supported by a Cable Burial Risk Assessment (CBRA), which will outline how external cable protection shall be used and/or minimised, should cable burial be achieved. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Cable Plan. |
| C-OFF-07 | A Construction Method Statement (CMS) will be developed, which details the proposed construction methods and roles and responsibilities of parties involved. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Construction Method Statement. |
| C-OFF-08 | Development of and adherence to a Construction Programme (CoP) to confirm the timeline for construction. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Construction Programme. |
| C-OFF-10 | Development of and adherence to a Outline Environmental Management Plan (EMP). This will set out mitigation measures and procedures relevant to environmental management, including but not limited to chemical usage, invasive and non-native species, pollution prevention and waste management. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Project Environmental Management Plan. |
| C-OFF-11 | Development of and adherence to a Decommissioning Programme (DP). The DP will outline measures for the decommissioning of the Proposed Development. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details provided in the Decommissioning Programme. |

| Code | Embedded Commitment | Commitment Type | How Commitment is Secured |
| --- | --- | --- | --- |
| C-OFF-12 | Development of and adherence to a Vessel Management Plan (VMP). The VMP will confirm the types and numbers of vessels that will be engaged on the Proposed Development and consider vessel coordination including indicative transit route planning. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Vessel Management Plan. |
| C-OFF-18 | Development of and adherence to a Piling Strategy (PS) (applicable where piling is undertaken). The PS will detail the method of pile installation and associated noise levels. It will describe any mitigation measures to be put in place (e.g., soft starts and ramp ups, use of ADDs) during piling to manage the effects of underwater noise on sensitive receptors. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Piling Strategy. |
| C-OFF-19 | Development of and adherence to Marine Mammal Mitigation Plan (MMMP). This will identify appropriate mitigation measures during offshore activities that are likely to produce underwater noise and vibration levels capable of potentially causing injury or disturbance to marine mammals. This will be developed alongside the PS and referred to in EPS licence applications. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details provided in the Marine Mammal Mitigation Plan. |
| C-OFF-22 | Development of and adherence to an Operation and Maintenance Programme (OMP) to safeguard environmental interests during O&M. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Operation and Maintenance Programme. |
| C-OFF-41 | Unexploded ordnance (UXO) hazards will be avoided where practicable and appropriate. If avoidance is not possible, decision making will relate to removal, with detonation considered if avoidance or removal is not possible. If detonation is required, and where practicable and appropriate, low-order deflagration will be the preferred method. Licensing of UXO clearance works will be subject to a standalone Marine Licence (and EPS licence) application. These applications will provide details of measures to minimising impacts on marine mammals where appropriate. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details provided in the MMMP and further details to be provided in the UXO marine licence application. |
| C-OFF-45 | Adherence by vessels to guidelines laid out in the Scottish Marine Wildlife Watching Code. | Tertiary | Secured through Section 36 and/or Marine Licence |

| Code | Embedded Commitment | Commitment Type | How Commitment is Secured |
|---|---|---|---|
| | | | conditions. Details to be provided in the Vessel Management Plan. |
| C-OFF-47 | Development of and adherence to an Entanglement Management Plan (EMP) to reduce the potential entanglement risk to marine life. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Entanglement Management Plan. |
| C-OFF-52 | Development of and adherence to a Marine Pollution Contingency Plan (MPCP). The MPCP will identify potential sources of pollution and associated spill response and reporting procedures. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details provided in the Marine Pollution Contingency Plan. |
| C-OFF-53 | Appointment of a Marine Mammal Observer (MMOb) as a form of mitigation where required, to maintain a record of any sightings of marine mammals and other megafauna, and maintain a record of the action taken to minimize injury caused to marine mammals and other megafauna during noisy activities. | Tertiary | MMOb |
| C-OFF-54 | Adherence by vessels to guidelines laid out in the Basking Shark Code of Conduct. | Tertiary | Secured through Section 36 and/or Marine Licence conditions. Details to be provided in the Vessel Management Plan. |

## Impacts Scoped Out of the Assessment

11.6.71 The impacts that have been scoped out of this marine mammals and other megafauna assessment are presented in Table 11.17.

11.6.72 The decision to scope out these impacts has been informed by the understanding of worst-case design scenarios, environmental baseline conditions and consultation with relevant stakeholders as per the Offshore Scoping Opinion as detailed in Table 11.3.

Table 11.17 Impacts Scoped out of the Marine Mammals and Other Megafauna Assessment

| Impact Scoped Out | Justification |
|---|---|
| Construction | |
| Changes in water quality from activities in the Proposed Development | Activities relating to the development may influence water quality as a result of sediment disturbance, for example. These impacts are expected to be localised and short-lived. |
| Changes in water quality from accidental pollution | The PEMP and MPCP ensure that if such an event were to occur, it would not have an impact at the population level. It is also anticipated that such events and its impact would be localised and short-lived. |
| O&M | |
| Electromagnetic field (EMF) impacts on marine mammals | EMFs are emitted along the lengths of subsea cables and can have behavioural and psychological effects on some species. Existing evidence suggests that the levels of EMFs emitted by offshore renewable energy export cables are at a level low enough that there is no potential for direct significant impacts on marine mammals (Copping and Hemery, 2020). EMF effects on potential prey species will be considered in the Benthic and Intertidal Ecology and Fish and Shellfish Ecology chapters of the EIA, and through the assessment of indirect impacts on marine mammal prey species. |
| Changes in water quality from activities in the Proposed Development | Activities relating to the development may influence water quality as a result of sediment disturbance, for example. These impacts are expected to be localised and short-lived. |
| Changes in water quality from accidental pollution | The PEMP and MPCP ensure that if such an event were to occur, it would not have an impact at population level. It is also anticipated that such events and its impact would be localised and short-lived. |
| Decommissioning | |
| Changes in water quality from activities in the Proposed Development | Activities relating to the development may influence water quality as a result of sediment |

| Impact Scoped Out | Justification |
|---|---|
| | disturbance, for example. These impacts are expected to be localised and short-lived. |
| Changes in water quality from accidental pollution | The PEMP and MPCP ensure that if such an event were to occur, it would not have an impact at population level. It is also anticipated that such events and its impact would be localised and short-lived. |

## Worst-case Design Scenario

11.6.73 The Applicant has adopted a Design Envelope approach to impact assessment (also known as a 'Rochdale Envelope'). In line with guidance from the Scottish Government (2022), the Design Envelope approach offers flexibility in the EIA process by enabling impact assessment to be carried out against several potential design options.

11.6.74 The assessment of marine mammals and other megafauna impacts has been undertaken with respect to the details provided in **Volume 1, Chapter 3: Project Description**. A worst-case design scenario has been selected for each impact which would lead to the greatest impact for all receptors or receptor groups, when selected from a range of values. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within **Volume 1, Chapter 3: Project Description** (e.g., different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

11.6.75 Table 11.18 presents the worst-case design scenario for each impact associated with LSE assessment on marine mammals and other megafauna, along with justification.

Table 11.18 Worst-case Design Scenarios With Respect to the Marine Mammals and Other Megafauna Assessment

| Impact | Embedded Commitment | Worst-case Design Scenario | Justification |
|---|---|---|---|
| Construction | | | |
| **Impact 1**: Injury and Disturbance From Underwater Noise From Piling | C-OFF-07, C-OFF-08, C-OFF-18, C-OFF-19, C-OFF-53 | WTGs<br>▪ 72 WTGs with 6 anchors per WTG;<br>▪ Maximum of 324 anchors;<br>▪ Maximum hammer energy of 2,400 kJ;<br>▪ Maximum 3.33 hours piling per anchor;<br>▪ Maximum of 3 anchors installed per day;<br>▪ Maximum anchor pile diameter of 4.5 m;<br>▪ Maximum number of piles installed in 24hrs: 4;<br>▪ Maximum number of piling days: 112 (assuming three piled anchors per day); and<br>▪ Soft start 20 mins at 15% hammer energy with a blow rate of 10 blows/min.<br><br>OSPs<br>▪ Maximum of three fixed jacket platforms;<br>▪ Maximum 2 pin piles per leg;<br>▪ Maximum pile diameter of 3 m;<br>▪ Maximum hammer energy of 3,500 kJ, maximum 3.33 hours per pin pile;<br>▪ Maximum number of piles installed in 24hrs: 4; and<br>▪ Soft start 20 mins at 15% hammer energy with a blow rate of 10 blows/min.<br><br>Total duration of piling = 112 days (WTGs) + 12 days (OSPs) = 124 days<br>Anchor piling: 2028 -2030<br>OSP piling: 2029 and 2030 | The scenario with the maximum number of piling days represents the temporal worst-case.<br><br>The scenario with the maximum predicted impact range for underwater noise represents the spatial worst-case. |
| **Impact 2**: Injury and Disturbance From Underwater Noise From UXO Clearance | C-OFF-07, C-OFF-08, C-OFF-41, C-OFF-53 | The type, size and number of possible UXO that might require clearance is currently unknown. The primary method will be low-order deflagration, with high-order being assessed as the worst-case scenario.<br><br>An illustrative assessment is presented using charge weights (TNT equivalent) ranging from 25 to 907 kg, with an additional donor weight of 0.5 kg, for high order detonation. A charge weight of 0.25 kg is used to provide an illustrative assessment of a low order (deflagration) detonation. | Any UXO clearance will be licensed under a separate Marine Licence but is included in the Offshore EIAR for illustrative purposes.<br><br>A detailed UXO survey will be completed prior to construction to determine the maximum size and number of UXOs to be cleared and clearance method. The maximum number of UXO requiring detonation and maximum charge results in the greatest noise impacts and the worst-case scenario. |
| **Impact 3**: Injury and Disturbance From Underwater Noise From Geophysical Surveys | C-OFF-07, C-OFF-08, C-OFF-19, C-OFF-53 | The exact equipment to be deployed during geophysical surveys are yet to be determined, therefore examples of different equipment and expected source levels have been used in this assessment. This might include:<br>▪ Multibeam Echo Sounder (MBES);<br>▪ Sidescan Sonar (SSS);<br>▪ Ultra-short Baseline (USBL);<br>▪ Sub-bottom Profiling (SBP); and<br>▪ Ultra-High Resolution Seismic (UHRS) sparkers. | The type of geophysical surveys and duration represents the maximum potential for underwater noise from geophysical surveys. |
| **Impact 4**: Injury and Disturbance From Underwater Noise From Other Construction Activities | C-OFF-07, C-OFF-08, C-OFF-19, C-OFF-53 | Other construction activities considered include:<br>▪ Cable laying;<br>▪ Dredging (backhoe and suction);<br>▪ Trenching;<br>▪ Suction anchor installation;<br>▪ and | The type of construction activities and duration of construction represents the maximum potential for underwater noise from other construction activities. |

| Impact | Embedded Commitment | Worst-case Design Scenario | Justification |
|---|---|---|---|
| | | ▪ Rock placement<br><br>Construction scheduled to take place over four years. | |
| **Impact 5**: Vessel Disturbance | C-OFF-07, C-OFF-08, C-OFF-12, C-OFF-45, C-OFF-54 | Vessel type; maximum number of vessels on site at one time; and maximum total return trips:<br>▪ Pre-construction Survey – 3 vessels – 9 return trips;<br>▪ Construction Support & Site Preparation (Light construction Vessel, Crew Change Vessel, Guard Vessel) – 3 vessels – 8 return trips;<br>▪ UXO Clearance Vessel – 1 vessel – 1 return trip<br>▪ Anchor and Mooring Installation (Anchor Handling Construction Vessel, Construction Support Vessel, Anchor Handling Tug) – 6 vessels – 216 return trips;<br>▪ WTG Integration (at port) (Anchor Handling Tugs, Anchor Handling Construction Vessel, Installation Support Vessel, Service Operation Vessel, Guard Vessel, Jack Up Vessel) – 7 vessels – 360 return trips;<br>▪ Tow out and Hook up of WTGs and floating foundations (Anchor Handling Tugs, Anchor Handling Construction Vessel, Installation Support Vessel, Service Operation Vessel, Guard Vessel) – 7 vessels – 360 return trips;<br>▪ OEP Installation (Heavy Lift Vessel, Jack Up Vessel, Anchor Handling Tugs, Heavy Transport Vessel, Service Operation Vessel, Guard Vessel) – 7 vessels – 72 return trips;<br>▪ IAC Installation (Construction Support Vessel, Cable Lay Vessel, Installation Support Vessel, Service Operation Vessel) – 9 vessels – 120 return trips;<br>▪ Interconnector or Offshore Export Cable Installation (Light Construction Vessel, Construction Support Vessel, Cable Lay Vessel, Flexible Fall Pipe Vessel, Guard Vessel) – 5 vessels – 20 return trips;<br>▪ Rock Placement (Array) (Rockdump Vessel) – 1 vessel – 3 return trips; and<br>▪ Cable protection and miscellaneous (commissioning, energisation, Balance of Plant) (Flexible Fall Pipe Vessel, Installation Support Vessel, Service Operation Vessel, Trenching Support Vessel, Light Construction Vessel, Construction Support Vessel) – 3 vessels – 65 return trips<br><br>Maximum number of vessels expected to be on site at one time during the construction phase: 52<br>Realistic number of vessels expected to be on site at one time: 8 - 10<br>Maximum number of return trips over the construction phase (scheduled to be four years): 1,234. | The maximum number of vessels and associated vessel movements represents the maximum potential for disturbance and collision risk. |
| **Impact 6**: Vessel Collision Risk | C-OFF-07, C-OFF-08, C-OFF-12, C-OFF-45, C-OFF-54 | | |
| **Impact 7**: Changes to Prey | C-OFF-07, C-OFF-10, C-OFF-18, C-OFF-19, C-OFF-41, C-OFF-47 | The impacts of changes of prey resources will be dependent on the result of the assessment presented in **Volume 2, Chapter 10: Fish and Shellfish Ecology**. | |
| O&M | | | |
| **Impact 8**: Vessel Disturbance | C-OFF-12, C-OFF-22, C-OFF-45, C-OFF-54 | Maximum number of vessels expected to be on site at one time: 11<br>Realistic number of vessels expected to be on site at one time: 5<br>Maximum number of 219 vessel round trips per year comprised of crew transfer vessels, jack-up vessels, cable repair vessels and other vessels, from local ports or transiting from a previously operational location.<br>Operational phase up to 35 years. | The maximum number of vessels and associated vessel movements represents the maximum potential for disturbance and collision risk. |
| **Impact 9**: Vessel Collision Risk | C-OFF-12, C-OFF-22, C-OFF-45, C-OFF-54 | | |
| **Impact 10**: Changes to Prey | C-OFF-22, C-OFF-10, C-OFF-47 | The impacts of changes of prey resources will be dependent on the result of the assessment presented in **Volume 2, Chapter 10: Fish and Shellfish Ecology**. | |

| Impact | Embedded Commitment | Worst-case Design Scenario | Justification |
|---|---|---|---|
| **Impact 11**: Entanglement Risk With Mooring Lines and Cables | C-OFF-22, C-OFF-47 | Total cross section in water column: 5429 metre squared ($m^2$)<br><br><u>Mooring Parameters</u><br>Maximum of two anchors per mooring lines, maximum of 6 anchors per WTG, maximum of 6 mooring lines per WTG. Maximum of 432 mooring lines in total.<br>Maximum mooring line radius: 1,100 m (Taut), 1,200 m (Semi Taut) and 1,200 m (Catenary)<br>Maximum mooring line length: 1,050 m (Taut), 1,150 m (Semi Taut) and 1,200 m (Catenary)<br>Mooring line material is synthetic and chain, and buoyancy elements (for taut or semi-taut)/chain and clump weights (for catenary).<br><u>Inter-Array Cables</u><br>▪ Maximum of 72 inter-array cables at the site;<br>▪ Maximum total length of inter-array cables in 300 km;<br>▪ Cable outer diameter of up to 220 mm;<br>▪ Total area of seabed coverage is 66,000 $m^2$;<br>▪ Length of cable floating for each WTG is 500 m; and<br>▪ Depth of cable floating in water column is at least 20 m.<br><br>The operational lifetime of the Project is 35 years. | The design, dimensions and maximum spatial extent of the mooring lines and inter-array cables represents the maximum potential for entanglement. |
| **Impact 12**: Noise Related Impacts Associated With Floating Foundations | C-OFF-19, C-OFF-22 | Maximum of 72 turbines, with a maximum rotor size of 280 m.<br>A maximum of 6 mooring lines per WTG for all mooring design options.<br>Mooring line material is synthetic and chain, and buoyancy elements (for taut or semi-taut)/chain and clump weights (for catenary).<br>The operational lifetime of the Project is 35 years. | The design, number and capacity of the WTGs which lead to the maximum underwater noise represent the worst-case scenario for noise related impacts. |
| **Impact 13**: Collision Risk With Floating Foundation<br>**Impact 14**: Habitat Loss/Change<br>**Impact 15**: Physical Barrier Effects | C-OFF-22<br>C-OFF-22<br>C-OFF-22 | Maximum of 72 steel semi-submersible WTGs and 3 OSPs<br>Maximum floater dimensions per WTG: 125 m x 110 m x 40 m, with three 16 m diameter vertical tubes<br>Minimum distance of 1.6 km between WTGs (this includes the minimum downwind and crosswind spacing)<br>Total Aspen Array Area: 333 $km^2$<br>Maximum mooring line radius: 1,100 m (Taut), 1,200 m (Semi Taut) and 1,200 m (Catenary)<br>Maximum mooring line length: 1,050 m (Taut), 1,150 m (Semi Taut) and 1,200 m (Catenary)<br>Total maximum lateral cross-section of the mooring system in the water column: 54.28 $m^2$<br>Total length of inter-array cables in the water column: 36,000 m<br><br>The operational lifetime of the Project is 35 years. | The spatial footprint of the wind farm, number of WTG and OSPs and total length of cables and mooring lines in the water column represents the maximum potential for collision risk, habitat loss/change and barrier effects. |
| **Impact 16**: EMF Impacts on Other Megafauna | C-OFF-04; C-OFF-22 | <u>Inter-Array Cables</u><br>▪ Maximum of 72 inter-array cables at the site;<br>▪ Maximum total length of inter-array cables is 300 km;<br>▪ Cable outer diameter of up to 220 mm;<br>▪ Total area of seabed coverage is 66,000 $m^2$;<br>▪ Length of cable floating for each WTG is 500 m; and<br>▪ Depth of cable floating in water column is at least 20 m<br>▪ Maximum carrying capacity of up to 72.5 KV<br><br><u>OTC Corridor</u> | The design, number and maximum spatial extent of the inter-array cables and OTC Corridor represent the worst-case scenario for EMF impacts. |

| Impact | Embedded Commitment | Worst-case Design Scenario | Justification |
|---|---|---|---|
| | | ▪ Maximum of 4 infill/export cables;<br>▪ Maximum total length of cables is 620 km;<br>▪ Cable outer diameter of up to 350 mm;<br>▪ Total area of seabed coverage is 1,740,000 $m^2$; and<br>▪ Maximum burial depth: 2 m<br>▪ Maximum carrying capacity of up to 220- 275 kV | |
| Decommissioning | | | |
| **Impact 17**: Vessel Disturbance | C-OFF-11, C-OFF-12, C-OFF-45, C-OFF-54 | The worst-case design scenario will be equal to (or less than) that of the construction phase. Please refer to Impacts 5 and 6. | The maximum number of vessels and associated vessel movements represents the maximum potential for disturbance and collision risk. |
| **Impact 18**: Vessel Collision Risk | C-OFF-11, C-OFF-12, C-OFF-45, C-OFF-54 | | |
| **Impact 19**: Changes to Prey | C-OFF-11 | The impacts of changes of prey resources will be dependent on the result of the assessment presented in **Volume 2, Chapter 10: Fish and Shellfish Ecology**. | |

## 11.7 Assessment of Likely Significant Effects

11.7.1 Assessment of LSE on marine mammals and other megafauna has been undertaken for all phases of the Proposed Development. A detailed description of each impact, informed by **Volume 1, Chapter 3: Project Description**, baseline information and various analytical methods including modelling is provided below.

### Construction Phase

#### Impact 1: Injury and Disturbance From Underwater Noise From Piling

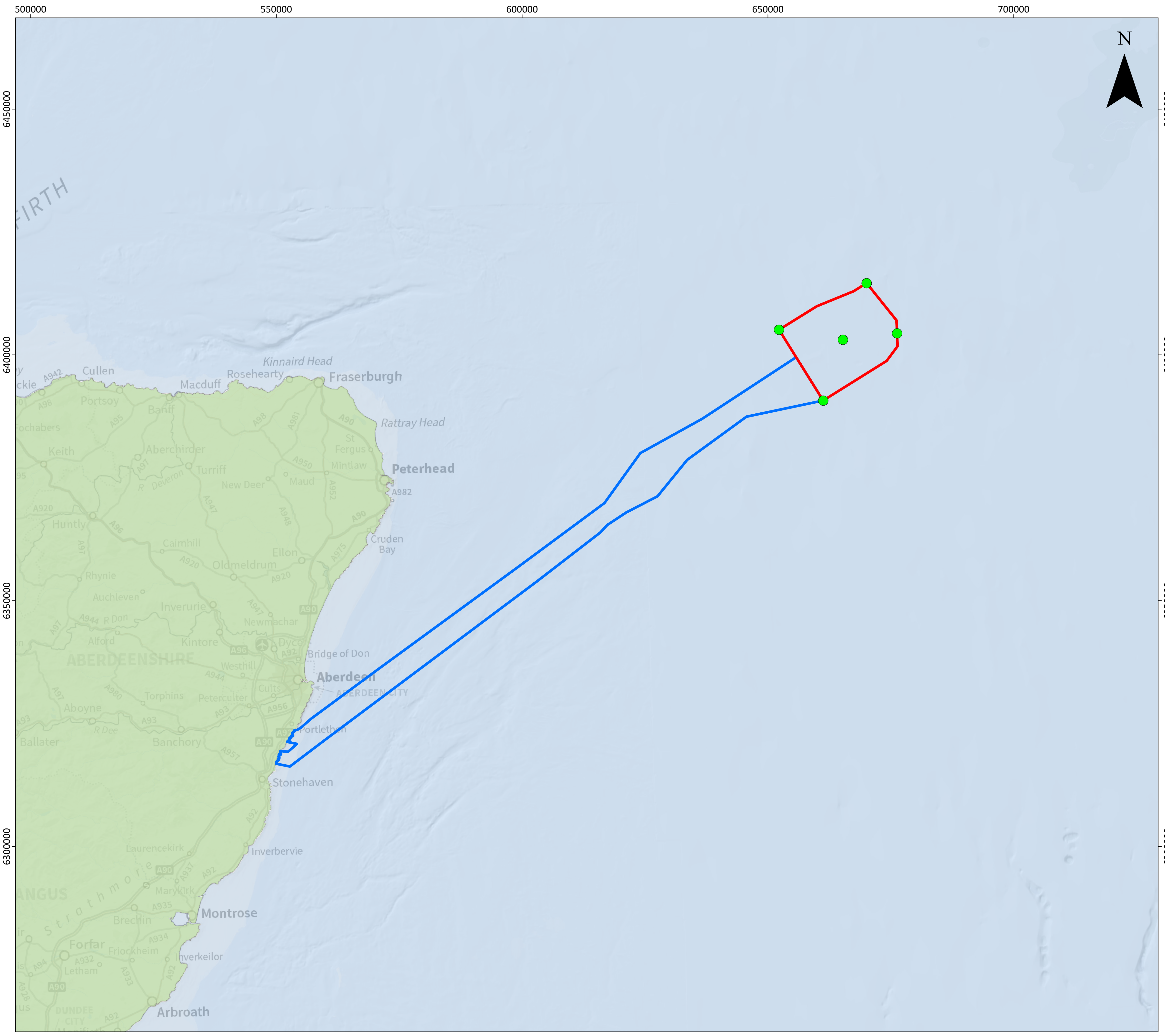
11.7.2 Underwater noise modelling has been undertaken by Subacoustech Environmental Ltd. using their Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model. Full details of the underwater noise modelling and the resulting impact areas and ranges are detailed in the **Volume 3, Appendix 3.1: Underwater Noise Technical Report**. Modelling has been undertaken at four locations (Figure 11.5). The selection of the modelling locations for anchor pile impact piling considered water depths, distance to shore and bathymetry stretching into deeper waters in order to support assessments of the maximum design scenarios that could be experienced when piling within the Aspen Array Area. As the location of the OSP is not yet known, a location in the centre of the site has been selected.

11.7.3 The first location is in the north corner (N) of the Offshore Array at 104.9 m depth. The second location is in the east edge (E) of the Offshore Array and is in some of the deeper waters (108.4 m) of the Offshore Array and therefore has the greatest potential for sound propagation. The third location is in the west corner (W) at 107.5 m and the fourth location is in south corner (S) one of the shallower points in the area (94.5 m) and therefore has the least potential for sound propagation. The modelling location for the OSP was a central location with 98.2 m depth.

11.7.4 Modelling was undertaken to determine the noise levels generated by pile driving of WTGs anchors and OSP jacket foundations. The assessment of auditory injury and disturbance includes piling at a single location alone. For auditory injury the worst-case scenario assumes up to four anchor piles are installed in a single day or up to four OSP jacket piles are installed in a single day. Piling parameters for anchors and jacket foundations are show in Table 11.19 and Table 11.20, respectively.

Table 11.19 Summary of the Soft Start and Ramp up Scenario Used for the Piled Anchor Foundation Modelling

| WTG Anchor Piles | 15% (360 kJ) | 40% (960 kJ) | 60% (1,140 kJ) | 80% (1,920kJ) | 100% (2,400 kJ) |
|---|---|---|---|---|---|
| Number of strikes | 200 | 350 | 350 | 350 | 5,250 |
| Duration (min) | 20 | 10 | 10 | 10 | 150 |
| Strike rate (blow/min) | 10 | 35 | 35 | 35 | 35 |
| 6,500 strikes over 3 hours and 20 minutes per pile<br>26,000 strikes over 13 hours and 20 minutes for four piles (worst-case) | | | | | |




CERULEAN WINDS

**Aspen Offshore Wind Farm**
Environmental Impact Assessment

**Modelling Locations for UWN Model**

**Legend**

- Aspen Array Area
- Offshore Transmission Cable Corridor
- UWN Modelling Locations

**Notes**

Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Contains Ordnance Survey data © Crown copyright and database rights (2024). OS OpenData.

Coordinate System:
WGS 1984 UTM Zone 30N

0 20 40 km

0 10 20 nm

| Scale | Date | Drawn by | Checked by | Approved by |
|---|---|---|---|---|
| 1:750,000 @A3 | 23/06/2025 | EV | GB | SB |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GoBe APEMGroup

**Figure 11.5**

Figure Reference: ASPEN_MM_Fig11.5_UWNModellingLocations_v1

Table 11.20 Summary of the Soft Start and Ramp up Scenario Used for the OSP Jacket Pile Foundation Modelling

| OSP Jacket Piles | 15% (525 kJ) | 40% (1,400 kJ) | 60% (2,100 kJ) | 80% (2,800kJ) | 100% (3,500 kJ) |
|---|---|---|---|---|---|
| Number of strikes | 200 | 350 | 350 | 350 | 5,250 |
| Duration (min) | 20 | 10 | 10 | 10 | 150 |
| Strike rate (blow/min) | 10 | 35 | 35 | 35 | 35 |
| 6,500 strikes over 3 hours and 20 minutes per pile<br>26,000 strikes over 13 hours and 20 minutes for four piles (worst-case) | | | | | |

### *Magnitude of Impact*

#### Auditory Injury - PTS

11.7.5 The following section provides the quantitative assessment of the impact of PTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for auditory injury (PTS-onset) from pile driving for each marine mammal species are also presented in Table 11.21 and Table 11.23. This includes the prediction of impact for each of the four modelling locations. A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.7.6 Table 11.22 shows results for instantaneous PTS ($SPL_{peak}$) for single anchor and OSP jacket pile foundations piling locations. Table 11.24 presents cumulative PTS ($SEL_{cum}$) results for single anchor and OSP jacket pile foundations piling locations, assuming the worst-case scenario of four anchor piles in 24 hours.

11.7.7 For harbour porpoise, assuming no mitigation is used, the maximum instantaneous PTS-onset impact range for single anchor piling was 730 m for all modelling locations and for OSP jacket pile foundations piling was 680 m (Table 11.21). This equates to two animals experiencing auditory injury (PTS) (<0.01% of the reference population) using the SCANS-IV survey block NS-D density (Table 11.22). Using the cumulative PTS-onset thresholds, the maximum impact range for single anchor piling was 7.9 km for the installation at the N modelling location and for OSP jacket pile foundations piling was 8.3 km (Table 11.23). This equates to a maximum of 96 animals experiencing PTS (0.06% of the UK reference population) for single anchor piling and a maximum of 120 animals (0.07% of the UK reference population) for OSP jacket foundation piling using the SCANS- IV survey block NS-D density (Table 11.24). It should be noted, that the maximum of animals potentially disturbed is predicted for the E modelling location, with 102 animals experiencing PTS (0.06% of the UK reference population).

11.7.8 The PTS impact range for bottlenose dolphin did not extend into the CES MU, therefore no bottlenose dolphins in the CES MU are expected to experience PTS (Table 11.21).

11.7.9 For all other dolphin species (including bottlenose dolphin in the GNS MU), assuming no mitigation is used, the maximum instantaneous PTS-onset impact range for single anchor and OSP jacket pile foundations piling was less than 50 m for all modelling locations (Table 11.21). This equates to less than one animal experiencing auditory injury (PTS) (<0.01% of the reference population) (Table 11.22). Using the cumulative PTS-onset thresholds, the maximum impact range for single anchor piling was less than 100 m for all modelling locations and for OSP jacket pile foundations piling was less than 0.1 km (Table 11.23). This equates to less than one animal experiencing auditory injury (PTS) from single anchor and OSP jacket pile foundations piling (<0.01% of the UK reference population) (Table 11.24).

11.7.10 For minke whales, assuming no mitigation is used, the maximum instantaneous PTS-onset impact range for single anchor piling was 60 m for all modelling locations and for OSP jacket pile foundations piling was less than 50 m (Table 11.21). This equates to less than one animal experiencing auditory injury (PTS) (<0.01% of the reference population) (Table 11.22). Using the cumulative PTS-onset thresholds, the maximum impact range for single anchor piling was 38 km for the installation at the N modelling location and for OSP jacket pile foundations piling was 37 km (Table 11.23). This equates to a maximum of 246 animals experiencing auditory injury (PTS) from single anchor and OSP jacket pile foundations piling using the SCANS-IV derived density surfaces (2.39% of the UK reference population) (Table 11.24).

11.7.11 For harbour and grey seals in the ES SMU, assuming no mitigation is used, the maximum instantaneous PTS-onset impact range for single anchor piling was 70 m for all modelling locations and for OSP jacket pile foundations piling was less than 60 m (Table 11.21). This equates to less than one animal in the ES SMU experiencing auditory injury (PTS) (<0.01% of the reference population) (Table 11.22). Using the cumulative PTS-onset thresholds, the maximum impact range for single anchor and OSP jacket pile foundations piling was less than 100 m for all modelling locations (Table 11.23). This equates to less than one animal experiencing auditory injury (PTS) (<0.01% of the reference population) (Table 11.24).

11.7.12 The PTS impact range for harbour and grey seals did not extend into the OC&O SMU, therefore no harbour and grey seals in the OC&O SMU are expected to experience PTS (Table 11.21).

11.7.13 As part of an expert elicitation workshop, experts in the relevant fields of marine mammal science discussed the nature, extent, and consequence of hearing threshold shifts on marine mammals arising from repeated exposures to low-frequency impulsive noise (Booth *et al*., 2019). It was acknowledged that energy from piling noise primarily concentrates between about 30 and 500 Hz, and peaks between 100 and 300 Hz with extension to above 2 kHz (Kastelein *et al*., 2015; 2016). The experts agreed that PTS and TTS as a result of piling would occur between the frequency range of 2 to 10 kHz (Kastelein *et al*., 2017), with PTS of 6 to 18 dB within this narrow range. They concluded that such change is not likely to adversely and significantly impact the survival and reproductive rates of marine mammals, including minke whales, which have a hearing range in the lower frequencies.

11.7.14 The impact is restricted to active piling days during the construction phase and is reasonably expected to occur. It is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to affect only a small proportion of the population, which is unlikely to impact the population trajectory. Therefore, the magnitude of impact is assessed as Low for harbour porpoise, minke and humpback whales, and Negligible for all other dolphin and seal species.

11.7.15 Basking sharks mortality, potential mortal injury and TTS (not PTS) are assessed in **Volume 2, Chapter 10: Fish and Shellfish Ecology**, Impact 1. As a group 1 species, the magnitude of the impact is predicted to be of small spatial extent, short duration, intermittent and reversible. Therefore, the magnitude of the impact is assessed as Low.

Table 11.21 Summary of Auditory Injury Instantaneous PTS ($SPL_{peak}$) Impact Ranges From Single Anchor and OSP Jacket Pile Driving for all Modelling Locations

| Species | Density (animals/km²) | Maximum Impact Range (m) at Modelling Location | | | | | Area (km²) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North (N) | East (E) | West (W) | South (S) | Central (C) | N | E | W | S | C |
| Harbour porpoise | 0.5444 | 730 | 730 | 730 | 730 | 680 | 1.70 | 1.70 | 1.70 | 1.70 | 1.40 |
| | 0.2510 | | | | | | | | | | |
| | 0.5985 | | | | | | | | | | |
| White-beaked dolphin | 0.2047 | <50 | <50 | <50 | <50 | <50 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | | | | | | | | | | |
| | 0.0799 | | | | | | | | | | |
| Bottlenose dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond) | <50 | <50 | <50 | <50 | <50 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0023 | | | | | | | | | | |
| Risso's dolphin | 0.0702 | <50 | <50 | <50 | <50 | <50 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0013 | | | | | | | | | | |
| Atlantic white-sided dolphin | 0.0100 | <50 | <50 | <50 | <50 | <50 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | 60 | 60 | 60 | 60 | <50 | 0.01 | 0.01 | 0.01 | 0.01 | <0.01 |
| | 0.0419 | | | | | | | | | | |
| Harbour Seal | 0.000008 | 70 | 70 | 70 | 70 | 60 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Grey seal | 0.004 | 70 | 70 | 70 | 70 | 60 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Species | Density (animals/km$^2$) | Maximum Impact Range (m) at Modelling Location | | | | | Area (km$^2$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North (N) | East (E) | West (W) | South (S) | Central (C) | N | E | W | S | C |
| | 0.0195 | | | | | | | | | | |

Table 11.22 Predicted Impact of Instantaneous PTS ($SPL_{peak}$) for Marine Mammals From Single Anchor and OSP Jacket Pile Driving for all Modelling Locations; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/km$^2$) | Impact | Modelling Location | | | | |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| Harbour porpoise | 0.5444 | # | <1 | <1 | <1 | <1 | <1 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.2510 | # | <1 | <1 | <1 | <1 | <1 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.5985 | # | 2 | 2 | 2 | 2 | <1 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| White-beaked dolphin | 0.2047 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0799 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | Modelling Location | | | | |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Bottlenose dolphin | 0.0023 | # | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.001 | # | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Risso's dolphin | 0.0702 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0013 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | Modelling Location | | | | |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | 0.0419 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0195 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

Table 11.23 Summary of Auditory Injury Cumulative PTS ($SEL_{cum}$) Impact Ranges From Worst-case Scenario Anchor and OSP Jacket Pile Driving for all Modelling Locations

| Species | Density (animals/km$^2$) | Maximum Impact Range (m) at Modelling Location | | | | | Area (km$^2$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | E | W | S | C | N | E | W | S | C |
| Harbour porpoise | 0.5444<br>0.2510<br>0.5985 | 7,900 | 7,600 | 7,500 | 7,300 | 8,300 | 160 | 170 | 160 | 150 | 200 |
| White-beaked dolphin | 0.2047<br>0.009<br>0.07999 | <100 | <100 | <100 | <100 | <100 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Bottlenose dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond)<br>0.0023<br>0.001 | <100 | <100 | <100 | <100 | <100 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Risso's dolphin | 0.0702<br>0.0013 | <100 | <100 | <100 | <100 | <100 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Atlantic white-sided dolphin | 0.0100 | <100 | <100 | <100 | <100 | <100 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Minke whale | 0.0769<br>0.0419 | 38,000 | 37,000 | 34,000 | 33,000 | 37,000 | 3,200 | 3,000 | 2,900 | 2,600 | 3,200 |
| Harbour Seal | 0.000008 | <100 | <100 | <100 | <100 | <100 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Grey seal | 0.004<br>0.0195 | <100 | <100 | <100 | <100 | <100 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

Table 11.24 Predicted Impact of Auditory Injury Cumulative PTS ($SEL_{cum}$) for Marine Mammals From Worst-case Scenario Anchor and OSP Jacket Pile Driving for all Modelling Locations; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/km$^2$) | Impact | Modelling Location | | | | |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| Harbour porpoise | 0.5444 | # | 88 | 93 | 88 | 82 | 109 |
| | | % NS MU | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 |
| | | % UK MU | 0.05 | 0.05 | 0.05 | 0.05 | 0.07 |
| | 0.2510 | # | 41 | 43 | 41 | 38 | 51 |
| | | % NS MU | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | | % UK MU | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 |
| | 0.5985 | # | 96 | 102 | 96 | 90 | 120 |
| | | % NS MU | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| | | % UK MU | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 |
| White-beaked dolphin | 0.2047 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.07999 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Bottlenose dolphin | 0.0023 | # | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.001 | # | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Risso's dolphin | 0.0702 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | Modelling Location | | | | |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0013 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | # | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | # | 246 | 231 | 223 | 200 | 246 |
| | | % CGNS MU | 1.22 | 1.15 | 1.11 | 0.99 | 1.22 |
| | | % UK MU | 2.39 | 2.24 | 2.17 | 1.94 | 2.39 |
| | 0.0419 | # | 135 | 126 | 122 | 109 | 135 |
| | | % CGNS MU | 0.67 | 0.62 | 0.60 | 0.54 | 0.67 |
| | | % UK MU | 1.30 | 1.22 | 1.18 | 1.06 | 1.30 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0195 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

Disturbance

11.7.16 The number of each marine mammal species predicted to experience behavioural disturbance as a result of pile driving is modelled at the N, E, W, S and C locations presented in Table 11.25 and Table 11.26 and assessed as the proportion of the respective reference population (as presented in Table 11.5). For dolphin species and minke whale, numbers of animals predicted to experience behavioural disturbance have been calculated using both the dose response method (Graham *et al*., 2017b) (Table 11.25) and Level B harassment thresholds (NMFS, 2024) (Table 11.26). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available, as this represents the worst-case scenario.

11.7.17 iPCoD modelling was conducted to determine whether the level of disturbance is expected to result in population level impacts. The results of the iPCoD modelling show that there is no significant effect of disturbance resulting from pile driving at the Proposed Development to harbour porpoise, bottlenose dolphin in the GNS MU, minke whale and harbour seal in the ES SMU, with the impacted population remaining on a stable trajectory, the same as the un-impacted population. Furthermore, for bottlenose dolphin in CES MU and grey seal in the ES SMU, impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population. For grey and harbour seals in the OS&O SMU, as the noise contour overlap with this SMU is only the 145 dB to 150 dB and based on Whyte *et al.* (2020) only approximately 36% of animals are anticipated to respond within this, iPCoD modelling was not undertaken separately for this SMU. The number of seals disturbed in the OS&O SMU was incorporate into the ES SMU total for iPCoD modelling. Furthermore, less than one harbour seal is predicted to be disturbed within the OS&O SMU and the combined total with the ES SMU remains at less than one harbour seal, therefore, adding this SMU to the iPCoD model would overinflate the size of the population that the model is run. Further details are included in **Volume 3, Appendix 11.2: iPCoD Modelling Report.**

Harbour Porpoise

WTG Anchors

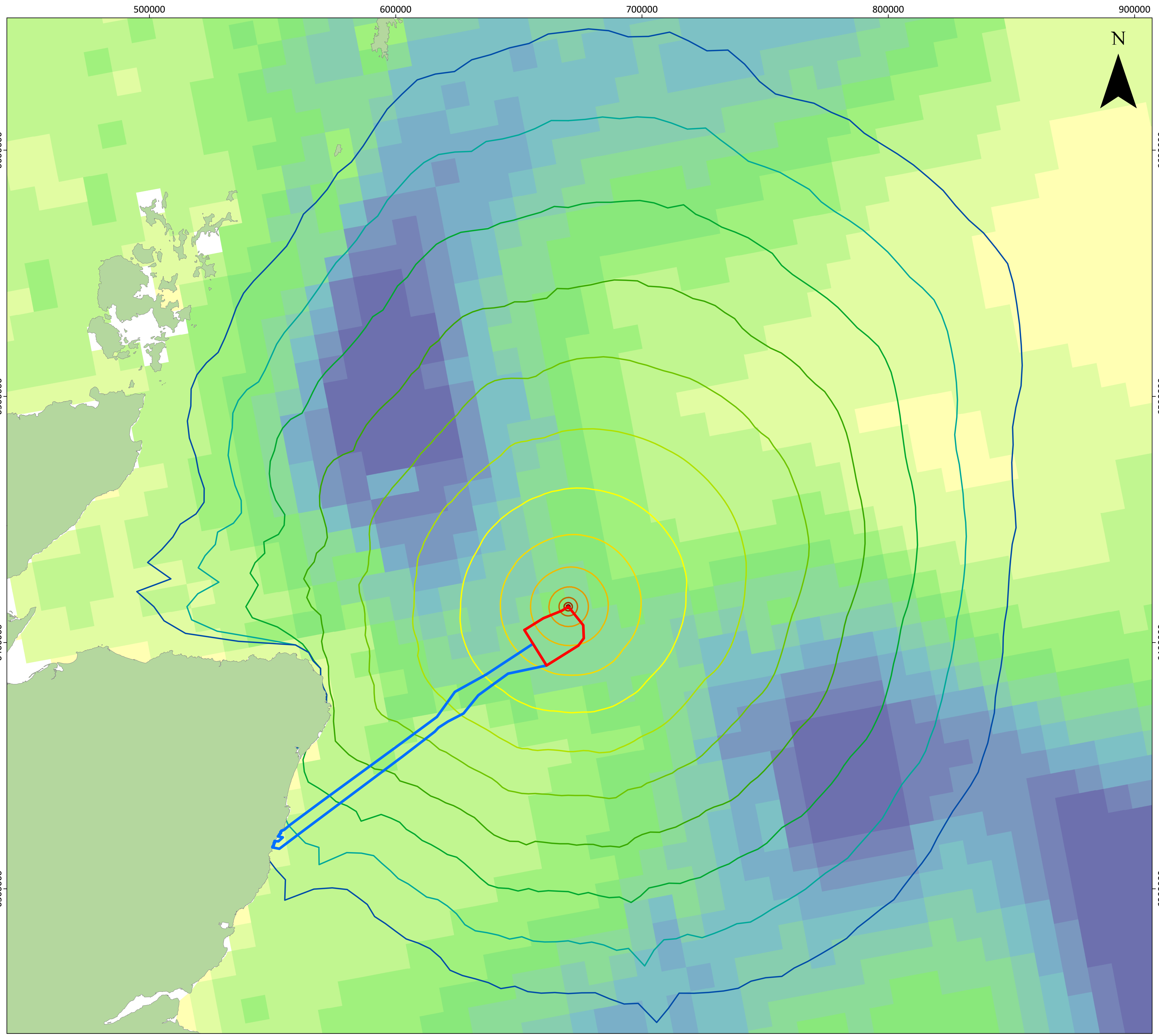
11.7.18 The maximum number of harbour porpoise predicted to be disturbed by anchor piling is 10,652 (3.07 % NS MU) animals at the N location using the SCANS-IV survey block density (Table 11.25, Figure 11.6).

OSP Jacket Pile

11.7.19 The maximum number of harbour porpoise predicted to be disturbed by OSP jacket piling is 10,603 animals (3.06 % NS MU) using the SCANS-IV survey block density (Table 11.25).

Magnitude Conclusions

11.7.20 The impact on harbour porpoises is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is unlikely to affect the population trajectory, as shown by iPCoD modelling. Therefore, the magnitude of impact is assessed as Low for harbour porpoises.




CERULEAN WINDS

**Aspen Offshore Wind Farm**
Environmental Impact Assessment

**Behavioural Disturbance Dose Response for Piling at the N Anchor Location for Harbour Porpoise**

**Legend**

- Aspen Array Area
- Offshore Transmission Cable Corridor

**Noise Contours (SELss, dB re 1 µPa2s)**

120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180

**Density (ind./km2) (Gilles *et al.*, 2025)**

0.00 - 0.10; 0.11 - 0.20; 0.21 - 0.30; 0.31 - 0.40; 0.41 - 0.50; 0.51 - 0.60; 0.61 - 0.70; 0.71 - 0.80; 0.81 - 0.90; 0.91 - 1.00; 1.01 - 1.10; >1.10

**Notes**



Coordinate System: WGS 1984 UTM Zone 30N

0 50 100 km
0 25 50 nm

| Scale | Date | Drawn by | Checked by | Approved by |
|---|---|---|---|---|
| 1:1,500,000@A3 | 23/06/2025 | EV | GB | SB |

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**Figure 11.6**

Figure Reference: ASPEN_MM_Fig11.6_HarbourPorpoiseSurfaceDensity_v1

### WTG Anchors

11.7.21 Using the dose-response function, the maximum number of white-beaked dolphins predicted to be disturbed by anchor piling is 3,644 animals (8.29 % CGNS MU) at the N location using the SCANS-IV density surface (Table 11.25).

11.7.22 Using the Level B harassment threshold, the maximum number of white-beaked dolphins predicted to be disturbed by anchor piling is 778 animals (1.77% NS MU) at the N location using the SCANS-IV density surface (Table 11.26).

### OSP Jacket Pile

11.7.23 Using the dose-response function, the maximum number of white-beaked dolphins predicted to be disturbed by OSP jacket piling is 3,627 animals (8.25 % NS MU) using the SCANS-IV density surface (Table 11.25).

11.7.24 Using the Level B harassment threshold, the maximum number of white-beaked dolphins predicted to be disturbed by OSP jacket piling is 819 animals (1.86% NS MU) using the SCANS-IV density surface (Table 11.26).

### Magnitude Conclusions

11.7.25 Limited information on the response of white-beaked dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of white-beaked disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al*. (2017b) and is therefore likely to be an over-estimate. Due to the lack of species-specific data to apply to the dose-response curve for white-beaked dolphin, the number and proportion of white-beaked dolphin disturbed during piling was also calculated using the Level B harassment threshold. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower. This suggests that the dose response method results in a very conservative calculation of the number and proportion of white-beaked dolphins disturbed. The greatest percentage of the MU predicted to be impacted is for WTG anchor installation, with 8.29% of the CGNS MU and 10.29 % of the UK MU.

11.7.26 White-beaked dolphins' movement in UK waters are not well understood, therefore the level of repeated disturbance that an individual would be exposed to is unknown. Due to their large distribution, it is likely that animals transit through the Proposed Development and are only likely to be disturbed over a small number of days. Furthermore, it is expected that dolphins would return soon after the piling event has finished, as demonstrated by more sensitive species (i.e harbour porpoise).

11.7.27 The impact on white-beaked dolphins is considered to result in a relatively small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to have long-term consequences that would affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium for white-beaked dolphins.

### Bottlenose Dolphin

#### WTG Anchors

11.7.28 Using the dose-response function, the maximum number of bottlenose dolphins predicted to be disturbed by anchor piling is 5 animals in the CES MU at the W location (1.82 % CES MU) and 40 animals in the GNS MU at the N location (1.98% GNS MU) (Table 11.25, Figure 11.7).

11.7.29 Using the Level B harassment threshold, no bottlenose dolphins in the CES MU are predicted to be disturbed and the maximum predicted to be disturbed by anchor piling is 9 animals in the GNS MU at the N, E, W and S location (0.43 % GNS MU) (Table 11.26).

#### OSP Jacket Pile

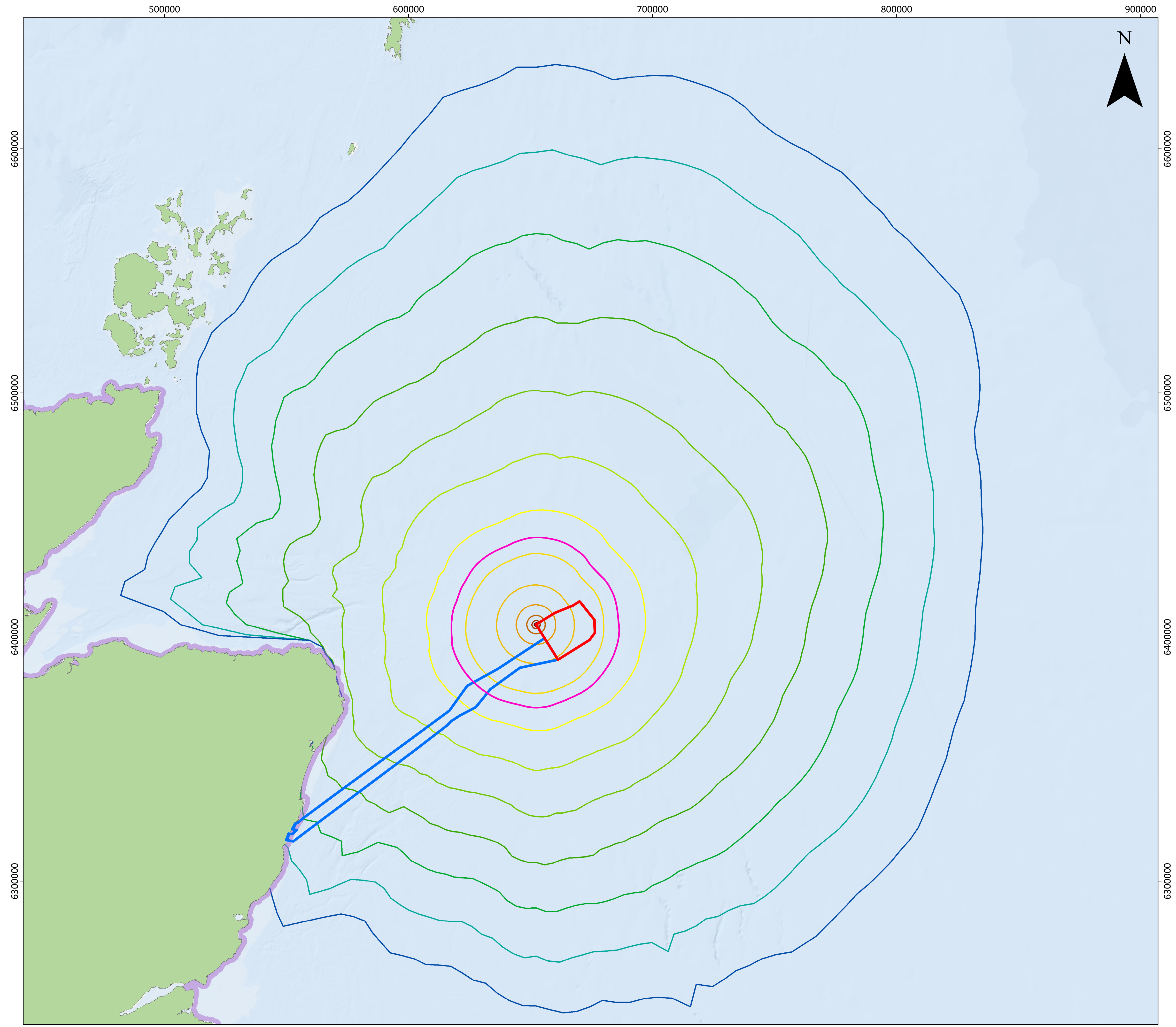
11.7.30 Using the dose-response function, the maximum number of bottlenose dolphins predicted to be disturbed by OSP jacket piling is 4 animals in the CES MU (1.44 % CES MU) and 40 animals in the GNS MU (1.95 % GNS MU) (Table 11.25).

11.7.31 Using the Level B harassment threshold, no bottlenose dolphins in the CES MU are predicted to be disturbed and the maximum number predicted to be disturbed by OSP jacket piling is 10 animals (0.45 % GNS MU) (Table 11.26).

#### Magnitude Conclusions

11.7.32 The number and proportion of bottlenose dolphin disturbed during pile driving was calculated using the dose-response curve for harbour porpoise from Graham *et al*. (2017b), as there is no corresponding species-specific data available for bottlenose dolphin. However, studies suggest that bottlenose dolphins are typically less sensitive to behavioural disturbance than harbour porpoise (e.g. Culloch *et al*., 2016; Kastelein *et al*., 2006; Stone *et al*., 2017). Therefore, it is expected that the probability of response to underwater noise from pile driving would be lower. To demonstrate this, the number and proportion of bottlenose dolphin disturbed during pile diving have also been calculated using the Level B harassment threshold. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower. This suggests that the dose response method results in a very conservative calculation of the number and proportion of bottlenose dolphins disturbed. The greatest percentage of the MU predicted to be impacted is for WTG anchor installation, with 1.98% of the GNS MU and 2.04 % of the UK MU.

11.7.33 The impact on bottlenose dolphins is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory, as shown by iPCoD modelling. Therefore, the magnitude of impact is assessed as Low for bottlenose dolphins.




CERULEAN WINDS

**Aspen Offshore Wind Farm**
Environmental Impact Assessment

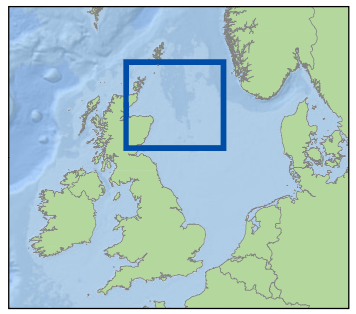
**Behavioural Disturbance Dose Response and Level B Harassment for Piling at the W Anchor Location for Bottlenose Dolphin**

**Legend**

- Aspen Array Area
- Offshore Transmission Cable Corridor
- 2km Coastal Buffer within CES MU
- Level B threshold 160dB re 1 uPa (SPLRMS)

**Noise Contours (SELss, dB re 1 µPa2s)**

| | |
|---|---|
| 120 | 155 |
| 125 | 160 |
| 130 | 165 |
| 135 | 170 |
| 140 | 175 |
| 145 | 180 |
| 150 | |



**Notes**

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Coordinate System:
WGS 1984 UTM Zone 30N

0 50 100 km
0 25 50 nm

| Scale | Date | Drawn by | Checked by | Approved by |
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**Figure 11.7**

Figure Reference: ASPEN_MM_Fig11.7_BottlenoseDolphinSurfaceDensity_v1

## Risso's Dolphin

### WTG Anchors

11.7.34 Using the dose-response function, the maximum number of Risso's dolphins predicted to be disturbed by anchor piling is 1,250 animals (10.16 % CGNS MU) at the N location, using the SCANS-IV survey block density (Table 11.25).

11.7.35 Using the Level B harassment threshold, the maximum number of Risso's dolphins predicted to be disturbed by anchor piling is 267 animals (2.17 % CGNS MU) at the N location, using the SCANS-IV survey block density (Table 11.26).

### OSP Jacket Pile

11.7.36 Using the dose-response function, the maximum number of Risso's dolphins predicted to be disturbed by OSP jacket piling is 1,244 animals (10.12 % CGNS MU), using the SCANS-IV survey block density (Table 11.25).

11.7.37 Using the Level B harassment threshold, the maximum number of Risso's dolphins predicted to be disturbed by OSP jacket piling is 281 animals (2.28 % CGNS MU), using the SCANS-IV survey block density (Table 11.26).

### Magnitude Conclusions

11.7.38 Limited information on the response of Risso's dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of Risso's dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al*. (2017b) and is therefore likely to be an over-estimate. Furthermore, it is expected that dolphins would return soon after the piling event has finished, as demonstrated by more sensitive species (i.e harbour porpoise).

11.7.39 Due to the lack of species-specific data to apply to the dose-response curve for Risso's dolphin, the number and proportion of Risso's dolphin disturbed during piling was also calculated using the Level B harassment threshold. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower. This suggests that the dose response method results in a very conservative calculation of the number and proportion of Risso's dolphins disturbed. The greatest percentage of the MU predicted to be impacted is for WTG anchor installation, with 10.16% of the CGNS MU and 13.82 % of the UK MU.

11.7.40 It is also worth noting, that the maximum number of animals impacted have been estimated using the densities for the adjacent block, due to no densities being available for SCANS-IV survey block NS-D for Risso's dolphins. When using densities calculated from Waggit *et al*. (2019) the maximum number of animals estimated to be impacted are 24 (0.19% of the CGNS MU) or 23 (0.26% of the UK MU).

11.7.41 The impact on Risso's dolphins is considered to result in a relatively small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium for Risso's dolphins.

### WTG Anchors

11.7.42 Using the dose-response function, the maximum number of Atlantic white-sided dolphins predicted to be disturbed by anchor piling is 178 animals (0.98 % CGNS MU) at the N location, using the SCANS-III survey block density (Table 11.25).

11.7.43 Using the Level B harassment threshold, the maximum number of Atlantic white-sided dolphins predicted to be disturbed by anchor piling is 38 animals (0.21 % CGNS MU) at the N location, using the SCANS-III survey block density (Table 11.26).

### OSP Jacket Pile

11.7.44 Using the dose-response function, the maximum number of Atlantic white-sided dolphins predicted to be disturbed by OSP jacket piling is 178 animals (0.98 % CGNS MU), using the SCANS-III survey block density (Table 11.25).

11.7.45 Using the Level B harassment threshold, the maximum number of Atlantic white-sided dolphins predicted to be disturbed by OSP jacket piling is 40 animals (0.22 % CGNS MU), using the SCANS-III survey block density (Table 11.26).

### Magnitude Conclusions

11.7.46 Limited information on the response of Atlantic white-sided dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of Atlantic white-sided dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al*. (2017b) and is therefore likely to be an over-estimate. Furthermore, it is expected that dolphins would return soon after the piling event has finished, as demonstrated by more sensitive species (i.e harbour porpoise).

11.7.47 Due to the lack of species-specific data to apply to the dose-response curve for Atlantic white-sided dolphin, the number and proportion of Atlantic white-sided dolphin disturbed during piling was also calculated using the Level B harassment threshold. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower. This suggests that the dose response method results in a very conservative calculation of the number and proportion of Atlantic white-sided dolphins disturbed. The greatest percentage of the MU predicted to be impacted is for WTG anchor installation, with 0.98% of the CGNS MU and 1.39 % of the UK MU.

11.7.48 The impact on Atlantic white-sided dolphins is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for Atlantic white-sided dolphins.

WTG Anchors

11.7.49 Using the dose-response function, the maximum number of minke whale predicted to be disturbed by anchor piling is 1,368 animals (6.80 % CGNS MU) at the N location, using the SCANS-IV density surface (Table 11.25, Figure 11.8).

11.7.50 Using the Level B harassment threshold, the maximum number of minke whale predicted to be disturbed by anchor piling is 293 animals (1.45 % CGNS MU) at the N location, using the SCANS-IV density surface (Table 11.26).

OSP Jacket Pile

11.7.51 Using the dose-response function, the maximum number of minke whale predicted to be disturbed by OSP jacket piling is 1,362 animals (6.77 % CGNS MU), using the SCANS-IV density surface (Table 11.25).

11.7.52 Using the Level B harassment threshold, the maximum number of minke whale predicted to be disturbed by OSP jacket piling is 308 animals (1.53 % CGNS MU), using the SCANS-IV density surface (Table 11.26).

Magnitude Conclusions

11.7.53 Limited information on the response of minke whale to behavioural disturbance to pile driving is available. Therefore, the number and proportion of minke whale disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al*. (2017b) and is therefore likely to be an over-estimate. Furthermore, it is expected that minke whale would return soon after the piling event has finished, as demonstrated by more sensitive species (i.e harbour porpoise).

11.7.54 Due to the lack of species-specific data to apply to the dose-response curve for minke whale, the number and proportion of minke whale disturbed during piling was also calculated using the Level B harassment threshold. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower. This suggests that the dose response method results in a very conservative calculation of the number and proportion of minke whale disturbed. The greatest percentage of the MU predicted to be impacted is for WTG anchor installation, with 6.80% of the CGNS MU and 12.78 % of the UK MU.

11.7.55 The impact on minke whale is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory, as shown in the iPCoD modelling. Therefore, the magnitude of impact is assessed as Low for minke whale. As humpback whales are also low frequency cetaceans they are also conservatively assessed as Low.

### Harbour Seal

#### WTG Anchors

11.7.56 Using the dose-response function, the maximum number of harbour seal predicted to be disturbed by anchor piling is less than one animal in the ES SMU at the N, E, S and W locations (<0.01 % ES SMU) and less than one animal in the NC&O SMU at the N, E and W location (<0.01 % NC&O SMU; Table 11.25).

#### OSP Jacket Pile

11.7.57 Using the dose-response function, the maximum number of harbour seal predicted to be disturbed by OSP jacket piling is less than one animal in the ES SMU (<0.01 % ES SMU) and less than one animal in the NC&O SMU (<0.01 % NC&O SMU; Table 11.25).

#### Magnitude Conclusions

11.7.58 The impact on harbour seal is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but would not alter the population trajectory, as shown by the iPCoD modelling. Therefore, the magnitude of impact is assessed as Negligible for harbour seal.

### Grey Seal

#### WTG Anchors

11.7.59 Using the dose-response function, the maximum number of grey seal predicted to be disturbed by anchor piling is 109 animals in the ES SMU at the E location (1.73 % ES SMU) and 13 animals in the NC&O SMU at the N location (0.04 % NC&O SMU; Table 11.25).

#### OSP Jacket Pile

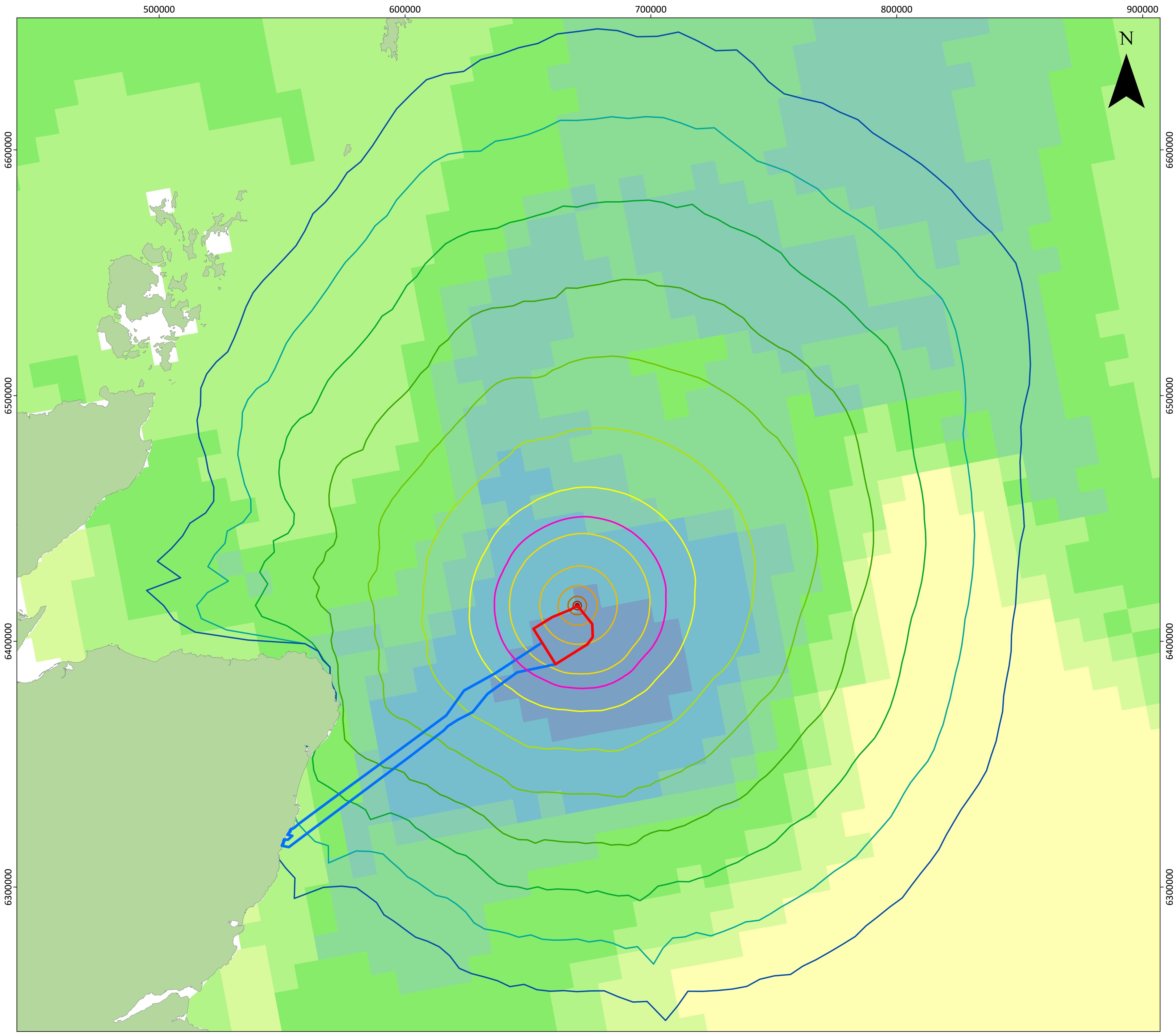
11.7.60 Using the dose-response function, the maximum number of grey seal predicted to be disturbed by OSP jacket piling is 114 animals in the ES SMU (1.81% ES SMU) and 3 animals in the NC&O SMU (<0.01 % NC&O SMU; Table 11.25).

#### Magnitude Conclusions

11.7.61 The impact on grey seal dolphins is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but would not alter the population trajectory, as shown by iPCoD modelling. Therefore, the magnitude of impact is assessed as Low for grey seal.

### Basking Shark

11.7.62 Basking sharks disturbance is assessed in **Volume 2, Chapter 10: Fish and Shellfish Ecology**, Impact 1. As a group 1 species, the magnitude of the impact is predicted to be of small spatial extent, short duration, intermittent and reversible. Therefore, the magnitude of the impact is assessed as Low.




CERULEAN WINDS

# Aspen Offshore Wind Farm

## Environmental Impact Assessment

## Behavioural Disturbance Dose Response and Level B Harassment for Piling at the N Anchor Location for Minke Whale

**Legend**

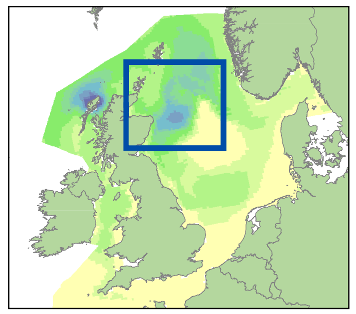
- Aspen Array Area
- Offshore Transmission Cable Corridor
- Level B threshold 160dB re 1 uPa (SPLRMS)

**Noise Contours (SELss, dB re 1 µPa2s)**

120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180

**Density (ind./km2) (Gilles *et al.*, 2025)**

- 0.000 - 0.005
- 0.006 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.040
- 0.041 - 0.050
- 0.051 - 0.075
- 0.076 - 0.100
- 0.101 - 0.125
- >0.125



**Notes**



Coordinate System: WGS 1984 UTM Zone 30N

0 50 100 km

0 25 50 nm

| Scale | Date | Drawn by | Checked by | Approved by |
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**Figure 11.8**

Figure Reference: ASPEN_MM_Fig11.6_HarbourPorpoiseSurfaceDensity_v1

Table 11.25 Predicted Impact of Disturbance to Marine Mammals From Pile Driving Using Dose Response Curves; # = Number of Animals Disturbed; % = the Percentage of the Reference Population.

| Species | Density (animals/km$^2$) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| Harbour porpoise | 0.5444 | # | 9,690 | 9,436 | 9,027 | 8,598 | 9,645 |
| | | % NS MU | 2.80 | 2.72 | 2.60 | 2.48 | 2.78 |
| | | # UK | 9,313 | 9,082 | 8,862 | 8,436 | 9,189 |
| | | % UK MU | 5.83 | 5.69 | 5.55 | 5.28 | 5.76 |
| | 0.2510 | # | 4,468 | 4,351 | 4,162 | 3,964 | 4,447 |
| | | % NS MU | 1.29 | 1.26 | 1.20 | 1.14 | 1.28 |
| | | # UK | 4,294 | 4,188 | 4,086 | 3,890 | 4,237 |
| | | % UK MU | 2.69 | 2.63 | 2.56 | 2.44 | 2.65 |
| | 0.5985 | # | 10,652 | 10,373 | 9,924 | 9,452 | 10,603 |
| | | % NS MU | 3.07 | 2.99 | 2.86 | 2.73 | 3.06 |
| | | # UK | 10,238 | 9,984 | 9,742 | 9,273 | 10,101 |
| | | % UK MU | 6.41 | 6.25 | 6.10 | 5.81 | 6.33 |
| White-beaked dolphin | 0.2047 | # | 3,644 | 3,549 | 3,395 | 3,234 | 3,627 |

| Species | Density (animals/km²) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | | % CGNS MU | 8.29 | 8.07 | 7.72 | 7.36 | 8.25 |
| | | # UK | 3,502 | 3,416 | 3,333 | 3,172 | 3,456 |
| | | % UK MU | 10.29 | 10.04 | 9.79 | 9.32 | 10.15 |
| | 0.009 | # | 161 | 156 | 150 | 143 | 160 |
| | | % CGNS MU | 0.36 | 0.35 | 0.34 | 0.32 | 0.36 |
| | | # UK | 154 | 151 | 147 | 140 | 152 |
| | | % UK MU | 0.45 | 0.44 | 0.43 | 0.41 | 0.45 |
| | 0.0799 | # | 1,422 | 1,385 | 1,325 | 1,262 | 1,415 |
| | | % CGNS MU | 3.24 | 3.15 | 3.01 | 2.87 | 3.22 |
| | | # UK | 1,367 | 1,333 | 1,301 | 1,238 | 1,348 |
| | | % UK MU | 4.02 | 3.92 | 3.82 | 3.64 | 3.96 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond) | # | 3 | 2 | 5 | 4 | 4 |
| | | % CES MU | 0.05 | 0.81 | 1.82 | 1.42 | 1.44 |
| | 0.0023 | # | 40 | 39 | 37 | 35 | 40 |

| Species | Density (animals/km²) | Impact | Anchor N | E | W | S | OSP C |
|---|---|---|---|---|---|---|---|
| | | % GNS MU | 1.98 | 1.93 | 1.81 | 1.73 | 1.95 |
| | | # UK | 39 | 38 | 36 | 34 | 39 |
| | | % UK MU | 2.04 | 2.00 | 1.90 | 1.82 | 2.03 |
| | 0.001 | # | 18 | 17 | 16 | 16 | 18 |
| | | % GNS MU | 0.86 | 0.84 | 0.79 | 0.75 | 0.85 |
| | | # UK | 17 | 17 | 16 | 15 | 17 |
| | | % UK MU | 0.89 | 0.87 | 0.83 | 0.79 | 0.88 |
| Risso's dolphin | 0.0702 | # | 1,250 | 1,217 | 1,164 | 1,109 | 1,244 |
| | | % CGNS MU | 10.16 | 9.90 | 9.47 | 9.02 | 10.12 |
| | | # UK | 1,201 | 1,172 | 1,143 | 1,088 | 1,185 |
| | | % UK MU | 13.82 | 13.48 | 13.15 | 12.52 | 13.64 |
| | 0.0013 | # | 24 | 23 | 22 | 21 | 23 |
| | | % CGNS MU | 0.19 | 0.18 | 0.18 | 0.17 | 0.19 |
| | | # UK | 23 | 22 | 22 | 21 | 22 |
| | | % UK MU | 0.26 | 0.25 | 0.24 | 0.23 | 0.25 |

| Species | Density (animals/km$^2$) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| Atlantic white-sided dolphin | 0.0100 | # | 178 | 174 | 166 | 158 | 178 |
| | | % CGNS MU | 0.98 | 0.96 | 0.91 | 0.87 | 0.98 |
| | | # UK | 172 | 167 | 163 | 155 | 169 |
| | | % UK MU | 1.39 | 1.36 | 1.32 | 1.26 | 1.37 |
| Minke whale | 0.0769 | # | 1,368 | 1,333 | 1,275 | 1,214 | 1,362 |
| | | % CGNS MU | 6.80 | 6.62 | 6.33 | 6.03 | 6.77 |
| | | # UK | 1,315 | 1,283 | 1,252 | 1,191 | 1,298 |
| | | % UK MU | 12.78 | 12.46 | 12.16 | 11.56 | 12.61 |
| | 0.0419 | # | 746 | 727 | 695 | 482 | 742 |
| | | % CGNS MU | 3.71 | 3.61 | 3.45 | 2.39 | 3.69 |
| | | # UK | 717 | 699 | 682 | 473 | 707 |
| | | % UK MU | 6.97 | 6.79 | 6.63 | 4.59 | 6.87 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 |
| | | % ES MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | 0.00000014 | # | <1 | <1 | <1 | <1 | <1 |
| | | % NC&O MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | 22 | 23 | 22 | 21 | 24 |
| | | % ES MU | 0.35 | 0.37 | 0.35 | 0.33 | 0.38 |
| | 0.0195 | # | 107 | 109 | 104 | 99 | 114 |
| | | % ES MU | 1.70 | 1.73 | 1.65 | 1.57 | 1.81 |
| | 0.03292 | # | 13 | 3 | 5 | No overlap | 3 |
| | | % NC&O MU | 0.04 | <0.01 | 0.01 | | <0.01 |

Table 11.26 Predicted Impact of Disturbance to Marine Mammals From Pile Driving Using Level B Harassment Thresholds; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/km$^2$) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| White-beaked dolphin | 0.2047 | # | 778 | 758 | 758 | 717 | 819 |
| | | % NS MU | 1.77 | 1.72 | 1.72 | 1.63 | 1.86 |
| | | % UK MU | 2.29 | 2.23 | 2.23 | 2.11 | 2.41 |
| | 0.009 | # | 35 | 34 | 34 | 32 | 36 |
| | | % NS MU | 0.08 | 0.08 | 0.08 | 0.07 | 0.08 |
| | | % UK MU | 0.10 | 0.10 | 0.10 | 0.09 | 0.11 |
| | 0.0799 | # | 304 | 296 | 296 | 280 | 320 |
| | | % NS MU | 0.69 | 0.67 | 0.67 | 0.64 | 0.73 |
| | | % UK MU | 0.89 | 0.87 | 0.87 | 0.82 | 0.94 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and 0.023 (beyond) | # | No overlap | | | | |
| | | % CES MU | | | | | |
| | 0.0023 | # | 9 | 9 | 9 | 9 | 10 |
| | | % GNS MU | 0.43 | 0.42 | 0.42 | 0.40 | 0.45 |
| | | % UK MU | 0.46 | 0.45 | 0.45 | 0.43 | 0.49 |

| Species | Density (animals/km$^2$) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | 0.001 | # | 4 | 4 | 4 | 4 | 4 |
| | | % GNS MU | 0.19 | 0.18 | 0.18 | 0.17 | 0.20 |
| | | % UK MU | 0.20 | 0.20 | 0.20 | 0.19 | 0.21 |
| Risso's dolphin | 0.0702 | # | 267 | 260 | 260 | 246 | 281 |
| | | % NS MU | 2.17 | 2.11 | 2.11 | 2.00 | 2.28 |
| | | % UK MU | 3.07 | 2.99 | 2.99 | 2.83 | 3.23 |
| | 0.0013 | # | 5 | 5 | 5 | 5 | 6 |
| | | % NS MU | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| | | % UK MU | 0.06 | 0.06 | 0.06 | 0.05 | 0.06 |
| Atlantic white-sided dolphin | 0.0100 | # | 38 | 37 | 37 | 35 | 40 |
| | | % NS MU | 0.21 | 0.20 | 0.20 | 0.19 | 0.22 |
| | | % UK MU | 0.31 | 0.30 | 0.30 | 0.28 | 0.33 |
| Minke whale | 0.0769 | # | 293 | 285 | 285 | 269 | 308 |
| | | % NS MU | 1.45 | 1.41 | 1.41 | 1.34 | 1.53 |

| Species | Density (animals/km$^2$) | Impact | Anchor | | | | OSP |
|---|---|---|---|---|---|---|---|
| | | | N | E | W | S | C |
| | | % UK MU | 2.84 | 2.76 | 2.76 | 2.61 | 2.99 |
| | 0.0419 | # | 160 | 155 | 155 | 147 | 168 |
| | | % NS MU | 0.79 | 0.77 | 0.77 | 0.73 | 0.83 |
| | | % UK MU | 1.55 | 1.51 | 1.51 | 1.43 | 1.63 |

### *Sensitivity of Receptor*

#### Auditory Injury – PTS

11.7.63 For marine mammals, hearing is a key sensory mechanism via which they negotiate the underwater environment. It is essential for navigation, communication and locating prey (Southall *et al*., 2007). Permanent and irreversible hearing impairment (PTS), therefore has the potential to negatively affect vital life functions, including foraging, mating and predator detection, with possible consequences to an animal's health or vital rates (Erbe *et al*., 2018). This could result in disruption in key life functions and deterioration of health, possibly leading to mortality of individuals and reduced birth rates.

11.7.64 At a Department of Business, Energy, and Industrial Strategy (BEIS)-funded expert elicitation workshop in 2018, experts discussed the nature, extent, and potential consequences of PTS to marine mammal species in the UK (Booth *et al*., 2019). Using the best and most recent data available on the effects of PTS on marine mammals, the experts concluded that PTS did not mean animals were deaf, but that they permanently lose sensitivity in hearing across the impacted frequencies. The magnitude and frequency band in which PTS occurs is critical to assessing the effect on vital rates.

11.7.65 A non-recoverable elevation of the hearing threshold by 6 dB is considered to constitute the onset of PTS (Southall *et al*., 2007). Based on TTS growth rates obtained from scientific literature, it has been assumed that PTS-onset occurs after TTS has grown to 40 dB. Studies of auditory injury in relation to a typical piling sequence have suggested that hearing impairment caused by exposure to piling noise is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum (Kastelein *et al*., 2013a). For piling noise, most energy is between ~30 – 500 Hz, with a peak between 100-300 Hz and energy extending above 2 kHz (Kastelein *et al*., 2015; Kastelein *et al*., 2016). Studies have shown that exposure to impulsive pile driving noise induces TTS in a relatively narrow frequency band in both harbour porpoise and harbour seals (Finneran, 2015), with statistically significant TTS occurring at 4 and 8 kHz, respectively (Kastelein *et al*., 2016) and centred at 4 kHz (Kastelein *et al*., 2012a; Kastelein *et al*., 2012b; Kastelein *et al*., 2013b; Kastelein *et al*., 2017). As a result, at an expert elicitation workshop, it was agreed that any threshold shifts to hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al*., 2017). It was also agreed that a PTS of 6 – 18 dB in a narrow frequency band in the 2 – 10 kHz region is unlikely to significantly affect the ability of individuals to survive and reproduce (Kastelein *et al*., 2017).

#### Harbour Porpoise (VHF Cetaceans)

11.7.66 Harbour porpoise are considered to be a cetacean with a VHF hearing range (Southall *et al*., 2019). The species has a vocal repertoire (and hearing range) ranging between 275 Hz to 160 kHz (NMFS, 2018; Southall *et al*., 2019) which includes their VHF, short-range and narrow-band high-frequency (NBHF) echolocation clicks. The hearing sensitivity of harbour porpoises is greatest in the higher part of this range (e.g. 100 to 125 kHz; Morell *et al*., 2021).

11.7.67 During an expert elicitation workshop, experts discussed the nature, extent, and potentially consequences of PTS from low-frequency impulsive noise (such as from piling and airgun pulses) on harbour porpoises; concluding that the probability of PTS significantly affecting the survival and reproduction of harbour porpoises was very low (Booth and Heinis, 2018).

11.7.68 Data collected during the construction of OWFs have shown that harbour porpoise detections around the pile driving area decline for several hours prior to the commencement of pile driving (Benhemma-Le Gall *et al*., 2021; Benhemma-Le Gall *et al*., 2023; Brandt *et al*., 2018; Graham *et al*., 2019). For example, during the installation campaigns of both Beatrice and Moray East OWFs, harbour porpoise acoustic detections gradually declined by up to 33% during the 48-hour period prior to piling (Benhemma-Le Gall *et al*., 2023). It is assumed that this was due to an increase in other construction-related activities and the presence of vessels in advance of pile driving which act as a deterrent to harbour porpoise, therefore reducing the risk of auditory injury (Benhemma-Le Gall *et al*., 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity of the pile at the start of the activity. Consequently, the assessment of underwater noise in relation to pile driving, which assumes harbour porpoises will be present in the immediate vicinity during pile driving, is extremely precautionary.

11.7.69 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of harbour porpoise.

11.7.70 Based on the above, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Dolphin Species (HF Cetaceans)

11.7.71 The ecological consequences of PTS for bottlenose dolphin, Risso's dolphin, white-beaked dolphin and Atlantic white-sided dolphin are uncertain but could result in effects that influence survival and reproductivity, as discussed in paragraph 11.7.63.

11.7.72 Bottlenose dolphins have a vocal repertoire ranging between 200 Hz to 135 kHz, including barks (0.2 – 16 kHz), whistles (0.8 – 24 kHz; peak 3.5 – 14.5 kHz) and echolocation (peak 15 – 135 kHz) (David, 2006; Nachtigall *et al*., 2016). However, their hearing range also extends to 150 kHz (Nachtigall *et al*., 2016). Risso's dolphins have a vocal repertoire (and hearing range) ranging between 4 kHz to 128 kHz, with a peak in hearing sensitivity at 11.2 kHz and between 40 and 80 kHz (Mooney *et al*., 2015). White-beaked dolphins have a vocal repertoire and hearing range between 16 and 181 kHz with a peak sensitivity between 50 and 64 kHz (Nachtigall *et al*., 2008). Atlantic white-sided dolphins have a vocal repertoire and hearing range between 2 and 200 kHz, including whistles (5.6 - 19.6 kHz), clicks (16 -31 kHz) and burst pulses (maximum frequency 200 kHz) (Calderan *et al*., 2024).

11.7.73 As described for harbour porpoise, studies have shown that there are frequency-specific differences in the onset and growth of noise-induced threshold shifts in relation to the characteristics of the noise source and hearing sensitivity of the receiving species. At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of bottlenose dolphins was very low, assuming an impact a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.7.74 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of dolphin species.

11.7.75 Based on the above, bottlenose dolphin, Risso's dolphin, white-beaked dolphin and Atlantic white-sided dolphin are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of very high value. The sensitivity of the receptors is Low.

#### Minke and Humpback Whale (LF Cetaceans)

11.7.76 The low frequency noise produced during piling may be more likely to overlap with the hearing range of LF cetaceans such as minke and humpback whales. Very little is known about baleen whales hearing, with it being likely that they use sound for communication and are thought to be capable of hearing sounds through their skull bones (Cranford and Krysl, 2015).

11.7.77 There are no direct measures of auditory threshold for baleen whales, in part due to the challenges associated with studying large animals in controlled environments; therefore, current understanding of their hearing range is assumed to overlap the bandwidth of vocalisations. Minke whales produce low-frequency vocalisations between 50 Hz and 9.4 kHz (Edds-Walton, 2000; Gedamke *et al*., 2001; Mellinger *et al*., 2000; Risch *et al*., 2013; 2014). It is estimated that their hearing range falls between 40 Hz and 15 kHz due to behavioural responses to vessels and ADDs outwith their recorded vocalising range (Ketten and Mountain, 2011; Risch *et al*. 2013; Cranford and Krysl, 2015; Boisseau *et al*., 2021). Tubelli *et al*. (2012) estimated the most sensitive hearing range for minke whales extends from 30 to 100 Hz and 7.5 to 25 kHz.

11.7.78 Humpback whale vocalisations consist of songs (20 Hz to 24 kHz), social calls (50 Hz to >10 kHz) and repetitive tones (loud signals produced in long series but monotonal when compared to songs) (Au *et al*., 2006; Recalde-Salas *et al*., 2020; Stimpert *et al*. 2011; Zoidis *et al*., 2008; Palanca, 2021). Tubelli *et al.* (2018) estimated the most sensitive hearing range extends from 15 Hz to 3 kHz and 200 Hz to 9 kHz.

11.7.79 As for other FHGs above, it is assumed that animals experiencing PTS would suffer a biological effect that could impact on the health and vital rates of the animal (Erbe *et al*., 2018) and could ultimately lead to reduced birth rate in females or mortality of individuals.

11.7.80 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of minke and humpback whales as only a small region of their hearing would be potentially affected.

11.7.81 Based on the above, minke and humpback whales are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Harbour and Grey seal (Phocids in Water)

11.7.82 Seals use sound in air and water for communication, predator avoidance, and reproductive interactions, being less dependent on hearing for foraging than cetaceans (Deecke *et al*., 2002). Seals have very well developed tactile sensory systems that are used for foraging, but in certain conditions they may also listen to sounds produced by vocalising fish whilst hunting for prey (Dehnhardt *et al*., 2001; Schulte-Pelkum *et al*., 2007). Seals might rely on sound for communication with conspecifics and predator avoidance (Deeke *et al*., 2002).

11.7.83 At a BEIS-funded expert elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of grey and harbour seals was very low, assuming a 6 dB PTS in the 2 and 10 kHz range (Booth *et al*., 2019). Potential threshold shifts in hearing caused by pile driving would manifest in the range of 2 to 10 kHz (Kastelein *et al*., 2017).

11.7.84 Calculations of SELs of tagged seals during the construction of the Lincs OWF (Southern North Sea, UK) estimated that at least 50% of tagged seals would have received a dose of sound greater than published thresholds for PTS (Hastie *et al*., 2015). However, it is important to note that published thresholds have since been updated in Southall *et al*. (2019) and therefore this estimate is now expected to be lower. For instance, Whyte *et al*. (2020) found that the percentage of tagged seals predicted to experience PTS-onset varied from 0 to 17% depending on the onset threshold applied. The extent of OWF construction within the Wash (England, UK) over the last decade and the degree of overlap with foraging ranges of harbour seals in this region would suggest that a large number of individuals within the Wash population may have experienced levels of sound that have the potential to cause PTS (Russell *et al*., 2016). However, the increase in the Wash harbour seal population during this period suggests that either the survival and fitness of individuals is not affected or that seals are not developing PTS despite predictions of exposure that indicate that they should be.

11.7.85 PTS is a permanent effect which cannot be recovered from, although, seals do not generally use hearing as the primary sensory function for locating prey and evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of seals.

11.7.86 Based on the above, harbour and grey seals are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of very high value. The sensitivity of the receptor is Low.

Basking Shark

11.7.87 There is very limited information on basking sharks responses to underwater noise from OWF construction in general (Drewery, 2012). Basking sharks, and other elasmobranchs, lack a swim bladder and detect sound using inner ear end organs primarily (Casper *et al.*, 2012). They may only detect particle motion (Popper *et al*., 2014) and are therefore considered less sensitive to underwater noise compared to other fish hearing groups with gas-filled organs, and teleost with otoliths. Basking sharks hearing physiology and auditory capabilities are usually inferred from other shark species due to the limited relevant knowledge available (Casper and Mann, 2010; Popper *et al*., 2014). According to studies on lemon shark (*Negaprion brevirostris*), scalloped hammerhead (*Sphyrna lewini*) and sharpnosed shark (*Rhisoprionodon terranovae*), elasmobranch species in general have higher sensitivity to low frequency sound (Casper and Mann, 2010), and therefore low frequency noise may be detectable by basking sharks.

11.7.88 Playback studies conducted by the US Navy showed that other coastal and oceanic shark species avoid sudden onset of loud noise of low frequencies, but became habituated after a few trials (Myrberg, 2001).

11.7.89 Basking sharks are of mobile nature and unconstrained and therefore able to flee from noise disturbance. Based on their low vulnerability to noise impacts, and their mobile nature, these receptors are expected to recover quickly.

11.7.90 Based on the above and the assessment in the **Volume 2, Chapter 10: Fish and Shellfish Ecology** for mortality, potential injury and TTS (not PTS), basking sharks are considered to be of high adaptability, high tolerance, high recoverability, and are of very high value. The sensitivity of the receptor is Low.

Disturbance

Harbour Porpoise

11.7.91 Harbour porpoises are particularly vulnerable to disturbance, with the main impact being loss of foraging opportunities (Nabe-Nielsen *et al*., 2018). They are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently to maintain a high metabolic rate with little energy remaining for fat storage (Rojano-Doñate *et al*., 2018; Wisniewska *et al*., 2016). Therefore, there is a risk of changes to their overall fitness if they are displaced from high-quality foraging grounds or if their foraging efficiency is disturbed, and they are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. However, results from studies using Digital Acoustic Recording Tags (DTAGs) suggest that harbour porpoise are able to respond to short-term reductions in food intake and may have some resilience to disturbance (Wisniewska *et al*., 2016).

11.7.92 Several studies have shown that harbour porpoises are displaced during periods of pile driving (e.g. Benhemma-Le Gall *et al*., 2021; Brandt *et al*., 2016; Graham *et al*., 2019;). For example, monitoring of harbour porpoise during piling at Beatrice OWF in northeast Scotland indicated that porpoises were displaced from the immediate vicinity of the piling activity with a 50% probability of response occurring at approximately 7 km at the first piled location (Graham *et al*., 2019). However, the 50% probability of response reduced to 1.3 km by the final piling location, suggesting that the response of harbour porpoise diminished over the construction period (Graham *et al*., 2019).

11.7.93 This is supported by studies in the German North Sea at eight OWFs where declines in porpoise detection of >90% were recorded at noise levels above 170 dB compared to a baseline period of 24 to 48 hours (Brandt *et al*., 2016). A decline in detections of 25% at noise levels between 145 and 150 dB showed a decrease in effect with increase in distance from the piling location (Brandt *et al*., 2016). Furthermore, the detection rates showed that animals were only displaced from the area for a short period (one to three days) (Brandt *et al*., 2011; Brandt *et al*., 2016; Brandt *et al*., 2018; Dähne *et al*., 2013).

11.7.94 Recent studies at two OWFs in Scotland showed that detections of clicks, associated with echolocation, and buzzing, associated with prey capture, in the short range (2 km) did not cease in response to piling, suggesting that porpoises were not completely displaced from the piling area (Benhemma-Le Gall *et al*., 2021). Furthermore, the study suggests that animals that experience displacement may be able to compensate for missed foraging opportunities and increased energy expenditure of fleeing the piling area as detections of both clicks and buzzing were positively related to the distance from the piling activity (Benhemma-Le Gall *et al*., 2021) which could be due to an increase in foraging activities beyond the piling impact range.

11.7.95 At an expert elicitation workshop in 2019, experts agreed that juvenile and adult survival were unlikely to be significantly affected by missed foraging opportunities as a result of disturbance from piling (Booth *et al*., 2019).

11.7.96 Based on the above, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

#### Bottlenose Dolphin

11.7.97 A study of bottlenose dolphin response to impulsive noise (including the piling campaigns of Beatrice OWF and Moray East OWF, northeast Scotland), suggest that these activities did not cause displacement of the species from the southern coast of the Moray Firth (Fernandez-Betelu *et al.*, 2021). At the small temporal scale, dolphin detections increased, and the species remained within the predicted impacted area close to the offshore activities, for a median of two hours per day, on days with impulsive noise. This could be due to modifications in group size and/or behaviour, or changes in vocalisation rate or amplitude in response to impulsive noise generated by offshore activities. It is also important to note that bottlenose dolphin occurrence is largely influenced by various natural drivers, such as prey abundance, which could be deemed of higher importance in affecting their occurrence. Other studies in the Cromarty Firth (northeast Scotland) have suggested small spatial and temporal scale disturbance of bottlenose dolphins from piling activities have occurred previously, as evidenced by a slight reduction of the presence, detection positive hours, and the encounter duration in the vicinity of construction works, although dolphins were not excluded entirely from the area (Graham *et al.*, 2017a).

11.7.98 There is potential for behavioural disturbance from piling to result in disruption in foraging and resting activities and an increase in travel and energetic costs in bottlenose dolphins (Marley *et al.*, 2017a; Pirotta *et al.*, 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that while there is potential for disturbance to affect bottlenose dolphin behaviour and health, which will then impact vital rates and population dynamics, individuals are able to compensate for immediate behavioural responses to disturbances caused by vessel activity. This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance.

11.7.99 Based on the above, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

#### Risso's Dolphin

11.7.100 There is limited information on the response of Risso's dolphin to pile driving and there are few studies to investigate the effects of other impulsive noise sources, such as seismic surveys. The frequency range of seismic airguns may be similar to that of low-frequency noise produced by pile driving, although its duration and cumulative acoustic energy levels will differ. A study on the effects of seismic operations in UK waters showed no response by Risso's dolphin to seismic airguns (Stone *et al.*, 2017). During controlled experiments where Risso's dolphin were exposed to simulated military sonar (SPLs of 135 dB re 1µPa), no clear behavioural response was recorded (Southall *et al.*, 2011).

11.7.101 Based on the limited information available, Risso's dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### White-beaked Dolphin

11.7.102 There are no studies on the response of white-beaked dolphins to pile driving. Rasmussen *et al.* (2016) played different amplitude modulated tones and synthetic pulse-bursts, with behavioural responses observed in 90 out of 123 playbacks, with received levels varying between 153 and 161 dB re 1 µPa for pulse-burst signals. Stone *et al*. (2017) observed that white-beaked dolphins reacted negatively to airgun noise, which indicates sensitivity to low frequency noise.

11.7.103 Given the limited information on the effects of disturbance on white-beaked dolphins, bottlenose dolphins can be used as a proxy given that both species are HF cetaceans.

11.7.104 Based on the above, white-beaked dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Atlantic White-sided Dolphin

11.7.105 There are no studies on the response of Atlantic white-sided dolphins to pile driving or other noise sources. Given this, bottlenose dolphins can be used as a proxy given that both species are HF cetaceans.

11.7.106 Based on the above, Atlantic white-sided dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Minke Whale

11.7.107 There is limited information on the behavioural responses of minke whales to underwater noise. A study on the behavioural responses of minke whale to sonar signals showed that they displayed prolonged avoidance, increase in swim speed directly away from the source, and cessation of feeding for a received SPL of 146 dB re 1 µPa and long-term (six hour) avoidance of the area for a received SPL of 158 dB re 1 µPa (Sivle *et al*., 2015). A study detailing minke whale responses to the Lofitech 'seal scarer' ADD showed minke whales within 500 m and 1,000 m of the source (source level of 204 dB re 1 µPa @1 m) exhibiting responses of increased swim speeds and movement away from the source (McGarry *et al*., 2017). The monitoring showed that fine-scale temporal occurrence of minke whales was reduced by the presence of construction related activity (which did not include pile driving but did assess vessel presence as a proxy for other activities, including seismic surveys and multi-beam surveys) in Broadhaven Bay, north-west Ireland (Culloch *et al*., 2016).

11.7.108 While information on the behavioural responses of minke whales to underwater noise is limited, it is anticipated that minke whales, as seasonal migrants to Scottish waters, will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage.

11.7.109 Based on the above, minke whales are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Humpback Whale

11.7.110 There is limited information on the behavioural responses of humpback whales to underwater noise, particularly piling noise. A study conducted on humpback whales during their southward migration off eastern Australia observed no abnormal behaviour to suggest signs of stress when seismic airguns were fired, although displacement when airguns were active occurred, with some deviations in migration course being recorded (Dunlop *et al*., 2017). Exposure to airguns was found to reduce dive time and increase respiration (blow) rate when compared to the baseline group in which no airguns or vessels were present, however, these changes were also observed when vessels towing inactive airguns were present. Therefore, these behavioural changes may be in response to vessel presence rather than exposure to airguns. Despite this, behavioural changes were considered to be mild and within their normal behavioural repertoire.

11.7.111 Based on the above and considering that humpback whales are LF cetaceans and therefore will have a similar sensitivity to minke whales, humpback whales are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Harbour Seal

11.7.112 Behavioural disturbance of harbour seals as a result of underwater noise during pile driving could have an effect on both survival if it results in the separation of a pup from its mother, and reproduction via body condition if it results in the animal spending less time feeding or conserving energy by resting (Booth *et al*., 2019).

11.7.113 A study of telemetry tagged harbour seals in the Wash, southeast England, showed displacement during piling with a 19 to 83% reduction in abundance compared to during piling breaks (Russell *et al*., 2016). The study shows that abundance was significantly reduced up to 25 km from the piling activity (Russell *et al*., 2016). However, seals within the area returned to usage levels similar to non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term.

11.7.114 It is possible that displacement of harbour seals could result in an increased energetic cost if they are required to travel greater distances to compensate for missed foraging opportunities, which could potentially affect the reproductive success of a small number of individuals. However, during an expert elicitation workshop in 2018, the experts considered it unlikely that an individual would repeatedly return to an area where it had been previously displaced, and therefore unlikely to result in reduced foraging opportunities over a number of days that would be required to reduce body condition or fertility (Booth *et al*., 2019).

11.7.115 During the expert elicitation workshop in 2018, experts also agreed that harbour seals have a reasonable ability to compensate for missed foraging opportunities from disturbance (from exposure to low frequency broadband pulsed noise such as piling driving) due to their generalist diet, adequate fat stores, mobility, and life-history traits (Booth *et al*., 2019), for example, they have a thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods. Therefore, they are likely to have the capacity to tolerate short-term displacement from foraging grounds during piling activity. Foraging ranges of up to 273 km from a haul-out have been reported for harbour seals, based on analysis of telemetry data (Carter *et al*., 2022). However, typically, harbour seals normally forage within 50 km of their haul-out site and show high site fidelity (Carter *et al*., 2022).

11.7.116 Based on the above, harbour seals are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Grey Seal

11.7.117 There is limited information on the behavioural responses of grey seals to underwater noise during pile driving. Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the construction of the Luchterduinen wind farm and from 16 grey seals in 2015 during the construction of the Gemini wind farm (Aarts *et al*., 2018). The most common response suggested a change in behaviour from foraging to horizontal movement, although various other responses were recorded including altered surfacing and diving behaviour, changes in swim direction, and no response (Aarts *et al*., 2018). Data from this study also showed that seals returned to the area on subsequent trips, despite receiving multiple exposures.

11.7.118 During an expert elicitation workshop in 2018, it was concluded that grey seals were considered to have a reasonable ability to compensate for missed foraging opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al*., 2019). In general, experts agreed that grey seals would be more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet and more adaptable in their foraging strategies (Booth *et al*., 2019). Experts also agreed that moderate-high levels of repeated disturbance would be required for any effect on grey seal fertility rates (Booth *et al*., 2019).

11.7.119 Grey seals are highly adaptable to a changing environment. They can adjust their metabolic rate and foraging strategies and can compensate for lost opportunities due to their generalist diet, mobility, and adequate fat stores (Smout *et al*., 2014; Stansbury *et al*., 2015). They are also able to tolerate periods of fasting as part of their life history because of their large body size and thick layer of blubber (i.e. more energy reserve) (Pomeroy *et al*., 1999). Foraging ranges of up to 448 km from a haul-out have been reported for grey seals, and 100 km on average distances based on the analysis of telemetry data (Carter *et al*., 2022).

11.7.120 Based on the above, grey seals are considered to be of high adaptability, reasonable to high tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Basking Shark

11.7.121 As detailed in paragraphs 11.7.87 to 11.7.90 basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise, and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.122 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors are presented in Table 11.27 and Table 11.28.

11.7.123 The magnitude of impact is deemed to be Low for harbour porpoise, minke and humpback whales and basking sharks and Negligible for other dolphin and seals species for auditory injury from underwater noise from piling (Table 11.27). The sensitivity of the receptor is Low for injury from underwater noise from piling. The effect will, therefore, be of Minor or Negligible significance, which is not significant in EIA terms.

11.7.124 The magnitude of impact is deemed to be Medium for Risso's Dolphin and white-beaked dolphin, Low for harbour porpoise, bottlenose dolphin, Atlantic white-sided dolphin, minke whale, humpback whale, grey seal and basking shark and, Negligible for harbour seal for disturbance from underwater noise from piling Table 11.28. The sensitivity of the receptor is Low for disturbance from underwater noise from piling. The effect will, therefore, be of Minor or Negligible significance, which is not significant in EIA terms.

Table 11.27 Significance of Impact 1: Injury From Underwater Noise From Piling

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Negligible | Low | Negligible |
| Risso's dolphin | Negligible | Low | Negligible |
| Atlantic white-sided dolphin | Negligible | Low | Negligible |
| White-beaked dolphin | Negligible | Low | Negligible |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Negligible | Low | Negligible |
| Basking shark | Low | Low | Minor |

Table 11.28 Significance of Impact 1: Disturbance From Underwater Noise From Piling

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Medium | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Medium | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

*Secondary Mitigation and Residual Effect*

11.7.125 The significance of the effect from injury and disturbance to marine mammals and basking sharks from underwater noise from piling is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.126 Cetaceans are EPS listed on Annex IV of the European Union (EU) Habitats Directive, making it an offence to kill, injure or disturb them. An EPS risk assessment is required to assess the risk that an offence will occur assess the need for an EPS license and provide MD-LOT with the information required in support of the application.

11.7.127 The Applicant will provide an EPS risk assessment for injury and disturbance from piling at the post consent stage, once final piling parameters are confirmed. It is expected that, with the commitment to a MMMP (C-OFF-19) to reduce the auditory injury to Negligible levels, no EPS will be injured, and therefore an EPS licence for injury is unlikely to be required. For disturbance, the impact assessment has concluded that disturbance from piling will not be detrimental to maintaining the species at FCS, meeting the EPS test 3. It is expected that an EPS licence for disturbance might be required.

## Impact 2: Injury and Disturbance From Underwater Noise From UXO Clearance

11.7.128 It is possible that UXO items with a range of charge weights (or quantity of contained explosive) are present within the boundaries of the Proposed Development, therefore there is potential for UXO clearance to be required prior to construction. While it may be possible for identified UXO to be either avoided, removed, or relocated, there is potential that underwater detonation could be required where it is deemed necessary and unsafe to remove the UXO.

11.7.129 The preferred method of UXO clearance considered for the Proposed Development is low order detonation, with high order used as last resort (worst-case scenario) as per the Unexploded Ordnance Joint Position Statement (UK Government, 2025; Marine Directorate, 2025). Both high and low order detonation are included in the assessment.

11.7.130 The number of UXO that may require clearance and duration of UXO clearance operations are currently unknown. Therefore, it is important to note that the assessments for UXO clearance presented within this chapter are, at this stage, illustrative and based on different charge weight as detailed in paragraph 11.6.35, with the maximum charge weight estimated to be present in the Aspen Array area being 907 kg.

11.7.131 The severity of the consequences of UXO detonation will depend on several variables, including, but not limited to, the charge weight and its proximity to the receptor. Potential impacts of underwater detonation of UXOs on marine mammals include auditory injury from exposure to the acoustic wave, resulting in permanent auditory injury or loss in hearing sensitivity (PTS), or temporary loss in hearing sensitivity (TTS); and behavioural disturbance which could impact on feeding, mating, breeding, and/or resting (Ketten, 2004; Richardson *et al*., 1995; von Benda-Beckmann *et al*., 2015).

### *Magnitude of Impact*

#### Auditory Injury - PTS

11.7.132 The following section provides the quantitative assessment of the impact of PTS from UXO clearance on marine mammals. A UXO detonation is defined as a single pulse, therefore both the weighted $SEL_{cum}$ criteria and the unweighted $SPL_{peak}$ criteria from Southall *et al*. (2019) have been presented in Table 11.13 and the source levels (unweighted $SPL_{peak}$ and $SEL_{ss}$) for each charge weight are presented in Table 11.15, whereby $SEL_{cum}$ is equivalent to $SEL_{ss}$. As a result, animal fleeing assumptions do not apply to the values presented. The predicted impact ranges for auditory injury (PTS-onset) from UXO clearance for each FHG are presented in Table 11.29 and the number of animals predicted to experience PTS-onset from UXO clearance are presented in Table 11.30 and Table 11.31.

11.7.133 In general, the estimated auditory injury (PTS-onset) impact ranges increased with the size of the charge for all FHGs. For harbour porpoise, the maximum PTS-onset impact range was 15 km ($SPL_{peak}$). This equates to a maximum of 424 individuals experiencing auditory injury (0.27% of the UK reference population) from a high order UXO clearance using the greatest charge weight (907 kg plus donor) using the SCANS-IV survey block density estimates (Table 11.30).

11.7.134 For all charge sizes, HF cetaceans (dolphin species) have the smallest predicted impact range of up to 880 m ($SPL_{peak}$) (Table 11.29). For bottlenose dolphin, Risso's dolphin, white-beaked dolphin and Atlantic white-sided dolphin, the maximum PTS-onset impact range was 880 m ($SPL_{peak}$), which equates to <1 individual experiencing auditory injury (<0.01% of the UK reference population) from a high order UXO clearance when using the SCANS-IV density estimates (Table 11.30).

11.7.135 For all FHGs, the unweighted $SPL_{peak}$ impact ranges are higher than the weighted $SEL_{ss}$ impact ranges with the exception of LF cetaceans (minke whale), due to the sensitivity of their hearing (Table 11.29). For minke whale, the maximum PTS-onset impact range was 12 km ($SEL_{ss}$) (Table 11.29). This equates to a maximum of 35 individuals experiencing auditory injury (0.34% of the reference population) from a high order UXO clearance using the greatest charge weight (907 kg plus donor) when using the SCANS-IV density surface estimates (Table 11.31).

11.7.136 For seals, the maximum PTS-onset impact range was 3 km ($SPL_{peak}$) (Table 11.29). This equates to <1 grey seal (0.01% of the reference population) and <1 harbour seal (<0.01% of the reference population) experiencing auditory injury from a high order UXO clearance using the greatest charge weight (Table 11.30).

11.7.137 For all FHGs, the auditory injury (PTS-onset) impact range for low order clearance is small, with a maximum range of 990 m (Table 11.29).

11.7.138 A quantitative assessment has not been conducted for humpback whales due to the lack of density estimates and MU size. The expected PTS-onset impact ranges would be the same as those presented for LF cetaceans (Table 11.29). As humpback whales are less frequently sighted in the Proposed Development area than minke whales, it is expected that the number of individuals impacted would be smaller.

11.7.139 Basking sharks have also not been quantitatively assessed due to the lack of density estimates. The impacts of mortality, potential mortal injury and TTS (not PTS) are assessed in **Volume 2, Chapter 10: Fish and Shellfish Ecology**, Impact 1. The maximum impact range from high order UXO clearance is up to 910 m for the highest charge weight (907 kg plus donor) and for low order up to 60 m. As a group 1 species, the magnitude of the impact is predicted to be of small spatial extent, short duration, intermittent and reversible. Therefore, the magnitude of the impact is assessed as Low.

11.7.140 For all marine mammal species, the impact is considered to result in a very small proportion of the population affected and very unlikely to affect the population trajectory, although auditory injury (PTS) is expected to have a permanent change to the receptor. Therefore, the magnitude of impact is assessed as Low for harbour porpoise, minke whale and humpback whales. For all other dolphin species, grey seal and harbour seal, <1 animal is predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible.

Table 11.29 Summary of Auditory Injury (PTS-onset) Impact Ranges for UXO Detonation Using Impulsive Noise Criteria from Southall *et al.* (2019) for Marine Mammals

| Charge Weight (kg) | PTS-onset (unweighted $SPL_{peak}$) | | | | PTS-onset (weighted $SEL_{ss}$) | | | |
|---|---|---|---|---|---|---|---|---|
| | LF | HF | VHF | PCW | LF | HF | VHF | PCW |
| Low order (0.25 kg) | 170 m | 60 m | 990 m | 190 m | 230 m | <50 m | 80 m | <50 m |
| 25 kg (+donor) | 820 m | 260 m | 4.6 km | 910 m | 2.2 km | <50 m | 570 m | 390 m |
| 55 kg (+donor) | 1.0 km | 340 m | 6.0 km | 1.1 km | 3.2 km | <50 m | 740 m | 570 m |
| 120 kg (+donor) | 1.3 km | 450 m | 7.8 km | 1.5 km | 4.7 km | <50 m | 950 m | 830 m |
| 240 kg (+donor) | 1.7 km | 560 m | 9.8 km | 1.9 km | 6.5 km | <50 m | 1.1 km | 1.1 km |
| 525 kg (+donor) | 2.2 km | 730 m | 12.0 km | 2.5 km | 9.5 km | 50 m | 1.4 km | 1.6 km |
| 698 kg (+donor) | 2.4 km | 810 m | 13.0 km | 2.7 km | 10.0 km | 60 m | 1.5 km | 1.9 km |
| 750 kg (+donor) | 2.5 km | 830 m | 14.0 km | 2.8 km | 11.0 km | 60 m | 1.5 km | 2.0 km |
| 907 kg (+donor) | 2.7 km | 880 m | 15.0 km | 3 km | 12.0 km | 70 m | 1.6 km | 2.2 km |

Table 11.30 Predicted Impact of PTS-onset (unweighted $SPL_{peak}$) for Marine Mammals From UXO Clearance; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/km$^2$) | Impact | PTS-onset (unweighted $SPL_{peak}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| Harbour porpoise | 0.5444 | # | 2 | 37 | 62 | 105 | 165 | 247 | 289 | 336 | 385 |
| | | % NS MU | <0.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.07 | 0.08 | 0.10 | 0.11 |
| | | % UK MU | <0.01 | 0.02 | 0.04 | 0.07 | 0.10 | 0.15 | 0.18 | 0.21 | 0.24 |
| | 0.2510 | # | <1 | 17 | 29 | 48 | 76 | 114 | 134 | 155 | 178 |
| | | % NS MU | <0.01 | <0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.04 | 0.04 | 0.05 |
| | | % UK MU | <0.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.07 | 0.08 | 0.10 | 0.11 |
| | 0.5985 | # | 2 | 40 | 68 | 115 | 181 | 271 | 318 | 369 | 424 |
| | | % NS MU | <0.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.08 | 0.09 | 0.11 | 0.12 |
| | | % UK MU | <0.01 | 0.02 | 0.04 | 0.07 | 0.11 | 0.17 | 0.20 | 0.23 | 0.27 |
| White-beaked dolphin | 0.2047 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | PTS-onset (unweighted $SPL_{peak}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | 0.0799 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond) | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CES MU | <0.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.09 | 0.11 | 0.11 | 0.12 |
| | 0.0023 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.001 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Risso's dolphin | 0.0702 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0013 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | PTS-onset (unweighted $SPL_{peak}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | # | <1 | <1 | <1 | <1 | <1 | 1 | 1 | 2 | 2 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| | 0.0419 | # | <1 | <1 | <1 | <1 | <1 | 1 | 1 | 1 | 1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0195 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

Table 11.31 Predicted Impact of PTS-onset (weighted $SEL_{ss}$) for Marine Mammals From UXO Clearance; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/km$^2$) | Impact | PTS-onset (weighted $SEL_{ss}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| Harbour porpoise | 0.5444 | # | <1 | 1 | 1 | 2 | 3 | 4 | 4 | 4 | 5 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.2510 | # | <1 | <1 | <1 | <1 | 1 | 2 | 2 | 2 | 3 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.5985 | # | <1 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 5 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| White-beaked dolphin | 0.2047 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0799 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CES MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/km$^2$) | Impact | PTS-onset (weighted $SEL_{ss}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | 0.0023 (beyond) | | | | | | | | | | |
| | 0.0023 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.001 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Risso's dolphin | 0.0702 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0013 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | # | <1 | 2 | 3 | 6 | 11 | 22 | 25 | 30 | 35 |
| | | % CGNS MU | <0.01 | 0.01 | 0.01 | 0.03 | 0.05 | 0.11 | 0.12 | 0.15 | 0.17 |
| | | % UK MU | <0.01 | 0.01 | 0.02 | 0.05 | 0.10 | 0.21 | 0.23 | 0.28 | 0.34 |
| | 0.0419 | # | <1 | 1 | 2 | 3 | 6 | 12 | 14 | 16 | 19 |
| | | % CGNS MU | <0.01 | <0.01 | 0.01 | 0.01 | 0.03 | 0.06 | 0.07 | 0.08 | 0.09 |
| | | % UK MU | <0.01 | 0.01 | 0.01 | 0.03 | 0.05 | 0.12 | 0.13 | 0.15 | 0.18 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |

| Species | Density (animals/km²) | Impact | PTS-onset (weighted $SEL_{ss}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0195 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

### Disturbance

11.7.141 This section provides the quantitative assessment for behavioural disturbance during UXO clearance using high order and low order methodologies as described in section 11.6.

#### 26 km EDR for High Order Clearance

11.7.142 The number of each marine mammal species predicted to experience behavioural disturbance as a result of high order UXO detonation using a 26 km EDR is quantified by multiplying the area of impact (assuming a 26 km EDR results in an impact area of 2,123.72 $km^2$) by the respective species-specific density estimate. For bottlenose dolphins in the CES MU, due to the limited range of the MU within the 2 km of the coast, a UXO detonation location that resulted in the maximum overlap with the 2 km of the coast area and the CES MU was selected as the worst-case scenario, resulting in an impact area of 1,261.49 $km^2$.

11.7.143 The results are presented in Table 11.32 and assessed as the proportion of the respective reference population (as presented in Table 11.5). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.7.144 The greatest estimated disturbance occurs for harbour porpoise (1,271 individuals, <1% UK reference population), white-beaked dolphins (435 individuals, 1.72% UK reference population) and minke whale (164 individuals, 1.59% UK reference population) (Table 11.32).

11.7.145 For Risso's dolphin, in addition to the density for the Aspen Array Area (Waggit *et al.*, 2019), neighbouring block densities were also considered due to uncertainties with data quality. This translates in 150 individuals (1.72% of the UK reference population) potentially being disturbed in a worst-case scenario, but three individuals (0.03% of the UK reference population) being disturbed using densities specific for the Aspen Array Area (Table 11.32). This is considered a small proportion of the MU.

11.7.146 For all other species, <1% of the MU is predicted to be impacted, except for bottlenose dolphins with up to 16 individuals within the CES MU, up to 6.70% of the population may be disturbed. This is considered a moderate proportion of the MU.

11.7.147 While it is expected that a high order UXO detonation would elicit a startle response and therefore, only a very short-term duration behavioural response is expected (JNCC, 2020); there is however no empirical evidence of any marine mammal species' response to these events. The impact is considered to result in a small proportion of the population affected (except for bottlenose dolphins which is moderate) with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory.

11.7.148 For harbour seals, as less than one individual is predicted to be impacted by disturbance from high order UXO clearance the magnitude is assessed as Negligible.

11.7.149 For Risso's dolphins, while a moderate proportion of the MU may be disturbed by high-order UXO clearance, the extent and duration of the disturbance is not expected to result in a change to the population trajectory. Therefore, the impact of disturbance from high order UXO clearance is assessed as having a Low magnitude.

11.7.150 For the bottlenose dolphin CES MU while a moderate proportion of the MU may be disturbed by high-order UXO clearance, the extent and duration of the disturbance is not expected to result in a change to the population trajectory. In addition, the implementation of the embedded commitments that the Applicant has committed to, will reduce the risk of disturbance as for example the use of ADD will displace animals, reducing the number likely to be disturbed. Therefore, the impact of disturbance from high order UXO clearance is assessed as having a Medium magnitude.

11.7.151 For all other marine mammal species, the impact of disturbance from high order UXO clearance is assessed as having a Low magnitude.

11.7.152 Basking sharks have also not been quantitatively assessed due to the lack of density estimates. The impact of disturbance is assessed in **Volume 2, Chapter 10: Fish and Shellfish Ecology**, Impact 1 for all group species, including basking sharks. The behavioural impacts of high order UXO clearance on basking sharks are expected to be within tens to hundreds of metres from the source, with the risk reducing to low at greater distances (Popper *et al*., 2014). Basking sharks are expected to move away from the area before UXO clearance works take place, greatly reducing the risk of disturbance. Given the intermittent and localised nature of UXO clearance and the precautionary nature of underwater noise modelling for UXO impact ranges, the impact of disturbance is estimated to affect a very small proportion of the population and is very unlikely to affect the population trajectory. Therefore, the magnitude of the impact is assessed as Low.

Table 11.32 Predicted Impact of Disturbance to Marine Mammals From UXO Clearance Assuming a 26 km EDR

| Species | Density (animals/km$^2$) | Number of animals disturbed | Percentage of the MU (%) | Percentage of the UK MU (%) |
|---|---|---|---|---|
| Harbour porpoise | 0.5444 | 1,157 | 0.33 | 0.72 |
| | 0.2510 | 534 | 0.15 | 0.33 |
| | 0.5985 | 1,271 | 0.37 | 0.80 |
| White-beaked dolphin | 0.2047 | 435 | 0.99 | 1.28 |
| | 0.009 | 20 | 0.04 | 0.06 |
| | 0.0799 | 170 | 0.39 | 0.50 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond) | 16[4] | 6.70 | |

[4] Assuming a UXO detonation location with a maximum overlap with the 2 km from coast area.

| Species | Density (animals/km²) | Number of animals disturbed | Percentage of the MU (%) | Percentage of the UK MU (%) |
|---|---|---|---|---|
| | 0.0023 | 5 | 0.24 | 0.26 |
| | 0.001 | 3 | 0.11 | 0.11 |
| Risso's dolphin | 0.0702 | 150 | 1.21 | 1.72 |
| | 0.0013 | 3 | 0.02 | 0.03 |
| Atlantic white-sided dolphin | 0.0100 | 22 | 0.12 | 0.17 |
| Minke whale | 0.0769 | 164 | 0.81 | 1.59 |
| | 0.0419 | 89 | 0.44 | 0.86 |
| Harbour Seal | 0.000008 | <1 | <0.01 | <0.01 |
| Grey seal | 0.004 | 9 | 0.13 | 0.13 |
| | 0.0195 | 42 | 0.66 | 0.66 |

### 5 km EDR for Low Order Clearance

11.7.153 The number of each marine mammal species predicted to experience behavioural disturbance as a result of low order UXO detonation using a 5 km EDR is quantified by multiplying the area of impact (assuming a 5 km EDR results in an impact area of 78.54 km$^2$) by the respective species-specific density estimate. For bottlenose dolphins in the CES MU, due to the limited range of the MU within the 2 km of the coast, a UXO detonation location that resulted in the maximum overlap with the 2 km of the coast area and the CES MU was selected as the worst-case scenario, resulting in an impact area of 78.54 km$^2$.

11.7.154 The results are presented in Table 11.33 and assessed as the proportion of the respective reference population (as presented in Table 11.5). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.7.155 The greatest estimated disturbance occurs for harbour porpoise (47 individuals), white-beaked dolphin (17 individuals) and minke whale (six individual) (Table 11.33).

11.7.156 For Risso's dolphin, in addition to the densities for the Aspen Array Area (Waggit *et al*., 2019), neighbouring block densities were also considered due to uncertainties with data quality. This translates in six individuals potentially being disturbed in a worst-case scenario, but less than one individual being disturbed using densities specific for the Aspen Array Area (Table 11.33).

11.7.157 For all marine mammal species, the predicted impact of the relevant UK MU is <1%. The only exception is the bottlenose dolphins in the CES MU where up 1.14% of the MU is predicted to be disturbed.

11.7.158 The impact of low order detonation is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for all marine mammal species, with the exception of bottlenose dolphins GNS, Atlantic white-sided dolphin and harbour seals as less than one individual is predicted to be impacted by disturbance from low order UXO clearance they are assessed as Negligible.

11.7.159 Basking sharks were assessed qualitatively due to the lack of density estimates. The impact of disturbance is assessed in **Volume 2, Chapter 10: Fish and Shellfish Ecology**, Impact 1 for all group species, including basking sharks. The behavioural impacts of low order UXO clearance on basking sharks are expected to be lower than high order impacts. Given the intermittent and localised nature of UXO clearance and the precautionary nature of underwater noise modelling for UXO impact ranges, the impact of disturbance is estimated to affect a very small proportion of the population and is very unlikely to affect the population trajectory. Therefore, the magnitude of the impact is assessed as Negligible.

Table 11.33 Predicted Impact of Disturbance to Marine Mammals From UXO Clearance Assuming a 5 km EDR

| Species | Density (animals/km$^2$) | Number of animals disturbed | Percentage of the Reference Population | Percentage of the UK Reference Population |
|---|---|---|---|---|
| Harbour porpoise | 0.5444 | 43 | 0.01 | 0.03 |
| | 0.2510 | 20 | 0.01 | 0.01 |
| | 0.5985 | 47 | 0.01 | 0.03 |
| White-beaked dolphin | 0.2047 | 17 | 0.04 | 0.05 |
| | 0.009 | 1 | <0.01 | <0.01 |
| | 0.0799 | 7 | 0.01 | 0.02 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond) | 3[5] | 1.14 | |
| | 0.0023 | <1 | 0.01 | 0.01 |
| | 0.001 | <1 | <0.01 | <0.01 |
| Risso's dolphin | 0.0702 | 6 | 0.04 | 0.06 |
| | 0.0013 | <1 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | <1 | <0.01 | 0.01 |
| Minke whale | 0.0769 | 6 | 0.03 | 0.06 |
| | 0.0419 | 4 | 0.02 | 0.03 |
| Harbour Seal | 0.000008 | <1 | <0.01 | <0.01 |
| Grey seal | 0.004 | <1 | <0.01 | <0.01 |
| | 0.0195 | 2 | 0.02 | 0.02 |

[5] Assuming a UXO detonation location with a maximum overlap with the 2 km from coast area.

## TTS as a Proxy

11.7.160 The predicted impact ranges for UXO clearance using TTS as a proxy for disturbance considering the different charge weights and impact criteria are presented in Table 11.34 and the number of animals predicted to experience TTS-onset from UXO clearance are presented in Table 11.35 and Table 11.36.

11.7.161 When dealing with high-order UXO clearances, using a maximum charge of 907 kg, the furthest distances at which disturbance effects are expected vary by species group, at approximately 120 km for LF cetaceans, 28 km for VHF cetaceans, 24 km for pinnipeds and 1.6 km for HF cetaceans. However, the projected 120 km impact radius for minke whales is likely overestimated. Research by Matei *et al.* (2024) suggests that noise levels above 180 dB are not exceeded beyond 20 km from detonation points in real-world UXO events.

11.7.162 For all FHGs, the unweighted $SPL_{peak}$ impact ranges are higher than the weighted $SEL_{ss}$ impact ranges with the exception of LF cetaceans (minke whale) and seals, due to the sensitivity of their hearing (Table 11.34).

11.7.163 Among all species assessed, minke whales were predicted to experience the greatest disturbance, with an estimated 3,477 individuals potentially disturbed, representing 17.28% of the CGNS MU and 33.80% of the UK MU (Table 11.36). Further, approximately 1,475 harbour porpoise are expected to be disturbed, accounting for 0.43% of the NS MU and 0.92% of the UK MU (Table 11.35). In addition, grey seals are also predicted to be disturbed, with around 36 individuals impacted, representing 0.56% of the East Scotland MU (Table 11.36). All other marine mammal species have fewer than two individuals predicted to experience disturbance, representing less than 0.01% of any relevant MU or UK MU.

11.7.164 For low-order clearances (0.25 kg) predicted disturbance ranges are up to 3.2 km for LF cetaceans, 1.80 km for VHF cetaceans, 0.57 km for pinnipeds and 0.1 km for HF cetaceans (Table 11.34). A maximum of three minke whales (0.01% of the CGNS MU and 0.02% of the UK MU populations) and seven harbour porpoise (<0.01% of both the NS MU and UK populations) are predicted to experience disturbance and less than one individual for all other marine mammal species(Table 11.35 and Table 11.36).

11.7.165 While high-order detonation represents the realistic worst-case scenario, in practise, low-order clearance methods such as deflagration are expected to be used instead for UXO clearance. These approaches are substantially less disruptive. Furthermore, Southall *et al.* (2007) noted that using TTS onset levels as a proxy for behavioural disturbance is likely a conservative assumption. TTS typically does not persist for an entire diel cycle and is unlikely to lead to lasting biological effects. Therefore, estimates based on TTS thresholds potentially overstate the actual behavioural impact on marine mammals.

11.7.166 The detonation of UXOs is anticipated to trigger a startle response in nearby marine mammals, possibly followed by brief and temporary behavioural changes. However, these effects are unlikely to result in broad-scale or sustained displacement. For most marine mammal species, the proportion of their respective MUs predicted to be impacted is very small the behavioural responses are expected to be short-lived and intermittent with temporary behavioural effects that are unlikely to alter the population trajectory.

11.7.167 As such, TTS impacts related to UXO clearance are considered Negligible for bottlenose dolphins, white-beaked dolphins, Risso's dolphins, Atlantic white-sided dolphin and harbour seal, each with two or fewer individuals expected to be disturbed. For harbour porpoise, humpback whale and grey seal, the impacts are characterised as Low, given the limited scale and transient nature of the disturbance. For minke whales, whilst the predicted numbers are considered precautionary, they suggest a higher proportion of the population could be temporarily disturbed. Nevertheless, the impacts remain short-term and are not expected to change long-term population trends. Given this, TTS effects from UXO clearance on minke whales are assessed as Medium due to the relatively higher scale of potential disturbance.

11.7.168 As detailed in sections 11.7.87 to 11.7.90 and **Volume 2, Chapter 10: Fish and Shellfish Ecology**, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise impacts (mortality and auditory injury). The sensitivity of the receptor is Low.

Table 11.34 Summary of Temporary Threshold Shift -onset Impact Ranges Used as a Proxy for Disturbance for UXO Detonation Using the Impulsive Noise Criteria from Southall *et al.* (2019) for Marine Mammals

| Charge Weight (kg) | TTS (unweighted $SPL_{peak}$) | | | | TTS (weighted $SEL_{ss}$) | | | |
|---|---|---|---|---|---|---|---|---|
| | LF | HF | VHF | PCW | LF | HF | VHF | PCW |
| Low order (0.25 kg) | 320 m | 100 m | 1.80 km | 360 m | 3.2 km | <50 m | 750 m | 570 m |
| 25 kg (+donor) | 1.5 km | 490 m | 8.5 km | 1.6 km | 29 km | 150 m | 2.4 km | 5.2 km |
| 55 kg (+donor) | 1.9 km | 640 m | 11 km | 2.1 km | 41 km | 210 m | 2.8 km | 7.5 km |
| 120 kg (+donor) | 2.5 km | 830 m | 14 km | 2.8 km | 57 km | 300 m | 3.2 km | 10 km |
| 240 kg (+donor) | 3.2 km | 1.0 km | 18 km | 3.5 km | 76 km | 390 m | 3.5 km | 14 km |
| 525 kg (+donor) | 4.1 km | 1.3 km | 23 km | 4.6 km | 100 km | 530 m | 4 km | 19 km |
| 698 kg (+donor) | 4.5 km | 1.4 km | 25 km | 5.0 km | 110 km | 590 m | 4.1 km | 22 km |
| 750 kg (+donor) | 4.6 km | 1.5 km | 26 km | 5.1 km | 110 km | 600 m | 4.2 km | 22 km |
| 907 kg (+donor) | 4.9 km | 1.6 km | 28 km | 5.5 km | 120 km | 650 m | 4.3 km | 24 km |

Table 11.35 Predicted Impact of TTS-onset (unweighted $SPL_{peak}$) for Marine Mammals From UXO Clearance; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/ $km^2$) | Impact | TTS-onset (unweighted $SPL_{peak}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| Harbour porpoise | 0.5444 | # | 6 | 124 | 207 | 336 | 555 | 905 | 1,069 | 1,157 | 1,341 |
| | | % NS MU | <0.01 | 0.04 | 0.06 | 0.10 | 0.16 | 0.26 | 0.31 | 0.33 | 0.39 |
| | | % UK MU | <0.01 | 0.08 | 0.13 | 0.21 | 0.35 | 0.57 | 0.67 | 0.72 | 0.84 |
| | 0.2510 | # | 3 | 57 | 96 | 155 | 256 | 418 | 493 | 534 | 619 |
| | | % NS MU | <0.01 | 0.02 | 0.03 | 0.04 | 0.07 | 0.12 | 0.14 | 0.15 | 0.18 |
| | | % UK MU | <0.01 | 0.04 | 0.06 | 0.10 | 0.16 | 0.26 | 0.31 | 0.33 | 0.39 |
| | 0.5985 | # | 7 | 136 | 228 | 369 | 610 | 995 | 1,176 | 1,272 | 1,475 |
| | | % NS MU | <0.01 | 0.04 | 0.07 | 0.11 | 0.18 | 0.29 | 0.34 | 0.37 | 0.43 |
| | | % UK MU | <0.01 | 0.09 | 0.14 | 0.23 | 0.38 | 0.62 | 0.74 | 0.80 | 0.92 |
| White-beaked dolphin | 0.2047 | # | <1 | <1 | <1 | <1 | 1 | 2 | 2 | 2 | 2 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0799 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 1 | 1 |

| Species | Density (animals/ km²) | Impact | TTS-onset (unweighted $SPL_{peak}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and 0.0023 (beyond) | # | <1 | <1 | <1 | <1 | <1 | 1 | 1 | 1 | 1 |
| | | % CES MU | <0.01 | 0.04 | 0.07 | 0.11 | 0.16 | 0.27 | 0.32 | 0.36 | 0.41 |
| | 0.0023 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.001 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Risso’s dolphin | 0.0702 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 1 | 1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 |
| | 0.0013 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Species | Density (animals/ $km^2$) | Impact | TTS-onset (unweighted $SPL_{peak}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | # | <1 | 1 | 1 | 2 | 3 | 5 | 5 | 6 | 6 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 | 0.04 | 0.05 | 0.05 | 0.06 |
| | 0.0419 | # | <1 | <1 | 1 | 1 | 2 | 3 | 3 | 3 | 4 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.03 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0195 | # | <1 | <1 | <1 | <1 | 1 | 2 | 2 | 2 | 2 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 |

Table 11.36 Predicted Impact of TTS-onset (weighted $SEL_{ss}$) for Marine Mammals From UXO Clearance; # = Number of Animals Disturbed; % = the Percentage of the Reference Population

| Species | Density (animals/km$^2$) | Impact | TTS-onset (weighted $SEL_{ss}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| Harbour porpoise | 0.5444 | # | 1 | 10 | 14 | 18 | 21 | 28 | 29 | 31 | 32 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | | % UK MU | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 |
| | 0.2510 | # | 1 | 5 | 7 | 9 | 10 | 13 | 14 | 14 | 15 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | 0.5985 | # | 2 | 11 | 15 | 20 | 24 | 31 | 32 | 34 | 35 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | | % UK MU | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 |
| White-beaked dolphin | 0.2047 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.009 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0799 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % NS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Bottlenose Dolphin | 0.116 (within 2 km of the coast) and | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CES MU | <0.01 | <0.01 | 0.01 | 0.01 | 0.02 | 0.05 | 0.06 | 0.06 | 0.07 |

| Species | Density (animals/km²) | Impact | TTS-onset (weighted $SEL_{ss}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | 0.0023 (beyond) | | | | | | | | | | |
| | 0.0023 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.001 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % GNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Risso's dolphin | 0.0702 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 0.0013 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Atlantic white-sided dolphin | 0.0100 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % CGNS MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | | % UK MU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Minke whale | 0.0769 | # | 3 | 204 | 406 | 785 | 1,395 | 2,415 | 2,922 | 2,922 | 3,477 |
| | | % CGNS MU | 0.01 | 1.01 | 2.02 | 3.90 | 6.93 | 12.00 | 14.52 | 14.52 | 17.28 |
| | | % UK MU | 0.02 | 1.97 | 3.95 | 7.63 | 13.56 | 23.47 | 28.40 | 28.40 | 33.80 |
| | 0.0419 | # | 2 | 111 | 222 | 428 | 761 | 1,317 | 1,593 | 1,593 | 1,896 |

| Species | Density (animals/km²) | Impact | TTS-onset (weighted $SEL_{ss}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low Order (0.25 kg) | 25 kg + donor | 55 kg + donor | 120 kg + donor | 240 kg + donor | 525 kg + donor | 698 kg + donor | 750 kg + donor | 907 kg + Donor |
| | | % NS MU | 0.01 | 0.55 | 1.10 | 2.13 | 3.78 | 6.54 | 7.92 | 7.92 | 9.42 |
| | | % UK MU | 0.01 | 1.08 | 2.15 | 4.16 | 7.39 | 12.79 | 15.48 | 15.48 | 18.42 |
| Harbour Seal | 0.000008 | # | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | % ES SMU | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Grey seal | 0.004 | # | <1 | <1 | 1 | 2 | 3 | 5 | 7 | 7 | 8 |
| | | % ES SMU | <0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.07 | 0.10 | 0.10 | 0.11 |
| | 0.0195 | # | <1 | 2 | 4 | 7 | 13 | 23 | 30 | 30 | 36 |
| | | % ES SMU | <0.01 | 0.03 | 0.05 | 0.10 | 0.19 | 0.35 | 0.47 | 0.47 | 0.56 |

*Sensitivity of Receptor*

Auditory Injury - PTS

Marine Mammals

11.7.169 For marine mammals, hearing is a key sensory mechanism via which they negotiate the underwater environment. It is essential for navigation, communication and locating prey (Southall *et al.*, 2007). The ecological consequences of PTS are uncertain, although loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, in turn, potentially causing a change in an individual's heath or vital rates (Erbe *et al.*, 2018). Relating a potential loss of hearing to a biologically significant response is challenging due to a paucity of empirical data. However, a potential consequence of a disruption in key life functions is that the health of impacted individuals would deteriorate and potentially lead to reduced birth rate in females and potentially mortality.

11.7.170 The primary acoustic energy produced by a high order detonation is below the region of greatest sensitivity for harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW) (Southall *et al.*, 2019), with most acoustic energy produced below a few hundred Hz, and decreasing by around SEL 10 dB per decade above 100 Hz (von Benda-Beckmann *et al.*, 2015; Salomons *et al.*, 2021). There is also a pronounced reduction in energy levels above 5-10 kHz (von Benda-Beckmann *et al.*, 2015; Salomons *et al.*, 2021). Therefore, if PTS were to occur as a result of UXO clearance, there would be little impact to vital rates in harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW).

11.7.171 Recent evidence has found that the sound produced during UXO high order detonation has lower frequency components (<100 Hz) than previously assumed (Robinson *et al.*, 2022). Therefore, the primary acoustic energy produced by a high order detonation may not overlap with the hearing sensitivity of LF cetaceans, such as minke and humpback whales, as previously thought. Consequently, this assessment is likely to be overly precautionary for these species.

11.7.172 Comparison of high order detonation and low order deflagration methods for UXO clearance found a substantial reduction in the sound produced with low order deflagration (Robinson *et al.*, 2020; Lepper *et al.*, 2024). For low order deflagration, both peak SPL and SEL were around 20 dB lower than for the traditional high order detonation method (Lepper *et al.*, 2024).

11.7.173 PTS is a permanent effect which cannot be recovered from. If PTS were to occur within this low frequency range, it is unlikely that it would result in a significant impact on the vital rates of harbour porpoise, dolphin and seal species. As a result, these species are considered to be of reasonable adaptability, reasonable tolerance, have no recoverability, and are of very high value. The sensitivity of these receptors is Low**.**

11.7.174 While also considering minke and humpback whale's sensitivity to low frequency noise which overlap with the detonation noise during UXO clearance, the species is considered to be of reasonable adaptability, limited tolerance, have no recoverability, and are of very high value. The sensitivity of the receptors is Medium**.** However, as discussed in paragraph 11.7.171, this assessment is precautionary.

Basking shark

11.7.175 As detailed in sections 11.7.87 to 11.7.90 and **Volume 2, Chapter 10: Fish and Shellfish Ecology**, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise impacts (mortality and auditory injury). The sensitivity of the receptor is Low.

**Disturbance**

Marine Mammals

11.7.176 JNCC (2020) guidance states that 'a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement'. Each donation will be of short-term duration; therefore, it is not expected that behavioural disturbance from a single UXO detonation would cause a significant impact or result in any changes to the vital rates of individuals.

11.7.177 Based on the above, all marine mammal receptors within this assessment are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of these receptors is Low.

Basking Shark

11.7.178 As detailed in sections 11.7.87 to 11.7.90 and **Volume 2, Chapter 10: Fish and Shellfish Ecology**, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise, and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.179 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors are presented in Table 11.37, Table 11.38, Table 11.39, and Table 11.40.

11.7.180 The magnitude of impact is deemed to be Low for harbour porpoise, minke whale, humpback whale and basking shark and negligible for other dolphin species and harbour and grey seals for auditory injury from underwater noise from UXO clearance (Table 11.37). The sensitivity of the receptor is Low for injury from underwater noise from UXO clearance, with the exception of the minke and humpback whale and basking sharks which have Medium sensitivity to injury. The effect will, therefore, be of Negligible significance for all species with the exception of minke whale, humpback whale, harbour porpoise and basking shark which have Minor significance, which is not significant in EIA terms.

11.7.181 The magnitude of impact is deemed to be Low for all species for disturbance from underwater noise from high order UXO clearance, with the exception of bottlenose dolphins in the CES MU for which the magnitude is determined to be Medium, and for harbour seals with Negligible magnitude (Table 11.38). The sensitivity of all receptors is Low for disturbance from underwater noise from high order UXO clearance. The effect will, therefore, be of Minor significance for all species with the exception harbour seal which has Negligible significance, which is not significant in EIA terms.

The magnitude of impact is deemed to be Low for all species for disturbance from underwater noise from low order UXO clearance, with the exception of bottlenose dolphins GNS MU, Atlantic white-sided dolphin, harbour seals and basking sharks for which is Negligible (

11.7.182 Table 11.39). The sensitivity of all receptors is Low for disturbance from underwater noise from UXO clearance. The effect will, therefore, be of Minor significance for all species with the exception of bottlenose dolphin CES MU, Atlantic white-sided dolphin, harbour seal and basking shark which have Negligible significance, which is not significant in EIA terms.

11.7.183 The magnitude of impact is deemed to be Negligible for all species for disturbance from underwater noise using TTS as a Proxy, with the exception of harbour porpoise, humpback whale, grey seal and basking sharks which is Low, as well as minke whale which is Medium (Table 11.40). The sensitivity of all receptors is Low for disturbance from underwater noise from UXO clearance. The effect will, therefore, be of Negligible significance for all species, with the exception of harbour porpoise, minke whale, humpback whale, grey seal and basking shark for which is Minor, which is not significant in EIA terms.

Table 11.37 Significance of Impact 2: Auditory Injury From Underwater Noise From UXO Clearance

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Negligible | Low | Negligible |
| Risso's dolphin | Negligible | Low | Negligible |
| Atlantic white-sided dolphin | Negligible | Low | Negligible |
| White-beaked dolphin | Negligible | Low | Negligible |
| Minke whale | Low | Medium | Minor |
| Humpback whale | Low | Medium | Minor |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Negligible | Low | Negligible |
| Basking shark | Low | Low | Minor |

Table 11.38 Significance of Impact 2: Disturbance From Underwater Noise From High Order UXO Clearance

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin CES MU | Medium | Low | Minor |
| Bottlenose dolphin GNS MU | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

Table 11.39 Significance of Impact 2: Disturbance From Underwater Noise From Low Order UXO Clearance

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin CES MU | Low | Low | Minor |
| Bottlenose dolphin GNS MU | Negligible | Low | Negligible |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Negligible | Low | Negligible |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Low | Low | Minor |
| Basking shark | Negligible | Low | Negligible |

Table 11.40 Significance of Impact 2: Disturbance From Underwater Noise Using TTS as a Proxy

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin CES MU | Negligible | Low | Negligible |
| Bottlenose dolphin GNS MU | Negligible | Low | Negligible |
| Risso's dolphin | Negligible | Low | Negligible |
| Atlantic white-sided dolphin | Negligible | Low | Negligible |
| White-beaked dolphin | Negligible | Low | Negligible |
| Minke whale | Medium | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

*Secondary Mitigation and Residual Effect*

11.7.184 The significance of the effect from injury and disturbance to marine mammals and basking sharks from underwater noise from UXO clearance is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.185 The Applicant will provide an EPS risk assessment for injury and disturbance from UXO clearance at the post consent stage, once final UXO parameters are confirmed. It is expected that, with the commitment to a UXO MMMP (C-OFF-41) to reduce the auditory injury to Negligible levels, no EPS will be injured, and therefore an EPS licence for injury is unlikely to be required. For disturbance, the impact assessment has concluded that disturbance from UXO clearance will not be detrimental to maintaining the species at FCS, meeting the EPS test 3. It is expected that an EPS licence for disturbance might be required.

### Impact 3: Injury and Disturbance From Underwater Noise From Geophysical Surveys

11.7.186 Pre-construction and construction geophysical equipment could include any or all of the following:

- SBP is a type of geophysical survey equipment which utilises low or high frequency sound pulses to penetrate the sea floor and create detailed images of sub-surface layers, identifying different strata encountered in the shallow sediments. Low frequency sound pulses can penetrate deeper though subsurface sediment before being reflected, producing low resolution data. High frequency pulses have a shallower penetration depth but produce higher resolution data. The sound pulses produced by SBP have very strong directivity.

- MBES is a geophysical survey system used for collecting detailed topographical data of the seabed. It emits acoustic waves in a fan shape beneath its transceiver. The time taken for sound waves to reflect off the seabed and return to the transmitter is used to calculate water depth, in turn, allowing for high-resolution mapping of the seafloor. High frequency systems provide more detailed images; however they are limited in their depth range. Low frequency systems can be used to map deeper water but produce lower resolution images. The sound pulses produced by MBES have very strong directivity.
- SSS surveys are used to determine sediment characteristics and seabed features, providing detailed imagery of the seabed. Surveys use conical or fan-shaped sound pulses and create detailed images based on the intensity of echoes received from the seabed. SSS is typically towed behind the vessel on an armoured tow cable. However, some models may be pole mounted on the side of the vessel. The sound pulses produced by SSS have very strong directivity.
- USBL is a method of underwater acoustic positioning by which an acoustic pulse is transmitted from the transceiver to the subsea transponder, which responds with its own acoustic pulse. The pulse is detected by the transceiver and the time from transmission of the initial pulse is measured by the USBL system and converted into a range. USBL systems are used during sampling activities to obtain accurate equipment positioning.
- UHRS sparkers are a small seismic source used to carry out a seismic survey which can be described as a towed unit containing a cluster of electrodes. A high voltage impulse is discharged from the electrode tips, heating the surrounding sea water and generating a rapidly expanding steam bubble, resulting in an acoustic impulse (Hartley Anderson Ltd, 2020). UHRS sparkers have less directionality than other SBPs, however they are still omnidirectional towards the sea floor.

11.7.187 The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of the different survey equipment and expected source levels are presented in Table 11.41.

11.7.188 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.12) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.41; Southall *et al.*, 2019).

Table 11.41 Comparison of Survey Equipment Typical Source Level and Frequency Range with Hearing Ranges of Marine Mammals

| Survey Equipment | Typical Source Level (dB re 1 µPa) | Expected Frequency Range | Overlap with Hearing Groups | | | |
|---|---|---|---|---|---|---|
| | | | LF | HF | VHF | PCW |
| SBP | 185-250 ($SPL_{peak}$) (dependent on equipment type) (Hartley Anderson, 2020)<br>174-247 ($SPL_{rms}$) (dependent on equipment type) (NOAA, 2019) | 100 Hz – 22 kHz (Hartley Anderson, 2020) | Yes | Yes | Yes | Yes |
| MBES | 200-240 ($SPL_{peak}$) (Hartley Anderson, 2020) | 200 - 400 kHz (Hartley Anderson, 2020) | No | No | No | No |
| SSS | 210 ($SPL_{peak}$) (Crocker and Fratantonio, 2016, Crocker *et al.*, 2019) | 300 kHz – 900 kHz (Crocker and Fratantonio, 2016, Crocker *et al.*, 2019) | No | No | No | No |
| USBL | 188-204 ($SPL_{rms}$) (NOAA, 2019) | 17 kHz – 50 kHz (NOAA, 2019) | Yes | Yes | Yes | Yes |
| UHRS sparker | 200-226 ($SPL_{peak}$) (Hartley Anderson, 2020) | 100 Hz – 5 kHz (Hartley Anderson, 2020) | Yes | Yes | Yes | Yes |

### *Magnitude of Impact*

#### Auditory Injury – PTS

##### Marine Mammals

##### SBP

11.7.189 For all marine mammal species, source levels exceed the PTS-onset thresholds and therefore, these species are at risk of auditory injury. However, the spatial extent of this impact is likely to be very small. Underwater noise modelling carried out by BEIS (2020) for SBPs across three locations found that the onset of PTS could occur within 23 m of the SBP for harbour porpoise. Underwater noise modelling conducted for the Green Volt OWF determined a maximum impact range of 330 m for VHF cetaceans, with the lowest impact of 120 m for LF cetaceans and pinnipeds (Green Volt, 2023), while Arklow Bank Wind Park 2 estimated 517 m for VHF cetaceans and 68 m for LF cetaceans (Seiche Ltd, 2022).

11.7.190 The impact of PTS-onset from SBP is considered of local spatial extent, short term duration, intermittent and to affect a very small proportion of the population, although auditory injury is expected to have a permanent change to the receptor. In addition, the implementation of the embedded commitments of MMMP and MMOb will minimise the risk of PTS and as a minimum adhere to JNCC guidelines (JNCC, 2017). Therefore, the magnitude of the impact is assessed as Negligible for all marine mammal species.

##### MBES

11.7.191 The frequency range of the sound produced by MBES is outside the generalised hearing range of all marine mammal receptors (Table 11.12). JNCC (2017) do not advise that mitigation to avoid injury is necessary in shallow waters (less than 200 m), which is the case of the Proposed Development.

11.7.192 As stated in paragraph 11.7.186, the sound pulses produced by MBES have very strong directivity. This means that an individual would need to be within the beam of the sound source for injury to occur.

11.7.193 The impact is therefore predicted to be of local spatial extent, short term duration and intermittent. As a result of this, and with frequencies expected to be outside of the hearing range of receptors, the magnitude for marine mammal receptor species is assessed as Negligible.

##### SSS

11.7.194 The frequency range of the sound produced by SSS is outside the generalised hearing range of all marine mammal receptors (Table 11.12).

11.7.195 EPS guidance by JNCC *et al*. (2010) on the use of SSS states that 'this type of survey is of a short-term nature and results in a negligible risk of an injury or disturbance offence (under the regulations)'. Furthermore, despite sound output levels of SSS being relatively high, the intermittent nature of the noise produced by SSS results in lower noise doses than would occur for continuous signals (DECC, 2011). As stated in paragraph 11.7.186, the sound pulses produced by SSS have very strong directivity. This means that an individual would need to be within the beam of the sound source for injury to occur.

11.7.196 The impact is therefore predicted to be of local spatial extent, short term duration and intermittent. As a result of this, and in line with JNCC guidelines (JNCC *et al.,* 2019), the magnitude for all marine mammal receptor species is assessed as Negligible.

USBL

11.7.197 The source levels produced by USBL are below the PTS-onset thresholds for LF cetaceans, HF cetaceans and PCW. Given this, there is no risk of auditory injury (PTS) by this equipment. Therefore, the magnitude for LF cetaceans, HF cetaceans and PCW is assessed as Negligible.

11.7.198 For VHF cetaceans (harbour porpoise), source levels exceed the PTS-onset thresholds and therefore, these species are at risk of auditory injury. However, source levels only exceed the minimum threshold for PTS-onset by 2 dB. NMFS (2020) has determined that USBL is unlikely to lead to incidental take. As such, auditory injury to harbour porpoise is highly unlikely.

11.7.199 The impact of PTS-onset from USBL is considered of local spatial extent, short term duration, intermittent and to affect a very small proportion of the population. Therefore, the magnitude of the impact is assessed as Negligible for VHF cetaceans.

UHRS Sparker

11.7.200 The source levels produced by UHRS sparkers are below the PTS-onset thresholds for HF cetaceans (all dolphin species). As such, there is no risk of auditory injury (PTS) to any of the dolphin receptor species. Therefore, the magnitude for all dolphin receptor species is assessed as Negligible.

11.7.201 For all other marine mammal species, source levels exceed the PTS-onset thresholds and therefore, these species are at risk of auditory injury. As described in paragraph 11.7.186, while UHRS sparkers have less directionality than other SBPs, they are still omnidirectional towards the sea floor. Therefore, the impact of auditory injury as a result of UHRS sparkers is likely to occur over a small spatial extent.

11.7.202 Despite the duration and extent of the impact being predicted to be short-term and high localised, with auditory injury being deemed unlikely to occur, the risk of auditory injury to a small number of individuals cannot be excluded. Therefore, the magnitude of the unmitigated impact has been assessed as Low for all other marine mammal receptor species.

11.7.203 With the implementation of the embedded commitment of a MMMP (C-OFF-19), the magnitude of the impact will be reduced to Negligible for all other marine mammal receptor species.

Basking Sharks

11.7.204 The hearing sensitivity of sharks is limited to low frequency sounds (between 20 Hz and 1,500 Hz) peaking between 200 and 600 Hz, depending on the species (Carroll *et al*., 2016 and Chapuis *et al*., 2019). There is limited information on sound detection in basking sharks and no direct evidence of sound causing mortality or stress (Wilson *et al*., 2021).

11.7.205 The peak hearing sensitivity of elasmobranchs is below the frequencies emitted by all geophysical equipment, with only an overlap on the higher range of hearing for SBP (Table 11.41). Therefore, it is very unlikely that basking sharks will hear the underwater sound produced by the survey equipment. As such, auditory injury is highly unlikely.

11.7.206 The impact of mortality, injury and TTS from all survey equipment is considered of local spatial extent, short term duration, intermittent and to affect a very small proportion of the population. Therefore, the magnitude of the impact is assessed as Negligible for basking sharks.

#### Disturbance

##### Marine Mammals

###### SBP

11.7.207 JNCC *et al*. (2010) states that the sound energy generated by SBP will be directed downwards to the seabed and that it has a very short duration on a moving source. As the lower frequencies overlap with the hearing range of marine mammals they have the potential to cause short-term impacts on behaviour such as avoidance (JNCC *et al*. 2010). BEIS (2020) predicted a maximum impact range of 2.5 km for behavioural disturbance for harbour porpoises and that there is a low risk of disturbance. In addition, JNCC guidance for assessing disturbance against Conservation Objectives of harbour porpoises SACs recommends a 5 km EDR for other geophysical surveys. As there is no EDR recommendation for other species the 5 km EDR is followed for them.

11.7.208 Therefore, the impact of disturbance to all marine mammal species from SBP is considered to result in a small proportion of the population affected, it is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low for all marine mammal species.

###### MBES and SSS

11.7.209 MBES and SSS operate at frequencies in the higher end of the frequency range and therefore fall outside of the hearing range of marine mammal receptor species (JNCC, 2017). EPS guidance by JNCC *et al*. (2010) on the use of SSS states that 'this type of survey is of a short-term nature and results in a negligible risk of an injury or disturbance offence (under the regulations)' and that MBES is unlikely to cause any disturbance. As a result, there is no potential for disturbance to occur for any of the marine mammal receptor species. Therefore, the magnitude of the impacts is assessed as Negligible.

###### 11.7.210 USBL

11.7.211 Pace *et al*. (2021) conducted a sound verification study which demonstrated that the potential for behavioural disturbance within a limited spatial extent (i.e. few hundred meters). The low noise frequency sound emissions generated by USBL are within the hearing range of marine mammals. Therefore, there is the potential to illicit a disturbance response in animals that are present during the surveys.

11.7.212 The impact of disturbance to all marine mammal species from USBL is considered to result in a small proportion of the population affected, it is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low for all marine mammal species.

### UHRS Sparker

11.7.213 UHRS may be audible to marine mammals as it overlaps with their hearing range and therefore there might be a potential for disturbance. As the majority of acoustic energy will be directed at the seabed rather, the impacts of noise emissions and therefore disturbance on nearby marine mammals will be reduced. UHRS is designed to have a highly focused beam that aims directly at the seabed, meaning there is limited horizontal transmission of noise and potential for disturbance.

11.7.214 The impact of disturbance to all marine mammal species from UHRS sparker is considered to result in a small proportion of the population affected, it is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low for all marine mammal species.

### Basking Sharks

11.7.215 The hearing sensitivity of sharks is limited to low frequency sounds (between 20 Hz and 1,500 Hz) peaking between 200 and 600 Hz, depending on the species (Carroll *et al.*, 2016 and Chapuis *et al.*, 2019). There is limited information on sound detection in basking sharks and no direct evidence of sound causing mortality or stress (Wilson *et al.*, 2020).

11.7.216 The peak hearing sensitivity of elasmobranchs is below the frequencies emitted by all geophysical equipment, with only an overlap on the higher range of hearing for SBP (Table 11.41). Therefore, it is very unlikely that basking sharks will hear the underwater sound produced by the survey equipment. As such, disturbance is highly unlikely.

11.7.217 The impact of disturbance from all survey equipment is considered of local spatial extent, short term duration, intermittent and to affect a very small proportion of the population. Therefore, the magnitude of the impact is assessed as Negligible for basking sharks.

## *Sensitivity of Receptor*

### Auditory Injury – PTS

#### Marine Mammals

11.7.218 There is currently limited information available of the impacts of geophysical surveys to marine mammals, with most available studies focussing on the impact of seismic airguns.. The ecological consequences of PTS are uncertain, although loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, in turn, potentially causing a change in an individual's heath or vital rates (Erbe *et al*., 2018). Relating a potential loss of hearing to a biologically significant response is challenging due to a paucity of empirical data. However, a potential consequence of a disruption in key life functions is that the health of impacted individuals would deteriorate and potentially lead to reduced birth rate in females and potentially mortality.

11.7.219 Studies suggest that harbour porpoises exposed to such noise sources would likely move away from the source, leaving the impact range of PTS-onset (Hermannsen *et al*., 2015). Furthermore, it is expected that increased vessel presence in the vicinity will act as a deterrent to harbour porpoise, reducing the risk of auditory injury (Benhemma-Le Gall *et al.*, 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any survey activity. A study by Lucke *et al.* (2009) indicated that TTS could be induced in harbour porpoise at 350 m when exposed to an airgun impulse at a peak pressure of 200 $dB_{pk-pk}$ re 1 µPa with corresponding SEL of 164.5 dB re $\mu Pa^2{}_s$) in shallow waters (approximately 4 m), however this study is highly conservative as it assumes that the animal would remain stationary throughout the exposure.

11.7.220 While PTS is a permanent effect which cannot be recovered from, the most likely response of a marine mammal to noise levels that could induce TTS is to flee the area (Southall *et al*., 2007). Therefore, animals exposed to these noise levels that could induce TTS are likely to actively avoid hearing damage by moving away from the source.

11.7.221 Although there is limited information available for the impacts of underwater noise from geophysical surveys on marine mammals , considering the evidence available it is unlikely that PTS and TTS from geophysical surveys would significantly impact the survival of reproductive rates of marine mammal species in this assessment.

11.7.222 Based on the above, all marine mammal receptors within this assessment are considered to be of high adaptability, reasonable tolerance, have between no and full recoverability, and are of very high value. The sensitivity of the receptors is Low.

#### Basking Shark

11.7.223 As detailed in paragraphs 11.7.87 to 11.7.90, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise (when considering mortality, injury and TTS), and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low**.**

Disturbance

Marine Mammals

11.7.224 There is currently limited information available on the impacts of behavioural disturbance from geophysical surveys to marine mammals, with most available studies focussing on the impact of seismic airguns.

11.7.225 Analysis of MMOb reports from 201 seismic surveys between 1997 and 2000, suggests that that small cetaceans (including harbour porpoise) have a tendency to swim away from seismic airguns or tend to avoid survey vessels when airguns are firing up to a distance of ~1 km away (Stone, 2003). Small cetaceans were also observed swimming faster during periods of shooting (Stone, 2003). Thompson *et al*. (2013) observed short-term disturbance of harbour porpoise in response to a seismic survey in the North Sea. However, this did not lead to long-term displacement of harbour porpoises as animals were typically detected again in the vicinity within a few hours following the survey works. In addition, the time between the conclusion of survey works and the next porpoise detection decreased over the 10-day survey period. Similarly, Hoekendijk *et al*. (2018) concluded that short-term, irregular disturbance events are unlikely to significantly affect the energetic status of harbour porpoise, particularly where surveys are conducted in shallow waters where sound cannot propagate as far.

11.7.226 Acoustic data collected by Pirotta *et al*. (2014) showed that harbour porpoise that remained in the seismic survey impact area reduced their echolocation activity by 15% during the survey. This may be indicative of changes to foraging or social behaviour (van Beest *et al*., 2018).

11.7.227 For Risso's dolphins, no response was observed to seismic airguns (Stone *et al*., 2017) or simulated military sonar (Southall *et al*., 2011). During controlled experiments where Risso's dolphin were exposed to simulated military sonar (received levels between 100-140 dB re 1µPa SPLrms), no clear behavioural response was recorded (Southall et al., 2011).

11.7.228 However, a study on minke whale investigating the impacts of exposure to naval sonar (with acoustic characteristics of 1.3 – 2 kHz to a maximum SL of 214dB re 1µPa @ 1 m) found that these whales increased their swimming speeds to avoid the sound source (Kvadsheim *et al*., 2017). In turn, an increase in metabolic rates associated with avoidance behaviour such as fleeing, could have implications on energy expenditure and survival for individuals (Kvadsheim *et al*., 2017).

11.7.229 A study conducted on humpback whales during their southward migration off eastern Australia observed no abnormal behaviour to suggest signs of stress when seismic airguns were fired (Dunlop *et al*., 2017). Exposure to airguns was found to reduce dive time and increase respiration (blow) rate when compared to when no airguns or vessels were present, however, these changes were also observed when vessels towing inactive airguns were present. Therefore, these behavioural changes may be in response to vessel presence rather than exposure to airguns. Despite this, behavioural changes were considered to be mild and were still within their normal behavioural repertoire. Displacement of humpback whales as a result of active airguns also occurred, with some deviations in migration course being recorded.

11.7.230 Very limited data on the effects of seismic airguns on seals currently exists. However, studies on the behavioural effects of other impulsive noise sources to seals have shown varying responses in grey seals. During pile driving, many grey seals were frequently recorded changing behaviour from foraging to horizontal movement; altering surfacing and diving behaviour, and changing direction (Aarts *et al*., 2018). However, in other cases, no such changes were observed. A telemetry study during piling in southeast England found that harbour seals within the area returned to usage levels similar to that of non-piling periods within two hours of cessation of the piling activity, suggesting that displacement was short-term (Russell *et al*., 2016). Seals are generally considered to be relatively adaptable due to their generalist diets, wide foraging ranges, and adequate fat stores. This enable them to compensate for lost foraging opportunities as a result of disturbance, with impacts to vital rates being highly unlikely (Booth *et al*., 2019; Smout *et al*., 2014; Stansbury *et al*., 2015).

11.7.231 There is limited information available for the impacts of underwater noise from geophysical surveys on marine mammals therefore considering the evidence available. all marine mammal receptors within this assessment are considered to be of high adaptability, reasonable tolerance, high recoverability, and of very high value. The sensitivity of the receptors is Low.

#### Basking Shark

11.7.232 As detailed in paragraphs 11.7.87 to 11.7.90, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise, and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low.

### *Significance of Effect*

A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors are presented in Table 11.42 and

11.7.233 Table 11.43.

11.7.234 The magnitude of impact is deemed to be Negligible for all marine mammals and basking sharks for injury from underwater noise from geophysical surveys (Table 11.42). The sensitivity of the receptor is Low for injury from underwater noise from geophysical surveys. The effect will, therefore, be of Negligible significance, which is not significant in EIA terms.

The magnitude of impact is deemed to be Low for SBP, USBL and UHRS for all marine mammals, and Negligible for basking sharks for disturbance from underwater noise from geophysical surveys (

11.7.235 Table 11.43). The magnitude of impact is deemed to be Negligible for MBES and SSS for all marine mammals and basking sharks for disturbance from underwater noise from geophysical surveys. The sensitivity of the receptor is Low for disturbance from underwater noise from geophysical surveys. The effect will, therefore, be of Negligible significance for MBES and SSS and Minor significance for SBP, USBL and UHRS for all receptors with the exception of basking sharks which has Negligible significance. Both Minor and Negligible significance, are not significant in EIA terms.

Table 11.42 Significance of Impact 3: Injury From Underwater Noise From Geophysical Surveys

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | Low | **Negligible** |
| Bottlenose dolphin | Negligible | Low | **Negligible** |
| Risso's dolphin | Negligible | Low | **Negligible** |
| Atlantic white-sided dolphin | Negligible | Low | **Negligible** |
| White-beaked dolphin | Negligible | Low | **Negligible** |
| Minke whale | Negligible | Low | **Negligible** |
| Humpback whale | Negligible | Low | **Negligible** |
| Harbour seal | Negligible | Low | **Negligible** |
| Grey seal | Negligible | Low | **Negligible** |
| Basking shark | Negligible | Low | **Negligible** |

Table 11.43 Significance of Impact 3: Disturbance From Underwater Noise From Geophysical Surveys

| Receptor | Magnitude | | Sensitivity | Significance | |
|---|---|---|---|---|---|
| | SBP, USBL, UHRS | MBES and SSS | | SBP, USBL, UHRS | MBES and SSS |
| Harbour porpoise | Low | Negligible | Low | **Minor** | **Negligible** |
| Bottlenose dolphin | Low | Negligible | Low | **Minor** | **Negligible** |
| Risso's dolphin | Low | Negligible | Low | **Minor** | **Negligible** |
| Atlantic white-sided dolphin | Low | Negligible | Low | **Minor** | **Negligible** |
| White-beaked dolphin | Low | Negligible | Low | **Minor** | **Negligible** |
| Minke whale | Low | Negligible | Low | **Minor** | **Negligible** |
| Humpback whale | Low | Negligible | Low | **Minor** | **Negligible** |
| Harbour seal | Low | Negligible | Low | **Minor** | **Negligible** |
| Grey seal | Low | Negligible | Low | **Minor** | **Negligible** |
| Basking shark | Negligible | Negligible | Low | **Negligible** | **Negligible** |

### *Secondary Mitigation and Residual Effect*

11.7.236 The significance of the effect from injury and disturbance to marine mammals and basking sharks from underwater noise from geophysical surveys is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.237 The Applicant will provide an EPS risk assessment for injury and disturbance from geophysical surveys at the post consent stage, once final geophysical survey parameters are confirmed. It is expected that, with the commitment to a MMMP (C-OFF-19) to reduce the auditory injury to Negligible levels, no EPS will be injured, and therefore an EPS licence for injury is unlikely to be required. For disturbance, the impact assessment has concluded that disturbance from geophysical surveys will not be detrimental to maintaining the species at FCS, meeting the EPS test 3. It is expected that an EPS licence for disturbance might be required.

## Impact 4: Injury and Disturbance From Underwater Noise From Other Construction Activities

### *Magnitude of Impact*

11.7.238 The Proposed Development will require other construction activities such as trenching, rock placement), cable laying, dredging (backhoe and suction) and suction anchor installation.

#### Auditory Injury

11.7.239 Continuous noise from other construction activities generally considered to be very unlikely to result in PTS in marine mammals due to its non-impulsive nature, and the fact that it is likely to be dominated by noise produced by the vessels from which installation takes place. This is supported by the results presented in **Volume 3, Appendix 3.1: Underwater Noise Technical Report,** which estimates the impact ranges for vessels both large and medium to be less than 100 m for marine mammals.

11.7.240 Underwater noise modelling was undertaken using the Southall *et al.* (2019) non-impulsive thresholds (weighted $SEL_{cum}$), in the absence of specific guidance on the PTS-onset thresholds for noise impacts from non-piling noise. Further details on the modelling are included in **Volume 3, Appendix 3.1: Underwater Noise Technical Report**. It is worth noting that the model used does not specify ranges below 100 m for $SEL_{cum}$ and below 50 m for $SPL_{peak}$ due to complex noise fields at these distances from the pile and therefore it is likely that ranges will be smaller than these.

11.7.241 For all construction activities (Table 11.44), the PTS-onset impact range is <100 m for all marine mammal species. The only exception is for suction anchor installation, which has an impact of 130 m for low frequency cetaceans (i.e. minke whale) and 1.1 km for very high frequency cetaceans (i.e. harbour porpoises).

11.7.242 There are no impact ranges for basking sharks (Group 1 species), as they don't experience PTS. The only impacts provided for fish with swim bladders and these are <50 m.

Table 11.44 Predicted Impact Ranges for Auditory Injury for Marine Mammals Assuming a Fleeing Receptor

| | LF Cetaceans | HF Cetaceans | VHF Cetaceans | PCW |
|---|---|---|---|---|
| Cable laying | <100 m | <100 m | <100 m | <100 m |
| Trenching | <100 m | <100 m | <100 m | <100 m |
| Dredging | <100 m | <100 m | <100 m | <100 m |
| Drilling | <100 m | <100 m | <100 m | <100 m |
| Rock placement | <100 m | <100 m | <100 m | <100 m |
| Suction anchor installation | 130 m | <100 m | 1.1 km | <100 m |

11.7.243 The impact is therefore predicted to be of local spatial extent, short term duration, intermittent and have a low risk. The impact is expected to affect a small proportion of the population, which is unlikely to alter the population trajectory. Therefore, the magnitude of impact is assessed as Negligible for all species assessed.

### Disturbance

11.7.244 The main energy of noise from other construction activities is largely below 1 kHz, which is within the peak hearing range of minke whales but outside of the peak hearing sensitivity of porpoise, dolphin and seal species. Fixed EDRs are advised within JNCC (2020) guidance to account for radii of effect from noise impacts generated by pin-piling, conductor piling, piling under noise abatement and geophysical surveys. These distances account for the main impact ranges found within a variety of studies, but they do not account for all deterrence or disturbance in the associated area nor represent the limit at which effects can be detected. None of the recommended EDRs accounts for non-impulsive sound sources, which would have a lower impact radius than any geophysical surveys, with respect to underwater noise.

11.7.245 In the absence of an EDR for other noise sources, the precautionary EDR of 5 km for 'other geophysical surveys' was applied for all marine mammal receptors in this assessment, as there is potential to disturb and/or displace marine mammal receptors within the Proposed Development, due to noise disturbance during the construction phase of the Proposed Development.

11.7.246 Considering this, the estimated area of disturbance as a result of other activities was estimated to be 78.54 $km^2$, which is considered to be small given the anticipated local spatial range of impact for disturbance. The impact would also be expected to be temporary.

11.7.247 When considering noise from other (non-piling) construction activities, it is likely to be similar to the ambient noise level (Merchant *et al.,* 2016). In addition, it is likely any disturbance impact will be primarily dominated by underwater noise from vessels for non-piling works.

11.7.248 In view of the low risk of any adverse impact being anticipated, the impact of disturbance from other construction activities is considered to result in a small proportion of the population affected. Any change in behaviour and/or distribution are expected to be intermittent and temporary and unlikely to affect the population trajectory. Therefore, the magnitude of disturbance from other construction activities is assessed as Low for all marine mammal species assessed.

#### Basking Shark

11.7.249 When considering noise from other (non-piling) construction activities, it is likely to be similar to the ambient noise level (Merchant *et al.,* 2016). In addition, it is likely any disturbance impact will be primarily dominated by underwater noise from vessels for non-piling works.

11.7.250 In view of the low risk of any adverse impact being anticipated, the impact of disturbance from other construction activities is considered to result in a small proportion of the population affected. Any change in behaviour and/ or distribution are expected to be intermittent and temporary and unlikely to affect the population trajectory. Therefore, the magnitude of disturbance from other construction activities is assessed as Low for basking shark.

### *Sensitivity of Receptor*

#### Auditory Injury – PTS

#### Marine Mammals

11.7.251 Non-piling construction activities such as cable plough, dredging, trenching, jetting, drilling, mechanical cutting and rock placement produce a continuous and non-impulsive noise which is generally considered to be very unlikely to result in PTS in marine mammals. According to the MMO (2015), the main energy of non-piling construction activities such as dredging, trenching, drilling and cable installation, is listed as being below 1 kHz. This is within the estimated peak sensitivity range of minke and humpback whales but out of the peak hearing ranges of harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW).

11.7.252 If PTS were to occur as a result of these construction activities, there would be little impact to vital rates in harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW), as the hearing sensitivity of these receptors is relatively poor below 1 kHz (Southall *et al.,* 2019).

11.7.253 Cetaceans with a low frequency hearing range, such as minke whales and humpback whales (Southall *et al*., 2019), are likely to be more sensitive to PTS if it were to occur. Communication signals between minke whales have been found to be below 2 kHz (Edds-Walton, 2000; Mellinger *et al.,* 2000; Gedamke *et al.,* 2001; Risch *et al.,* 2013; 2014). While knowledge about the hearing range of baleen whales is not fully understood, it is assumed that the hearing frequency ranges of cetaceans are similar to the sounds they produce (White and Todd, 2024). Tubelli *et al.* (2012) estimated the hearing frequency range in minke whales to be approximately between 30 Hz and 7.5 kHz or between 100 Hz and 25 kHz depending on the stimulation location. The estimated hearing frequency range in humpback whales has been estimated as approximately between 15 Hz and 3 kHz or between 200 Hz and 9 kHz depending on simulation location (Tubelli *et al*., 2018). As demonstrated by the above studies, the hearing ranges of these receptors are more likely to overlap with the non-impulsive noise produced during these construction activities.

11.7.254 PTS is a permanent effect which cannot be recovered from. While also considering harbour porpoise, dolphin and seal species' sensitivity to low frequency noise, these species are considered to be of high adaptability, high tolerance, have no recoverability, and are of very high value. The sensitivity of these receptors is Low.

11.7.255 While for minke and humpback whale considering their sensitivity to low frequency noise, the species are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of very high value. The sensitivity of the receptors is Medium.

#### Basking Shark

11.7.256 As detailed in sections 11.7.87 to 11.7.90, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise, and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low.

### Disturbance

11.7.257 Limited information is currently available regarding the sensitivity of marine mammals to other construction activities such as cable plough, dredging, trenching, jetting, drilling, mechanical cutting and rock placement, with studies currently available primarily focusing on the impact of disturbance from dredging. These studies have confirmed that underwater noise from construction activities can cause displacement and disturbance to marine mammals (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Graham *et al.*, 2019; Pirotta *et al.*, 2014; Stone *et al.*, 2017). However, it is difficult to determine the sensitivity specifically to disturbance from other construction activities in isolation from the disturbance from vessel presence required for the activity (Todd *et al.*, 2015).

#### Harbour Porpoise

11.7.258 Harbour porpoises are particularly vulnerable to disturbance, with the main impact being loss of foraging opportunities (Nabe-Nielsen *et al.*, 2018). They are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently to maintain a high metabolic rate with little energy remaining for fat storage (Rojano-Doñate *et al.*, 2018; Wisniewska *et al.*, 2016). Therefore, there is a risk of changes to their overall fitness if they are displaced from high-quality foraging grounds or if their foraging efficiency is disturbed, and they are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. However, results from studies using DTAGs suggest that harbour porpoise are able to respond to short-term reductions in food intake and may have some resilience to disturbance (Wisniewska *et al.*, 2016).

11.7.259 Dredging activities have been shown to cause harbour porpoise displacement within a radius of 5 km around the dredging location (Verboom, 2014). Diederichs *et al.* (2010) noted there was short term avoidance (around 3 hours) at distances of up to 600 m from a trailing suction hopper dredger, but no significant long-term impacts. Modelling potential impacts of dredging of a port expansion predicted a disturbance range of 400 m, with a more conservative approach predicting avoidance of harbour porpoise up to 5 km (McQueen *et al.* 2020).

11.7.260 A monitoring study in north-west Ireland investigating the effects of construction-related activity, including but not limited to seismic surveys, multi-beam surveys, remotely operated vehicle (ROV) surveys, dredging, back filling, rock trenching, rock placement, rock breaking, pipe laying and umbilical laying, during the construction of a gas pipeline found a reduction in occurrence of harbour porpoise as a result of these construction-related activities in the area (Culloch *et al*., 2016).

11.7.261 Modelling conducted as part of the Greenlink Interconnector project for disturbance from cable laying installation, concluded that all marine mammals are vulnerable to disturbance, but the impact zone is in general small (130 m from activities; Greenlink, 2019).

11.7.262 A review of potential impacts of various cable types and installation methods including burial ploughs, machines, ROVs and sleds and the burial methods themselves including jetting, rock ripping, and dredging, used in the OWF industry concluded that it would be "highly unlikely that cable installation would produce noise at a level that would cause a behavioural reaction in marine mammals" (Business Enterprise and Regulatory Reform (BERR) and Defra, 2008).

11.7.263 The occurrence of harbour porpoise was found to decrease in the vicinity of the Beatrice and Moray East OWFs during non-piling construction periods (Benhemma-Le Gall *et al.,* 2021). Outside of piling hours, harbour porpoise detections decreased by 17%, with an increase in SPLs from vessels from 102 dB re 1 µPa to 159 dB re 1 µPa. Similarly, the probability of detecting buzzes decreased by 41.5% as SPLs from vessels increased from 104 dB re 1 µPa to 155 dB re 1 µPa. Despite this, harbour porpoise continued to be present across both sites throughout the three-year construction period. Displacement of harbour porpoise from the vicinity occurred at a local scale, with buzzing increasing once the individual was away from the noise source. This suggests that displaced individuals resumed foraging, potentially compensating for lost foraging opportunities or increased energy expenditure as a result of fleeing. Therefore, any impacts to harbour porpoise as a result of disturbance from other construction activities are likely to be localised and short-term. Hence, despite being particularly sensitive to disturbance, harbour porpoise are expected to be able to compensate for any displacement, with no impact to vital rates.

11.7.264 The presence of vessels has been shown to deter and disturb harbour porpoise out of the area before any non-piling construction activities start (Brandt *et al*., 2018). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any survey activity. Further information on vessel disturbance is covered in Impact 5.

11.7.265 Based on the above, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Dolphin Species

11.7.266 There is limited information on the response of dolphin species to non-impulsive noise sources, with most studies focusing on impulsive noise sources such as pile driving and seismic surveys utilising airguns.

11.7.267 A study analysing the impacts of dredging on bottlenose dolphins, observed a decrease in bottlenose dolphin presence in foraging areas of Aberdeen harbour with an increase in intensity of dredging activity, with bottlenose dolphins absent from the vicinity for five weeks during the initial dredge operations (Pirotta *et al*., 2013). The presence of shipping activity in this area is high all year round, with dolphins in the region considered to be habituated to high levels of vessel presence as a result. Therefore, in this instance, it was concluded that displacement was a direct result of dredging.

11.7.268 In western Australia, Marley *et al*. (2017a), reported varied responses to dredging between sites. No bottlenose dolphins were sighted during backhoe dredging activities at one site, while dolphins remained using the other site despite the same dredging activities occurring. This suggests that the response may be context specific (i.e. some sites being ecologically more important than others).

11.7.269 There is potential for behavioural disturbance due to underwater noise to result in disruption in foraging and resting activities and an increase in travel and energetic costs (Marley *et al.*, 2017a; Pirotta *et al.*, 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that while there is potential for disturbance events to affect bottlenose dolphin behaviour and health (which could then impact vital rates and population dynamics), individuals are able to compensate for immediate behavioural responses to disturbances caused by vessel activity. This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance.

11.7.270 There is limited information on the response of Risso’s dolphin to underwater noise, with those few studies focusing on impulsive noise sources such as seismic surveys as described in paragraph 11.7.227.

11.7.271 Based on the above, dolphin species are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Minke and Humpback Whale

11.7.272 There is limited information on the response of minke and humpback whales to non-impulsive underwater noise, such as that related to other construction activities. A study on the behavioural sensitivity of minke whale reactions to sonar signals showed that they displayed prolonged avoidance, increase in swim speed directly away from the source, and cessation of feeding for a received SPL of 146 dB re 1µPa and long-term (6 hour) avoidance of the area for a received SPL of 158 dB re 1µPa (Sivle *et al*., 2015). A study detailing minke whale responses to the Lofitech ‘seal scarer’ ADD showed minke whale within 500 m and 1,000 m of the source (SPL of 204 dB re 1 µPa at 1 m) exhibiting responses of increased swim speeds and movement away from the source (McGarry *et al*., 2017).

11.7.273 A monitoring study in north-west Ireland investigating the effects of construction-related activity, including but not limited to seismic surveys, multi-beam surveys, ROV surveys, dredging, back filling, rock trenching, rock placement, rock breaking, pipe laying and umbilical laying, during the construction of a gas pipeline found a reduction in minke whale occurrence as a result of these construction related activities in the area (Culloch *et al*., 2016).

11.7.274 A study of migrating humpback whales off Sydney, Australia, found that whales exhibited no observable response to underwater construction activities, such as dredging and drilling, with whales exhibiting similar behaviours (directionality, dive duration and swim speed) on days with and without construction (Pirotta, 2017). Behaviour of migrating humpback whales was assessed again five years post-construction. Analyses showed no change in behaviours, except for increased dive durations.

11.7.275 While information on the behavioural responses of minke and humpback whales to non-impulsive underwater noise is limited, it is anticipated that these species will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage. However, it is important to consider that both minke and humpback whales are capital breeders (Christiansen *et al*., 2013). Therefore, a reduction in foraging activity could result in decreased energy availability, leading to reduced reproductive success.

11.7.276 Based on the above, minke and humpback whales are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Grey and Harbour Seal

11.7.277 There is limited information on the response of grey and harbour seals to non-impulsive underwater noise from other construction activities. Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the construction of the Luchterduinen wind farm and from 16 grey seals in 2015 during the construction of the Gemini wind farm (Aarts *et al*., 2018). The most common response suggested a change in behaviour from foraging to horizontal movement, although various other responses were recorded including, altered surfacing and diving behaviour, changes in swim direction, and no response (Aarts *et al*., 2018). Data from this study also showed that seals returned to the area on subsequent trips, despite receiving multiple exposures. Construction activities during an OWF installation have a much greater risk of disturbance and injury compared to cable installation due to the impulsive noise sources such as impact pile driving.

11.7.278 The source level of dredging activities has been described to vary between SPL 172 and 190 dB re 1 µPa at 1 m with a frequency range of 45 Hz to 7 kHz (Verboom, 2014). It is expected that the underwater noise generated by dredging will be below the PTS-onset threshold (Todd *et al*., 2015) of seal species and thus the risk of injury is unlikely, though disturbance may occur. A study on the effects of dredging sound on aquatic life, demonstrated using acoustic modelling for pinnipeds that displacement could be caused to individuals between 400 m to 5 km from site (the frequency and sound pressure can vary considerably depending on the equipment; McQueen *et al*., 2020).

11.7.279 During an expert elicitation workshop in 2018, it was concluded that both harbour seals and grey seals were considered to have reasonable ability to compensate for missed foraging opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al.*, 2019). In general, experts agreed that grey seals are more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet. Grey seals are also more adaptable in their foraging strategies, while harbour seals also have thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods (Booth *et al.*, 2019).

11.7.280 Harbour seals in the Wash were studied during the construction phase of Lincs OWF. Russell *et al*. (2016) observed significant displacement of harbour seals during piling, but not during construction as a whole.

11.7.281 Based on the above, grey and harbour seals are considered to be of high adaptability, reasonable to high tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Basking Shark

11.7.282 As detailed in sections 11.7.87 to 11.7.90, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise, and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low.

## *Significance of Effect*

11.7.283 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors are presented in Table 11.45 and Table 11.46

11.7.284 .The magnitude of impact is deemed to be Negligible for auditory injury from underwater noise from other construction activities (Table 11.45). The sensitivity of the receptor is Low for from underwater noise from other construction activities, with the exception on minke and humpback whales which have Medium sensitivity to injury. The effect will, therefore, be of Negligible significance for all species, which is not significant in EIA terms.

11.7.285 The magnitude of impact is deemed to be Low for disturbance from underwater noise from other construction activities (Table 11.46). The sensitivity of the receptor is Low for disturbance from underwater noise from other construction activities. The effect will, therefore, be of Minor significance for all species, which is not significant in EIA terms.

Table 11.45 Significance of Impact 4: Auditory Injury From Underwater Noise From Other Construction Activities

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | Low | **Negligible** |
| Bottlenose dolphin | Negligible | Low | **Negligible** |
| Risso's dolphin | Negligible | Low | **Negligible** |
| Atlantic white-sided dolphin | Negligible | Low | **Negligible** |
| White-beaked dolphin | Negligible | Low | **Negligible** |
| Minke whale | Negligible | Medium | **Negligible** |
| Humpback whale | Negligible | Medium | **Negligible** |
| Harbour seal | Negligible | Low | **Negligible** |
| Grey seal | Negligible | Low | **Negligible** |
| Basking shark | Negligible | Low | **Negligible** |

Table 11.46 Significance of Impact 4: Disturbance From Underwater Noise From Other Construction Activities

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

#### *Secondary Mitigation and Residual Effect*

11.7.286 The significance of the effect from injury and disturbance to marine mammals and basking sharks from underwater noise from other construction activities is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

#### EPS Consideration

11.7.287 Due to the PTS impact range being less than 100 m, it is therefore expected that no individuals that are classified as an EPS will be injured, and consequently an EPS licence for injury is unlikely to be required. Further, as the impact of disturbance resulting from other construction activities has concluded that the impacts will not be detrimental to maintaining the species at FCS, hence passes EPS test 3. Given the low magnitude of disturbance and the short duration and temporary nature of any disturbance, the impacts are not considered to result in a disturbance offence, and it is expected that an EPS licence will not be required.

#### Impact 5: Vessel Disturbance

11.7.288 Increased vessel movement during the construction phase of the Proposed Development has the potential to result in a range of impacts on marine mammals and other megafauna. These include avoidance behaviour or displacement due to increased vessel presence, and in the case of marine mammals, vessel presence can cause masking of vocalisations or changes in vocalisation rate due to increased underwater noise.

11.7.289 The Aspen Array Area experiences low vessel traffic density, with one area with moderate density at the Buchan Oil Field and route from it to Aberdeen. The OTC corridor has low-moderate vessel traffic density, with a density hotspot close to Aberdeen. The main ports surrounding the Proposed Development are Peterhead (84 km), Fraserburgh (93 km) and Aberdeen (11 km north of the OTC Corridor). Two main routes traverse from southwest to northeast through the Aspen Array Area, containing up to 175 vessel tracks per year, while the majority of the Aspen Array Area exhibits less than 100 tracks per year. Vessel traffic crossing the OTC Corridor experiences between 300 and 1,100 transits per year at its densest location (20 km stretch located 13 km from cable Landfall). The main vessel types recorded within the Aspen Array Area overall were tug and service vessels (45%), fishing vessels (42%), and cargo vessels (9%). Tanker vessels accounted for 2.5% of transits within the Aspen Array Area, and both recreational vessels and passenger vessels accounted for <1% of transits. For further details see **Volume 2, Chapter 14: Shipping and Navigation**.

### *Magnitude of Impact*

11.7.290 During the construction phase, a maximum of 52 vessels are expected to be on site at one time, resulting in a maximum of 1,234 vessel return trips over the four-year construction period. However, in reality, the number of vessels on site at one time is expected to be notably less at 8 - 10. Vessels that will be used during the construction phase include pre-construction survey vessels, light construction vessels, crew change vessels, guard vessels, anchor handling tugs, anchor handling construction vessels, installation support vessels, service operation vessels, jack up vessels, heavy lift vessels, heavy transport vessels, service operation vessels, construction support vessels, cable lay vessels, flexible fall pipe vessels, rockdump vessels and trenching support vessels (Table 11.18).

11.7.291 Disturbance to marine mammals and other megafauna by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (Pirotta *et al*., 2015). It is not simple to identify individual drivers of vessel disturbance, therefore, it is assessed in general terms, covering both disturbance from vessel presence and underwater noise.

11.7.292 Noise levels from construction vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, cavitation and various rotating machinery (e.g., power generation, pumps) in the vicinity of the Proposed Development. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed, and ambient noise levels (Wilson *et al*., 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the construction exceeds the background ambient noise level.

11.7.293 Vessel noise levels are typically in the range of 10 to 100 Hz (Erbe *et al.,* 2018) with an estimated source level of 168 $SEL_{cum}$ dB re 1 µPa @ 1 m (Root Mean Square (RMS)) for large construction vessels and 161 $SEL_{cum}$ dB re 1 µPa @ 1 m (RMS) for medium construction vessels, travelling at a speed of 10 knots. In general, support and supply vessels (50-100 m) are expected to have broadband source levels in the range 165-180 dB re 1µPa, with the majority of energy below 1 kHz (OSPAR, 2009). Large commercial vessels (>100 m) produce relatively loud and predominately low frequency sounds, with the strongest energy concentrated below several hundred Hz (OSPAR, 2009).

11.7.294 As stated in paragraph 11.7.289, the area surrounding the Proposed Development, in particular the OTC Corridor, already experiences a relatively low-moderate level of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for the marine mammals or other megafauna present in the area.

### Marine Mammals

11.7.295 The reported distance between marine mammals and vessels at which behavioural responses are observed varies. Thomsen *et al*. (2006) reported that harbour porpoise respond to both small (~2 kHz, 1/3 octave SPL levels of ship noise) and large (~0.25 kHz, 1/3 octave SPL levels of ship noise) vessels at approximately 400 m.

11.7.296 In addition, a study on the impacts of construction-related activities at Beatrice and Moray East OWFs showed that harbour porpoises are displaced by OWF construction vessels, including offshore service vessels for pile driving and jacket/turbine installation, guard vessels, crew-transfer vessels, and port service craft (Benhemma-Le Gall *et al*., 2021). The median construction-related vessel density across the Moray Firth during the study period was 1.4 vessels/km$^2$. Passive acoustic monitoring (PAM) data from the site showed that the hourly occurrence of porpoise detections declined within 2 km of construction vessels, but that no response was observed out to 4 km, suggesting that responses declined within increasing distance to vessels (Benhemma-Le Gall *et al*., 2021).

11.7.297 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km$^2$). Comparatively, vessel traffic in the Shipping and Navigation study area averages a maximum of one vessel per day (see **Volume 2, Chapter 14: Shipping and Navigation**).

11.7.298 For bottlenose dolphins, responses to different types of vessel traffic have been reported in a number of studies, with behavioural effects including disruption of socialisation and resting behaviours, changes in vocalisation patterns and reduced foraging activity (Koroza and Evans, 2022; Lusseau, 2003; Pellegrini *et al*., 2021; Pirotta *et al*., 2015). Despite this, research on an increase of commercial vessels for the construction of an OWF found that bottlenose dolphin response to disturbance is not biologically significant in that health, vital rates and population dynamics remained unchanged (New *et al.,* 2013).

11.7.299 Jones *et al*. (2017) analysed the predicted co-occurrence of ships and seals at sea which demonstrated that there is a large degree of predicted co-occurrence UK-wide, particularly within 50 km of the coast close to seal haul-outs. Despite this, there is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and seals (Jones *et al*., 2017).

11.7.300 Despite the documented co-occurrence of vessels and seals (Jones *et al*., 2017), behavioural disturbance to vessels has been recorded in both harbour and grey seals. Thomsen *et al*. (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. When exposed to shipping noise of 122 dB re 1 µPa (received SPL), telemetry studies indicate an increased descent rate of benthic and shallow dives in adult grey seals (Trigg, 2019). These quick descent dives are often a response to a stressor, which could impact the animal's fitness, due to increased energy demands and reduced foraging opportunities if disturbance was persistent (Mikkelsen *et al*. 2019).

11.7.301 At haul-out sites, grey seals have been frequently observed entering the water and displaying alert behaviour when disturbed by boats and cruise ships approaching between 100 and 830 m (Andersen *et al*. 2012; Tripovich *et al*. 2012; Jansen *et al*. 2015). It is worth noting that no haul-out sites are located within the site-specific study area.

11.7.302 The reported distance between cetaceans and vessels from which behavioural responses are observed varies, however information on Risso's dolphin, white-beaked, Atlantic white-sided dolphins and minke and humpback whales suggests that the response distance to vessels is limited.

11.7.303 Throughout the construction of the Proposed Development, the VMP (C-OFF-12; **Volume 4, Appendix 8 Outline Vessel Management and Navigation Safety Plan**) will ensure that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals. In addition, vessels will also adhere to the Scottish Marine Wildlife Watching Code (C-OFF-45) which provides guidance on how to behave when animals are sighted.

11.7.304 While the presence of vessels in the area may cause displacement and/or changes in behaviour, marine mammal receptors are likely to return to the area quickly and resume pre-disturbance behaviours.

11.7.305 The proposed implementation of a VMP (C-OFF-12) will reduce the risk of vessel disturbance by controlling the speed and movement of vessels, limiting vessel speed and ensuring predictable routes which are less likely to cause disturbance (further details in **Volume 4, Appendix 8 Outline Vessel Management and Navigation Safety Plan**). This is supported by vessel simulation modelling by Findlay *et al*. (2023) which predicted that, when animals were exposed to vessels at a given distance with both a 20% and a 50% reduction in speed, all potential noise impacts were reduced. At a 20% reduction in speed, the vessel noise halved, reducing the average number of animals exposed by 50% and therefore reducing the number of animals that are likely to be disturbed (Findlay *et al*., 2023). In addition, the study demonstrated that moderate slowdowns strongly reduce vessel source levels, with a 20% reduction in speed decreasing mean source levels by 6 dB and a 50% speed reduction decreased mean source levels by 18 dB (Findlay *et al*., 2023).

11.7.306 The area of disturbance as a result of the Proposed Development activities identified above is considered to be small given the anticipated local spatial range of impact. The impact would also be expected to be temporary. Furthermore, all marine mammal receptors within this assessment are highly mobile and have a large distribution range within their respective MUs.

11.7.307 The impact of disturbance to marine mammals from vessel activities is considered to result in a small proportion of the population affected, to occur frequently throughout the construction phase, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory of any of the marine mammal receptor species given implementation of embedded commitments.

11.7.308 The impact is predicted to be of local spatial extent and short-term duration. The magnitude is therefore Low.

Basking Shark

11.7.309 Field observations suggest that basking sharks react to approaching vessels at distances approximately 10 m to 1 km away but appear relatively tolerant of the physical presence of vessels, often remaining undisturbed and appearing unaware of surface vessels (Bloomfield and Solandt, 2008; Speedie and Johnson, 2008; Speedie *et al.,* 2009; Compagno, 1984).

11.7.310 The proposed implementation of a VMP will reduce the risk of vessel disturbance by controlling the speed and movement of vessels, limiting vessel speed and ensuring predictable routes which are less likely to cause disturbance (further details in **Volume 4, Appendix 8 Outline Vessel Management and Navigation Safety Plan**). In addition, vessels will adhere to the Basking Shark Code of Conduct (C-OFF-54) which recommends reducing speeds to below 6 knots when sharks are sighted, avoid sudden changes of speed, not to chase or direct vessels towards animals and maintain a distance of 100 m.

11.7.311 The area of disturbance as a result of the Proposed Development activities identified above is considered to be small given the anticipated local spatial range of impact. The impact would also be expected to be temporary. Furthermore, basking sharks are highly mobile and have a wide distribution within Scottish waters.

11.7.312 The impact is predicted to be of local spatial extent and short-term duration. The magnitude is therefore Low.

### *Sensitivity of Receptor*

Harbour Porpoise

11.7.313 Harbour porpoises have a high frequency generalised hearing range (275 Hz–160 kHz) with a peak hearing sensitivity between 100-125 kHz (Morell *et al.,* 2021). Vessels generally emit low frequency noise, where large vessels are typically up to 10 kHz and small vessels are typically up to 40 kHz (Duarte *et al.,* 2021). These frequencies overlap with the hearing frequencies of harbour porpoise but are not within the species' peak hearing sensitivity. Roberts *et al.* (2019) observed that harbour porpoise presence, resting and feeding behaviour reduced in response to increasing vessel frequencies. Frequent, lower-level noise exposures can cause masking and behavioural disruption that may be hard to detect but can have cumulative long-term effects on populations (Tougaard *et al.,* 2015).

11.7.314 Harbour porpoises are particularly sensitive to anthropogenic noise, with the species having been documented to actively avoid vessels (e.g. Culloch *et al.,* 2016; Benhemma-Le Gall *et al.,* 2021). Harbour porpoises were observed being displaced up to 4 km from construction vessels during the construction of the Beatrice and Moray East OWFs in the Moray Firth, with increased vessel activity leading to a significant decreased in the acoustic detections and activity (Benhemma-Le Gall *et al.,* 2021). Gradient analyses from this study showed that the probability of detecting porpoises within the site decreased by up to 35.2% with increased vessel intensity and a decrease in distance to the nearest vessel. Similar impacts were also observed in a large-scale study of harbour porpoise density across UK waters. Using statistical analysis of multiple datasets, Heinänen and Skov (2015) found that increased vessel presence was associated with lower harbour porpoise densities.

11.7.315 Vessel disturbance has also been found to impact foraging activity in harbour porpoise. Wisniewska *et al.* (2018) collected telemetry data to study the change in foraging rates of harbour porpoise in response to vessel noise in coastal waters in the inner Danish waters and Belt seas. The results suggest that foraging may be disrupted at greater distances of up to 7 km as a result of vessel disturbance. In addition, disturbance from vessels may also lead to displacement from important foraging grounds, resulting in loss of foraging opportunities (Nabe-Nielsen *et al.,* 2018). As stated in paragraph 11.7.91, harbour porpoises overall fitness may be impacted if foraging activity is disrupted, or they are displaced from high-quality foraging grounds and are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. Despite this, results from studies suggest that harbour porpoises are able to respond to short-term reductions in food intake and therefore, may have some resilience to disturbance (Wisniewska *et al.,* 2016).

11.7.316 Wisniewska *et al.* (2018) also observed that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 μPa (16 kHz third octave; Wisniewska *et al.,* 2018). Behavioural responses of harbour porpoise to vessel noise have also been observed under controlled conditions. Four harbour porpoises in a semi-natural net pen were exposed to low levels of medium to high frequency vessel noise (Dyndo *et al.,* 2015). 'Porpoising', a stereotypical disturbance behaviour, was observed during 27.5% of noise recordings.

11.7.317 Despite studies demonstrating that harbour porpoise display changes in behaviour and distribution as a result of vessel disturbance, they also show a quick recovery time from being disturbed by vessel traffic and resume foraging activities shorty after disruption, with little cost to fitness. Harbour porpoises continue to be widespread and frequently recorded across the North Sea (Evans *et al.,* 2003), with higher densities recorded in the southern North Sea (JNCC, 2023c). As a result, it can be assumed that there are suitable foraging habitats across their range. Therefore, the relatively short-term disturbance across the Proposed Development is unlikely to have any significant population-level effect on harbour porpoise. Furthermore, harbour porpoise may also become habituated where construction vessel movements are regular and predictable (Wisniewska *et al.* 2018).

11.7.318 Based on the above, harbour porpoises are considered to be of reasonable adaptability, limited tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

Bottlenose Dolphin

11.7.319 Studies on the interactions of bottlenose dolphins with vessels have shown varying responses. In the Moray Firth, a passive acoustic monitoring study found that the presence of vessels resulted in a short-term reduction in foraging activity by 49%, with animals resuming foraging after the vessel had travelled through the area, suggesting that disturbance was limited to the time the vessel was physically present (Pirotta *et al.,* 2015). The behavioural disturbance observed was temporary, with foraging activities quickly resuming as vessels moved away from the area. As a result, this was the first study to conclusively show that the physical presence of vessels, plays a large role in disturbance of bottlenose dolphins.

11.7.320 Studies have found behavioural impacts as a result of vessel disturbance in bottlenose dolphins to include disruption of socialisation and resting behaviours and changes in vocalisation patterns (Koroza and Evans, 2022; Lusseau, 2003; Pellegrini *et al.,* 2021; Pirotta *et al.,* 2015; Marley *et al.,* 2017b; Piwetz, 2019), with effects often dependent on vessel size and speed. Bottlenose dolphins have been observed increasing their swim speeds in response to high levels of vessel activity (Marley *et al.,* 2017a; Piwetz, 2019). Activity changes were also seen, with bottlenose dolphins spending less time resting, socialising and foraging, in response to vessel presence (Marley *et al.,* 2017b; Piwetz, 2019). As a result, repeated disturbance may lead to an overall reduced energy intake in these individuals. Whistle structures of bottlenose dolphins have also been found to change in relation to vessel presence and the resulting underwater noise (Rako Gospic and Picculin, 2016; Marley *et al.,* 2017a; Pellegrini *et al.,* 2021)

11.7.321 In a modelling study by Lusseau *et al.* (2011), it was predicated that increased vessels movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphins, although it did note that foraging may be disrupted by disturbance from vessels.

11.7.322 A study by Marley *et al.* (2017a) on Indo-pacific bottlenose dolphins along the coast of Western Australia found a negative impact on density due to vessel present at one site, but no significant impact at another. From this, it has been hypothesised that the quality of the habitat has an effect on bottlenose dolphins' response to vessel disturbance, with the latter site being a known foraging area.

11.7.323 Bottlenose dolphins can tolerate vessel disturbance, particularly in areas where vessel traffic has always been high (Pirotta *et al.,* 2013). During the construction works of an oil pipeline in Broadhaven Bay, north-west Ireland, the presence of bottlenose dolphin was positively correlated with overall vessel number (Anderwald *et al.,* 2013). However, it is unclear whether this correlation is as a result of the bottlenose dolphins being attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.,* 2013). In Cardigan Bay, UK, bottlenose dolphins showed neutral and even positive responses towards some vessels, depending on the vessel type and speed (Gregory and Rowden, 2001).

11.7.324 New *et al.* (2013) found that bottlenose dolphins have the ability to compensate for their immediate behavioural response to an increase in vessel traffic. The study modelled an increase in traffic from 70 to 470 vessels and found that this increase in vessel traffic alone would not result in a biologically significant increase in disturbance.

11.7.325 The studies presented above show the variety of responses that bottlenose dolphins have been observed to display in response to vessel disturbance. Behavioural responses include changes in foraging behaviour, swim speed, behavioural state, avoidance, and acoustic behaviour (Pirotta *et al.,* 2015; Koroza and Evans, 2022; Lusseau, 2003; Pellegrini *et al.,* 2021; Pirotta *et al.,* 2015; Marley *et al.,* 2017a; 2017b; Piwetz, 2019; Rako Gospic and Picculin, 2016). However, evidence suggests that bottlenose dolphins can tolerate and habituate to vessel traffic, and therefore certain levels of temporary increases in vessel disturbance is unlikely to lead to high levels of disturbance (Pirotta *et al.,* 2013; Anderwald *et al.,* 2013; Gregory and Rowden, 2001; New *et al.,* 2013). Where behavioural changes do occur, bottlenose dolphins have demonstrated their ability to adapt to and quickly recover from vessel disturbance.

11.7.326 Based on the above, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Risso's Dolphin

11.7.327 There is limited information available on the behavioural response of Risso's dolphin to increased vessel disturbance. However, several studies have shown that vessel traffic can affect the behaviour, activity, energy budgets, habitat use, and reproductive success of dolphin species (Bejder *et al.,* 2006; Lusseau, 2003; Lusseau and Higham, 2004; Lusseau and Bejder, 2007).

11.7.328 A study of Risso's dolphin in the Azores, recorded Risso's displaying aversion behaviours in the presence of vessels and altering daily resting patterns in response to high vessel activity (Visser *et al.,* 2011). When more than five vessels were present in the vicinity, Risso's dolphins spent significantly less time resting and socialising. In turn, reduced resting and socialising rates may have negative impacts on the build-up of energy reserves and reproductive success (Visser *et al.,* 2011). In the Ionian Sea, a study on the impacts of cetacean watching vessels on behavioural activities of Risso's dolphins found that Risso's showed a neutral response to the presence of the vessel during 81.3% of sightings, a negative response in 17% of sightings and a positive response in 1% of sightings (Bellomo *et al.,* 2021). A study on the effects of anthropogenic noise on Risso's dolphin vocalisations in the North Ionian Sea found that click train and buzzes are particularly affected by the low frequency noise, suggesting that vessel noise is the anthropogenic stressor that most impacts Risso's acoustic behaviour (Carlucci *et al.,* 2024).

11.7.329 As limited information exists on the behavioural response of Risso's dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on Risso's dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups.

11.7.330 Based on the above, Risso's dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

#### Atlantic White-sided Dolphin / White-beaked Dolphin

11.7.331 There is currently no information on the behavioural effects as a result of vessel disturbance in Atlantic white-sided and white-beaked dolphins. Therefore, in the absence of species-specific data or published literature, the information provided for species with a similar hearing range (in this case bottlenose and Risso's dolphin) has been used as a proxy for the assessment of vessel disturbance on Atlantic white-sided and white-beaked dolphins.

11.7.332 Based on the information for bottlenose and Risso's dolphin, Atlantic white-sided and white-beaked dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

#### Minke Whale

11.7.333 A study into the response of minke whales to construction-related vessel traffic in Broadhaven Bay, northwest Ireland found a significant negative correlation between minke whale presence and both the number of overall vessels and the number of utility vessels (those emitting lower frequency noise but moving around more than construction vessels) (Anderwald *et al.,* 2013). This suggests that minke whale were displaced from the vicinity, most likely due to disturbance resulting from vessel presence.

11.7.334 Christiansen *et al.* (2013) found that minke whales change their diving patterns and behaviour in response to the presence of whale-watching vessels. Minke whales were recorded reducing dive times and increasing sinuous movements, which in turn, reduced foraging activity with observed surface feeding evenings decreasing during vessel interactions. The study also found that this reduction in foraging activity could result in decreased energy availability, leading to reduced reproductive success. Behavioural changes in response to vessel presence were also observed by Christiansen and Lusseau (2015a; b) who found that interactions with whale-watching vessels led to a 42.1% decrease in feeding activity and a 7.6% increase in non-feeding activity. This resulted in a 63.5% decrease in net energy intake. These bioenergetic effects were then examined in terms of their impacts on foetal growth. However, impacts were considered negligible, with there being no significant impact found on foetal growth, due to the very low number of interactions with vessels during the foraging season. It is important to note that noise levels were not measured in either study. Therefore, behavioural responses are considered to be related to vessel presence.

11.7.335 Despite minke whales displaying a clear behavioural response in relation to vessel presence, when considering the temporal and spatial rates of minke whale exposure to vessels across the whale-watching season, Christiansen *et al.* (2015) found no population-level effects. This is likely due to their large population size and migratory behaviour.

11.7.336 As limited information exists on the behavioural response of minke whales to construction-related vessels, studies on the impact of whale-watching vessels on minke whale behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from whale watching vessels are direct, whilst those from construction vessels would be indirect as interactions are unlikely to be deliberate or targeted.

11.7.337 Based on the above, minke whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### Humpback Whale

11.7.338 Sprogis *et al.* (2020) observed a decrease in resting rates by up to 30% and a double in respiration rates in humpback mother-calf pairs when vessels producing high level low-frequency noise were within 100 m of the pair, when compared to control low level noise scenarios. Swim speeds were also found to increase by 37%. These behaviours are likely to be a result of avoidance strategies, in turn increasing energy expenditure in these individuals. A study by Villagra *et al.* (2021) looked into the energetic effects of whale-watching vessels on humpback whales at a breeding ground in northern Peru. Results found that the mere presence of whale watching vessels did not lead to any significant behavioural changes.

11.7.339 However, an increase in swim speed and breath frequency was observed as the number of vessels and duration of interactions with vessels increased. Behavioural responses of humpback whales to whale-watching vessels were also observed by Stamation *et al.* (2010). Whales were observed increasing dive times and the percentage of time spent submerged, in the presence of vessels. Some surface behaviours also occurred less often when vessels were present. Pods containing calves also appear to be more sensitive to vessel disturbance than adult-only pods.

11.7.340 As limited information exists on the behavioural response of humpback whales to construction-related vessels, studies on the impact of whale-watching vessels on humpback whale behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from whale watching vessels are direct, whilst those from construction vessels would be indirect as interactions are unlikely to be deliberate or targeted.

11.7.341 Based on the above, humpback whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

Harbour and Grey Seals

11.7.342 There is limited information on the behavioural response of harbour and grey seals to increased vessel presence, particularly in relation to construction vessels. Seals rely heavily on sound for communication, orientation, navigation, to locate predators and foraging, and as a result, auditory disruption may affect their survival rates (Chen *et al.,* 2017; Southall *et al.,* 2000). Seals are particularly sensitive to disturbance by vessels which have a low frequency sound output, as seal vocalisations are relatively low frequency and are therefore at risk of being masked (Britton, 2012). Masking of harbour seal vocalisations by vessel noise is thought to occur up to 15 km from the source (Thomsen *et al.,* 2006).

11.7.343 Seals are also particularly sensitive to disturbance where vessel traffic overlaps with productive coastal waters (Robards *et al.,* 2016). Vessel disturbance may lead to changes in haul-out pattens, which, in turn may reduce the time spent resting or nursing pups. If disturbed while hauled-out, seals may ‘flush’ (enter) into the water. This behaviour is particularly detrimental during pupping season as an increase in vigilance/disturbance behaviours and flushing responses can have adverse effects on physical condition (Back *et al.,* 2018; Cowling *et al.,* 2015). Lactating seals rely on stored fat reserves whilst nursing, therefore, any reduction to time spent nursing due to disturbance can result in poor condition or abandonment of their young (Ruiz-Mar *et al.,* 2022; Osinga *et al.,* 2012; Twiss *et al.,* 2020; Bishop *et al.,* 2015; Curtin *et al.,* 2009). Furthermore, a flushing response to disturbance by either mother or both mother and pup may lead to separation of pup from its mother (Osinga *et al.,* 2012; Wilson, 2014). It is, however, noted that no haul-out sites of harbour or grey seals have been identified within or near the site-specific study area.

11.7.344 Britton (2012) recorded a significant correlation between boat speed and the distance at which hauled-out grey seals on the Isle of Man showed alert behaviour. A similar association was also observed between boat speed and movement and flushing response (entering the water) although this was not tested. The duration of the boat interaction was, however, found to be important, with flushing occurring in all vessel interactions lasting four minutes or longer (Britton, 2012).

11.7.345 Harbour and grey seals have a broad hearing range of 50 Hz – 86 kHz and have reportedly responded to small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m (Southall *et al.,* 2019; Thomsen *et al.,* 2006). Avoidance/disturbance behaviour has been observed in harbour seals at haul-out sites up to 100m from vessel activity (Richardson *et al.,* 1995). However, a study of 37 telemetry tagged harbour seals at sea in Moray Firth, Scotland reported no apparent response by seals to close passing vessels (Onoufriou *et al.,* 2016) Another telemetry study of harbour and grey seals in the UK found that despite shipping noise potentially causing TTS due to cumulative SELs exceeding the TTS-threshold, there was no evidence of reduced harbour and grey seal presence due to vessel traffic (Jones *et al.,* 2017).

11.7.346 Anderwald *et al.* (2013) found that grey seals sightings were significantly negatively correlated with the overall number of vessels and the number of utility vessels (i.e. those emitting lower frequency noise but moving around more than construction vessels) in the surrounding area, suggesting that grey seal were actively avoiding the area. However, it is important to note that this correlation was weaker than those with environmental variable such as sea state.

11.7.347 Grey seals have also been found to alter their surfacing and diving behaviour in relation to vessel presence (Trigg, 2019), demonstrating disturbance occurring in this species while at sea as well as when hauled-out.

11.7.348 Vessel type also has an impact on disturbance responses in grey seals, as they can become habituated to vessel presence, particularly wildlife watching or fishing. However, vessels which are not regularly occurring in an area are known to cause displacement from the vicinity (SCOS, 2023).

11.7.349 Based on the above, harbour and grey seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

#### Basking Shark

11.7.350 As stated in paragraph 11.7.309, basking sharks appear to be relatively tolerant of the physical presence of vessels with individuals often remaining undisturbed and appearing relatively unaware of surface vessels (Bloomfield and Solandt, 2008; Speedie and Johnson, 2008; Speedie *et al.,* 2009; Compagno, 1984). However, avoidance behaviour in the presence of boats (from 10 m to 1 km) has been recorded, such as diving deep, moving away from the vessel and disruption in courtship-like behaviour (Bloomfield and Solandt, 2008).

11.7.351 Speedie and Johnson (2008) reported no observable changes in basking shark behaviour towards slowly approaching vessels, which seems to indicate that vessel speed is likely to be a factor in behavioural responses. The angle of approach, engine noise and repeated approaches also appear to be a factor in disturbance (Wilson, 2000), however the significance of this effect is limited. Age of the individual may also play a part, with juvenile sharks being more easily disturbed. It is worth noting that the response of basking sharks to boats observed in the above studies may be due to either noise or visual disturbance. Currently no distinction between the causes of disturbance behaviours in basking sharks has been identified.

11.7.352 Based on the above, basking sharks are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.353 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.47.

11.7.354 The magnitude of impact is deemed to be Low for vessel disturbance for all receptors. The sensitivity of the receptors is Low for vessel disturbance (Table 11.47). The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.47 Significance of Impact 5: Vessel Disturbance (Construction)

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

### *Secondary Mitigation and Residual Effect*

11.7.355 The significance of the effect from vessel disturbance to marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.356 The assessment of impacts resulting from vessel disturbance, with the commitment to a VMP (C-OFF-12 and C-OFF-45), has determined that any associated disturbance is unlikely to hinder the ability to maintains the species FCS. As such, the activity is considered to meet the requirements of EPS test 3. Given the low number of vessels expected to be in the Proposed Development at one time, the impacts are not considered to result in a disturbance offence and it is anticipated that an EPS licence is unlikely to be required.

## Impact 6: Vessel Collision Risk

11.7.357 Increased vessel movement during the construction phase of the Proposed Development has the potential to result in a range of impacts on marine mammals and other megafauna. These include injury or death due to collision with vessels due to increased vessel presence.

11.7.358 The Aspen Array Area experiences mostly low vessel traffic density (apart from two areas) and the OTC corridor has low-moderate vessel traffic density, with a density hotspot close to Aberdeen. The main ports surrounding the Proposed Development are Peterhead (84 km), Fraserburgh (93 km) and Aberdeen (11 km north of the OTC Corridor) (see **Volume 2, Chapter 14: Shipping and Navigation**).

11.7.359 There are two areas of moderate density within the Array Study Area at the Buchan Oil Field, and along a narrow northeast-southwest route between Aberdeen and the Buchan Oil Field. These areas have 10 – 50 transits per month per 500 $m^2$ grid cell, as a result of the tug and service vessels that regularly service the oil field. The main vessel types recorded within the Aspen Array Area overall were tug and service vessels (45%), fishing vessels (42%), and cargo vessels (9%). Tanker vessels accounted for 2.5% of transits within the Aspen Array Area, and both recreational vessels and passenger vessels accounted for <1% of transits.

### *Magnitude of Impact*

11.7.360 During the construction phase, a maximum of 52 vessels will be present within the Aspen Array Area at any one time, resulting in a maximum of 1,234 vessel return trips over the four-year construction period (Table 11.13). Vessels that will be used during the construction phase include pre-construction survey vessels, light construction vessels, crew change vessels, guard vessels, anchor handling tugs, anchor handling construction vessels, installation support vessels, service operation vessels, jack up vessels, heavy lift vessels, heavy transport vessels, service operation vessels, construction support vessels, cable lay vessels, flexible fall pipe vessels, rockdump vessels and trenching support vessels (Table 11.18).

11.7.361 Vessel traffic associated with the Proposed Development has the potential to lead to an increase in vessel movements within the site-specific study area. This increase in vessel movement could lead to an increase in interactions between marine mammals and basking sharks and vessels during offshore construction. Whilst a broad range of vessel types have been involved in collisions with marine mammals (Laist *et al*., 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger strike impact for both marine mammals and basking sharks (Schoeman *et al.,* 2020). For example, a study by Laist *et al*. (2001) found that in 89% of collisions in which the whale was killed or seriously injured vessels were travelling at speeds of 14 km (7 m/s) or more, and the vessel exceeded a length of 80 m. Therefore, larger vessels travelling at 7 m/s or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al*., 2001). The majority of vessels used during the construction phase are likely to be large vessels that will either be travelling considerably slower than 7 m/s or will be stationary for significant periods of time.

11.7.362 Therefore, the actual increase in vessel traffic moving within the Proposed Development and to/from port will occur over short periods of the offshore construction activity. Smaller vessels involved in construction activities (i.e. tug/anchor handlers, guard vessels, survey vessels, and crew transfer vessels) are able to move to avoid marine mammals and basking sharks (when detected), even when an animal is close and the vessel is going at high speed, due to better manoeuvrability compared to larger vessels (Schoeman *et al*., 2020). In contrast, large vessels, such as jack-up vessels, have low manoeuvrability and may require larger distances to avoid an animal, but travel at slower speeds.

11.7.363 In addition, the embedded commitments (Table 11.16) which include a VMP (C-OFF-12), will advise that vessel traffic will move along predictable routes, which is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al*., 2001; Lusseau 2003; 2006). The VMP will also provide best practice guidance to minimise interactions with marine mammals and basking sharks and define how vessels should behave in the presence of them. In addition, adherence to the Scottish Marine Wildlife Watching Code (C-OFF-45) and the Basking Shark Code of Conduct (C-OFF-54) will also minimise the risk of collision.

11.7.364 Vessel collisions with basking sharks have been reported in the southwest of England during a yachting event, and with small boats off Carradale (Speedie *et al*., 2009). Basking sharks with propeller injuries and other injuries consistent with vessel collisions have been recorded on the west coast of Scotland, Wales and Ireland where higher basking shark numbers, as compared to the east coast of the UK, are recorded (Speedie and Johnson, 2008).

11.7.365 It is also likely that the noise emissions from vessels involved in the construction phase will be detectable by marine mammals and therefore will deter animals from the areas of potential impact. Whilst construction of the Proposed Development will lead to an uplift in vessel activity, vessel movements will be largely restricted to within the Aspen Array Area or along the OTC Corridor and Working Area and will follow existing shipping routes to/from ports. Due to the volume of vessel traffic around the site-specific study area already, the introduction of additional vessels during the construction phase of the Proposed Development will not be a novel impact for marine mammals present in the area. Therefore, it is not expected that vessel activities during the construction phase would increase the risk of injury due to vessel collision.

11.7.366 The impact of injury to all marine mammal species and basking sharks from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the construction phase, the effect is unlikely to occur given implementation of embedded commitments, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory.

11.7.367 The impact for marine mammals and basking sharks is therefore predicted to be of local spatial extent, short term duration and intermittent. The magnitude is therefore Negligible.

*Sensitivity of Receptor*

11.7.368 During construction of the Proposed Development, a potential source of impact from increased vessel activity is physical trauma from collision with a vessel. In general, three consequences of vessel collision are defined: direct (injuries to the animals that are the immediate result of collision), long-term (a decrease in the fitness of the animal over time), and population consequences (Schoeman *et al.,* 2020). With regards to injuries, both fatal and non-fatal injuries of marine mammals and basking sharks with vessels have been documented (Laist *et al.,* 2001; Vanderlaan *et al.,* 2008; Cates *et al.,* 2017; Sparkes, 2024; Speedie and Johnson, 2008). Fatal collisions have been evidenced via carcasses washing up on beaches (Laist *et al.,* 2001; Peltier *et al.,* 2019); carcasses caught on vessel bows (Laist *et al.,* 2001; Peltier *et al.,* 2019); and floating carcasses which have strong evidence of ship strike, such as propeller cuts, significant bruising, oedema, internal bleeding radiating from a specific impact site, fractures and ship paint marks (Jensen and Silber, 2003; Douglas *et al.,* 2008). Fatalities from ship strikes, however, often go unreported (Authier *et al.,* 2014). For non-fatal injuries, evidence of animals which have survived ship strikes with non-fatal injuries from propellers has been widely documented (Wells *et al.,* 2008; Luksenburg, 2014).

Marine Mammals

11.7.369 Although many species of marine mammals are able to detect and avoid vessels, it is unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al.,* 2020), although it has been suggested that behaviours such as resting, foraging, nursing, and socialising could distract animals from detecting the risk posed by vessels (Dukas, 2002). It is also possible that animals do not hear vessels when they are near the surface. Collisions between cetaceans and vessels, however, are not necessarily lethal on all occasions (Wells *et al.,* 2008; Luksenburg, 2014).

11.7.370 The risk of collision between marine mammals and vessels is directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al*, 2001), and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in. Vessels travelling at higher speeds (14 knots or faster) pose a higher risk (Laist *et al*, 2001). Smaller vessels (such as guard vessels) are also able to avoid marine mammals (when detected) due to better manoeuvrability compared to larger vessels (Schoeman *et al.,* 2020). Similar vessels during construction will have low to moderate working speeds, hence reducing the risk of collision.

11.7.371 There is currently a lack of information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality. There is little evidence from marine mammals stranded in the UK that injury from vessel collisions is an important source of mortality. The UK Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. According to the most recent CSIP report, post-mortems were conducted on 32 out of the 291 reported harbour porpoise strandings in 2022 (CSIP, 2023). A cause of death was identified for all examined individuals, with two individuals being identified as dying from physical trauma of an unknown cause, which could have been vessel strike. For bottlenose dolphin, of the nine strandings reported in 2022, three were investigated by post-mortem with cause of death established in all post-mortems. Cause of death was not identified as physical trauma for any individuals. For Risso's dolphin, only one of the seven strandings in 2022 was investigated. The cause of death for this individual was not physical trauma. A single white-beaked dolphin was reported stranded in 2022. This individual was examined, and the cause of death was not identified as physical trauma. In 2022, CSIP received its first report of a stranded Atlantic white-sided dolphin in nearly a decade. Cause of death of this individual was not physical trauma. For minke whales, two of the 11 strandings reported were investigated by post-mortem. Neither stranding was identified as being caused by physical trauma. In 2022, CSIP took part in a one-year pilot study to assess the viability of a seal mortality monitoring and investigation scheme across England and Wales. During the study, 480 dead stranded seals were reported. 34 grey seals and one harbour seal were examined by post-mortem. Of the grey seals, two died from physical trauma of an unknown cause, which could have been vessel strike. A cause of death could not be identified for the harbour seal. No strandings of humpback whales were reported in 2022. The CSIP data for 2022, aligns with that of previous years (CSIP 2016; 2017; 2018; 2019; 2020; 2021, 2022), with that very few strandings have been attributed to vessel collisions

11.7.372 In Scotland, The Scottish Marine Animal Stranding Scheme (SMASS) works alongside CSIP to collate, analyse and report data of marine mammal strandings around the Scottish coast. The most recent SMASS report for 2023, recorded 444 cetacean strandings and 476 seal strandings. Of these, 78 cetaceans and 86 seals were necropsied (Brownlow *et al.,* 2024). Physical trauma as a result of vessel strike was not found to be the cause of death for any of the species included in this assessment. Physical trauma as a result of vessel strike was not identified as the cause of death for any strandings in SMASS reports in 2022 or 2021 (SMASS, 2023; Brownlow *et al.,* 2024). However, in 2020, one harbour porpoise was identified as dying from physical trauma as a result of vessel strike (Davison and ten Doeschate, 2021).

11.7.373 While there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post-mortem examinations. However, it is important to note that the strandings data are biased to those carcasses that wash ashore for collection and therefore may not be representative. Furthermore, post-mortems are not undertaken for many carcasses, further reducing the representativity of strandings data.

11.7.374 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.,* 2001, Lusseau 2003, Lusseau 2006).

11.7.375 Collision risk for seals is less understood than for cetaceans, however trauma ascribed to collisions with vessels has been identified in a small proportion of both live stranded (Goldstein *et al.,* 1999) and dead stranded seals in the US (Swails, 2005). In these cases, however, less than 2% of all dead necropsied seals had vessel collision attributed to cause of death. A study in the Moray Firth showed that seals use the same areas as vessels during trips between haul-outs and foraging sites but that seals tended to remain beyond 20 m from vessels (only three instances over 2,241 days of seal activity resulted in passes at less than 20 m) (Onoufriou *et al.,* 2016), suggesting that the possibility of a risk of collision is very low.

11.7.376 Overall, marine mammals will avoid vessels and vessel collision is not considered to be a key source of mortality highlighted from post-mortem examinations of stranded animals. However, should a collision event occur, this is likely to kill or injure the animal.

11.7.377 Based on the above, all marine mammal receptors are considered to be of reasonable adaptability, limited to no tolerance, have medium-term to no recoverability, and are of very high value. The sensitivity of the receptor is High.

### Basking Shark

11.7.378 Basking sharks are slow-moving and large-sized with limited manoeuvrability, making them particularly susceptible to vessel collision (Witt *et al.,* 2019). This is of particular concern in summer and early autumn months when basking sharks feed and display breeding behaviour at or near the water surface closer to the coast. In addition, basking sharks have been observed appearing undisturbed and relatively unaware of surface vessels (Speedie *et al.,* 2009; Compagno, 1984; Speedie and Johnson, 2008), although it is thought that juveniles react more readily to vessel presence (Speedie *et al.,* 2009).

11.7.379 A total of 14 basking shark strandings were reported to CSIP between 2018 and 2022 (CSIP, 2019, 2020, 2021, 2022, 2023), with four of them reported on the east coast of Scotland. No sign of vessel interaction and/or collision was identified on stranded individuals investigated post-mortem. Between 2020 and 2023, a total of nine basking sharks were reported to SMASS (Brownlow *et al.,* 2024; SMASS, 2023; Davison and ten Doeschate, 2021). Physical trauma as a result of vessel strike was not identified as the cause of death for any strandings investigated by post-mortem. There is little evidence from basking sharks stranded in UK waters to suggest that injury from vessel collision is an important cause of shark mortality. As noted above, there is evidence that not all collision incidents are lethal (Speedie and Johnson, 2008), and that elasmobranchs in general have the potential for recovery from wound injuries (Riley *et al.,* 2009; Chin *et al.,* 2015). Furthermore, it is important to note that the strandings data are biased to those carcasses that wash ashore for collection and therefore may not be representative.

11.7.380 Camera footage of a collision between a boat and a basking shark has recently been captured off the coast of Ireland. In the video the female basking shark can be seen feeding on the surface before making sudden evasive move and then colliding with a boat, causing the animal to rapidly dive to the seabed. When the tag had automatically released 7 hours after the event, the individual had not resumed feeding and video showed visible damage and abrasions (Sparkes, 2024).

11.7.381 Based on the above, basking sharks are considered to be of reasonable adaptability, limited to no tolerance, have medium-term to no recoverability, and are of very high value. The sensitivity of the receptor is High.

### *Significance of Effect*

11.7.382 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.48.

11.7.383 The magnitude of impact is deemed to be Negligible for vessel collision risk (Table 11.48). The sensitivity of the receptor is High for vessel collision risk. The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.48 Significance of Impact 6: Vessel Collision Risk (Construction)

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | High | Minor |
| Bottlenose dolphin | Negligible | High | Minor |
| Risso's dolphin | Negligible | High | Minor |
| Atlantic white-sided dolphin | Negligible | High | Minor |
| White-beaked dolphin | Negligible | High | Minor |
| Minke whale | Negligible | High | Minor |
| Humpback whale | Negligible | High | Minor |
| Harbour seal | Negligible | High | Minor |
| Grey seal | Negligible | High | Minor |
| Basking shark | Negligible | High | Minor |

### *Secondary Mitigation and Residual Effect*

11.7.384 The significance of the effect of vessel collision risk to marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.385 It is expected that, with the commitment to a VMP (C-OFF-12) to reduce the vessel collision risk to Negligible levels, no EPS will be injured. As such, an EPS licence for injury is unlikely to be required.

## Impact 7: Changes to Prey

11.7.386 Marine mammals and basking sharks are dependent on prey for survival. As a result, there is the potential for indirect effects on marine mammals or basking sharks to occur as a result of impacts on their prey species or the habitats that support them. The key prey species for the receptors within this assessment are presented in Table 11.49.

### *Magnitude of Impact*

11.7.387 Potential impacts on prey species during the construction phase of the Proposed Development are described in **Volume 2, Chapter 10: Fish and Shellfish Ecology** of the Offshore EIAR and include:

- Mortality, injury, behavioural disturbance and auditory masking arising from noise and vibration;
- Temporary increase in suspended sediments and sediment deposition;
- Direct and indirect seabed disturbance leading to release of sediment contaminants;
- Temporary habitat disturbance;
- Increased risk of introduction and/or spread of marine Invasive Non-Native Species (INNS).

11.7.388 **Volume 2, Chapter 10: Fish and Shellfish Ecology** of the Offshore EIAR has concluded that there will be no likely significant effects arising on the fish and shellfish species during the construction phase, with the exception of the following impact, which has been concluded to have likely significant effects:

- Behavioural impacts from underwater noise (UWN) on Group 3 (static – spawning herring) valued ecological receptors (VERs) – Piling (anchor piles) has been concluded to have a Moderate significance, which is significant in EIA terms.

11.7.389 With the implementation of secondary mitigation measures, the significant of behavioural effects on Group 3 (static – spawning herring) VERs will be reduced to levels that are not significant. The residual effect will be minor which is not significant in EIA terms.

11.7.390 The impact to all marine mammals and basking shark receptors from changes to prey species is considered to be highly localised, to occur relatively frequently throughout the construction phase and is unlikely to occur with the implementation of secondary mitigation measures as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude is assessed as Low.

Table 11.49 Key Prey Species of the Receptors

| Receptor | Key Prey Species | Region | Reference |
|---|---|---|---|
| Harbour porpoise | **Sandeel**, **whiting**, **small cod,** blue whiting, **cod**, **haddock**, **saithe**, rocklings, **herring**, **sprat**, **mackerel**, scad, cephalopods, molluscs, brown shrimp, crabs, isopods, amphipods, other crustaceans | Scotland | Santos *et al.* (2004) |
| Bottlenose dolphin | Catsharks, **sprat**, scad, conger eel, **Atlantic salmon**, blue whiting, **whiting**, **haddock**, **saithe**, **Norway pout**, **pout, small cod**, silvery cod, **ling**, **hake**, **Atlantic horse mackerel**, **Atlantic mackerel**, **gobies**, sand smelt, lanternfish, **flounder**, **plaice**, **dab**, brill, **sole**, squid and octopus species | Scotland<br>Ireland | Santos *et al.* (2001)<br>Hernandez-Milian *et al.* (2015) |
| Risso's dolphin | Squid, cuttlefish and octopus, **haddock**, **whiting**, **poor cod** | Scotland | MacLeod *et al.* (2014) |
| Atlantic white-sided dolphin | **Poor cod, pouting, blue whiting, Atlantic mackerel**, myctophids, silvery pout | Northeast Atlantic | Hernandez-Milian *et al.* (2016) |
| White-beaked dolphin | **cod, true cod, hake, sole, sandeel, mackerel, whiting, goby, haddock**, squid, **herring**, **scad**, long rough dab, octopus | UK | Canning *et al.* (2008)<br>Jansen *et al.* (2010)<br>MacLeod (2013) |
| Minke whale | **Sandeel**, **herring**, **sprat**, **mackerel**, **Norway pout/poor cod**, **gobies** | Scotland | Pierce *et al.* (2004) |
| Humpback whale | Capelin, **herring**, krill, **mackerel**, blue whiting | Norwegian sea | Løviknes *et al.* (2021) |
| Harbour seal | **Sandeel**, **saithe**, **dab, plaice, flounder**, bullrout, sprat, **cod**, **haddock, ling**, dragonet, **herring, poor cod, Norway pout, rockling, mackerel, whiting**, blue whiting, **lemon sole** | Scotland | Wilson and Hammond (2016) |
| Grey seal | **Saithe, whiting, cod, haddock, rockling, ling**, blue whiting, **hake**, **pollock**, Norway pout, **small cod, plaice, lemon sole, sandeel, dover sole, dab, herring, sprat, mackerel**, **salmonid**, wrasse, catfish | Scotland | Hammond and Wilson (2016) |
| Basking shark | Zooplankton | UK | MarLIN (2025) |

### *Sensitivity of Receptor*

11.7.391 Impacts to prey resources will be largely restricted to the boundaries of the Proposed Development and, therefore, marine mammals and basking sharks occurring within this area also have the potential to be affected. The fish and shellfish species identified in the Offshore EIAR **Volume 2, Chapter 10: Fish and Shellfish Ecology** are typical of those present within the North Sea and provide a thorough dataset to consider the potential impacts on marine mammals and basking sharks.

#### Marine Mammals

11.7.392 Changes to prey availability could increase the energy expenditure required for feeding through increased effort. However, as the majority of marine mammal receptors within this assessment are generalist feeders, feeding on a variety of prey species (Table 11.49), thereby removing the requirement for additional energy expenditure. The exception to this is Risso's dolphins which feed primarily on cephalopods (MacLeod *et al.,* 2014). All marine mammal receptors are highly mobile and search large areas for prey. Therefore, no impact on survival or reproduction of any receptor is predicted.

11.7.393 Based on the above, marine mammals are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptors is Low.

#### Basking Shark

11.7.394 Changes to prey availability could increase the energy expenditure required for feeding through increased effort. However, the prey species of basking sharks are typically present within wider Scottish waters and are not exclusive to the vicinity of the Proposed Development. As basking sharks are highly mobile, it is reasonable to assume that they will be able to find nearby suitable habitat with sufficient and suitable prey resources.

11.7.395 While the copepods *C. helgolandicus* and *C. finmarchicus* may be the preferred prey species and comprise of a high proportion of the diet (MarLIN, 2025), basking sharks are considered as generalist feeders (Table 11.49) and therefore can exploit a variety of prey and are not reliant on few particular species.

11.7.396 Based on the above, basking sharks are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of the receptors is Low.

### *Significance of Effect*

11.7.397 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.50.

11.7.398 The magnitude of impact is deemed to be Low for changes to prey. The sensitivity of the receptor is Low for changes to prey (Table 11.50). The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.50 Significance of Impact 7: Changes to Prey (Construction)

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

#### *Secondary Mitigation and Residual Effect*

11.7.399 The significance of the effect of changes to prey for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

#### *EPS Consideration*

11.7.400 This impact is not direct disturbance to EPS, hence it is not applicable.

## Operation and Maintenance

11.7.401 This section presents the assessment of impacts arising from the O&M phase of the Proposed Development.

### Impact 8: Vessel Disturbance

11.7.402 Increased vessel movement during the O&M phase of the Proposed Development has the potential to result in a range of impacts on marine mammals and other megafauna. These include avoidance behaviour or displacement due to increased vessel presence, and in the case of marine mammals, vessel presence can cause masking of vocalisations or changes in vocalisation rate due to increased underwater noise.

11.7.403 The Aspen Array Area experiences low vessel traffic density, with one area with moderate density at the Buchan Oil Field and route from it to Aberdeen. The OTC corridor has low-moderate vessel traffic density, with a density hotspot close to Aberdeen. The main ports surrounding the Proposed Development are Peterhead (84 km), Fraserburgh (93 km) and Aberdeen (11 km north of the OTC Corridor). Two main routes traverse from southwest to northeast through the Aspen Array Area, containing up to 175 vessel tracks per year, while the majority of the Aspen Array Area exhibits less than 100 tracks per year. Vessel traffic crossing the OTC Corridor experiences between 300 and 1,100 transits per year at its densest location (20 km stretch located 13 km from cable Landfall). The main vessel types recorded within the Aspen Array Area overall were tug and service vessels (45%), fishing vessels (42%), and cargo vessels (9%). Tanker vessels accounted for 2.5% of transits within the Aspen Array Area, and both recreational vessels and passenger vessels accounted for <1% of transits. For further details see **Volume 2, Chapter 14: Shipping and Navigation**.

*Magnitude of Impact*

11.7.404 During the O&M phase, a maximum of eleven vessels are expected to be on site at one time, resulting in a maximum of 219 vessel return trips per year over the 35-year operational period (Table 11.18). However, in reality, the number of vessels on site at one time is expected to be notably less at 5 (Table 11.18). Vessels that will be used during the O&M phase include crew transfer vessels, jack-up vessels, cable repair vessels and other vessels (Table 11.18).

11.7.405 As stated in paragraph 11.7.289, the area surrounding the Proposed Development, in particular the OTC Corridor, experiences a relatively low-moderate level of vessel traffic. Therefore, the increase in vessel activity as a result of O&M is not considered a novel impact for the marine mammals or other megafauna present in the area.

11.7.406 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km$^2$). Comparatively, vessel traffic in the Shipping and Navigation study area averages one vessel per day (see **Volume 2, Chapter 14: Shipping and Navigation**). Considering a maximum of seven operations and management vessels will be present within the Aspen Array Area at any one time, vessel traffic in the area around the Proposed Development is not likely to exceed the value presented by Heinänen and Skov (2015) even with the addition of vessels involved in the operations and management phase.

11.7.407 As discussed in paragraph 11.7.305, the implementation of a VMP advises that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals and basking sharks, which will minimise the magnitude of any impact (further details in **Volume 4, Appendix 8 Outline Vessel Management and Navigation Safety Plan**).

11.7.408 Therefore, the impact of disturbance to all marine mammal and basking sharks species from vessel activities is considered to result in a small proportion of the population affected, to occur frequently throughout the operational and maintenance phase, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of embedded commitments (i.e. VMP).

11.7.409 The impact is predicted to be of local spatial extent and short-term duration. The magnitude is therefore Low.

### *Sensitivity of Receptor*

#### Harbour Porpoise

11.7.410 Harbour porpoise sensitivity to increased vessel disturbance is described in paragraphs 11.7.313 to 11.7.318. The sensitivity of the receptor is Low.

#### Bottlenose Dolphin

11.7.411 Bottlenose dolphin sensitivity to increased vessel disturbance is described in paragraphs 11.7.319 to 11.7.326. The sensitivity of the receptor is Low.

#### Risso's Dolphin

11.7.412 Risso's dolphin sensitivity to increased vessel disturbance is described in paragraphs 11.7.327 to 11.7.330. The sensitivity of the receptor is Low.

#### Atlantic White-sided Dolphin / White-beaked Dolphin

11.7.413 Atlantic white-sided dolphin and white-beaked dolphin sensitivity to increased vessel disturbance is described in paragraphs 11.7.331 to 11.7.332. The sensitivity of the receptors is Low.

#### Minke Whale

11.7.414 Minke whale sensitivity to increased vessel disturbance is described in paragraphs 11.7.333 to 11.7.337. The sensitivity of the receptor is Low.

#### Humpback Whale

11.7.415 Humpback whale sensitivity to increased vessel disturbance is described in paragraphs 11.7.338 to 11.7.341. The sensitivity of the receptor is Low.

#### Harbour and Grey Seals

11.7.416 Harbour and grey seals sensitivity to increased vessel disturbance is described in paragraphs 11.7.342 to 11.7.349. The sensitivity of the receptor is Low.

#### Basking Shark

11.7.417 Basking shark sensitivity to increased vessel disturbance is described in paragraphs 11.7.350 to 11.7.352. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.418 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.51.

11.7.419 The magnitude of impact is deemed to be Low for vessel disturbance. The sensitivity of the receptor is Low for vessel disturbance (Table 11.51). The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.51 Significance of Impact 8: Vessel Disturbance (O&M)

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

#### *Secondary Mitigation and Residual Effect*

11.7.420 The significance of the effect from vessel disturbance to marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

#### *EPS Consideration*

11.7.421 The assessment of impacts resulting from vessel disturbance, with the commitment to a VMP (C-OFF-12 and C-OFF-45), has determined that any associated disturbance is unlikely to hinder the ability to maintain the species FCS. As such, the activity is considered to meet the requirements of EPS test 3. Given the low number of vessels expected to be in the Proposed Development at one time, the impacts are not considered to result in a disturbance offence and it is expected that an EPS licence is unlikely to be necessary.

### Impact 9: Vessel Collision Risk

11.7.422 Increased vessel movement during the operations and maintenance phase of the Proposed Development has the potential to result in a range of impacts on marine mammals and other megafauna. These include injury or death due to collision with vessels due to increased vessel presence.

11.7.423 The Aspen Array Area experiences low vessel traffic density (with the exception of two areas) and the OTC corridor has low-moderate vessel traffic density, with a density hotspot close to Aberdeen. The main ports surrounding the Proposed Development are Peterhead (84 km), Fraserburgh (93 km) and Aberdeen (11 km north of the OTC Corridor) (see **Volume 2, Chapter 14: Shipping and Navigation**).

11.7.424 There are two areas of moderate density within the Array Study Area at the Buchan Oil Field, and along a narrow northeast-southwest route between Aberdeen and the Buchan Oil Field. These areas have 10 – 50 transits per month per 500 $m^2$ grid cell, as a result of the tug and service vessels that regularly service the oil field. The main vessel types recorded within the Aspen Array Area overall were tug and service vessels (45%), fishing vessels (42%), and cargo vessels (9%). Tanker vessels accounted for 2.5% of transits within the Aspen Array Area, and both recreational vessels and passenger vessels accounted for <1% of transits.

### *Magnitude of Impact*

11.7.425 During the operations and maintenance phase, a maximum of eleven vessels will be present within the Aspen Array Area at any one time, resulting in a maximum of 219 vessel return trips over the 35-year operational period (Table 11.13). Vessels that will be used during the operations and maintenance phase include crew transfer vessels, jack-up vessels, cable repair vessels and other vessels.

11.7.426 As stated in paragraph 11.7.289, the area surrounding the Proposed Development, in particular the OTC Corridor, already experiences a relatively low-moderate level of vessel traffic. Vessel movements will be within the Aspen Array Area or along the OTC Corridor and will follow existing shipping routes to/from ports. Therefore, the increase in vessel activity as a result of O&M phase is not considered a novel impact for the marine mammals or other megafauna present in the area and it is not expected that vessels activities during the operational and maintenance phase would increase the risk of injury due to vessel collision.

11.7.427 Marine mammals and basking sharks are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.7.363, the implementation of embedded commitments, including a VMP (C-OFF-12), adherence to the Scottish Marine Wildlife Watching Code (C-OFF-45) and the Basking Shark Code of Conduct (C-OFF-54) will advise that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, some of these vessels will be stationary or slow moving throughout O&M activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.7.428 Furthermore, all marine mammal and basking sharks are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality, as highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2023).

11.7.429 The impact of injury to all marine mammal species and basking sharks from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the operations and maintenance phase, the effect is unlikely to occur given implementation of the embedded commitments mentioned above, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory.

11.7.430 The impact for marine mammals and basking sharks is therefore predicted to be of local spatial extent, short term duration and intermittent. The magnitude is therefore Negligible.

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.431 Marine mammal receptors sensitivity to vessel collision risk is described in paragraph 11.7.369 to 11.7.377. The sensitivity of the receptors is High.

#### Basking Shark

11.7.432 Basking shark sensitivity to vessel collision risk is described in paragraph 11.7.378 to 11.7.381. The sensitivity of the receptor is High.

### *Significance of Effect*

11.7.433 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.52.

11.7.434 The magnitude of impact is deemed to be Negligible for vessel collision risk (Table 11.52). The sensitivity of the receptor is High for vessel collision risk. The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.52 Significance of Impact 9: Vessel Collision Risk (O&M)

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | High | Minor |
| Bottlenose dolphin | Negligible | High | Minor |
| Risso's dolphin | Negligible | High | Minor |
| Atlantic white-sided dolphin | Negligible | High | Minor |
| White-beaked dolphin | Negligible | High | Minor |
| Minke whale | Negligible | High | Minor |
| Humpback whale | Negligible | High | Minor |
| Harbour seal | Negligible | High | Minor |
| Grey seal | Negligible | High | Minor |
| Basking shark | Negligible | High | Minor |

### *Secondary Mitigation and Residual Effect*

11.7.435 The significance of the effect of vessel collision risk to marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.436 It is expected that, with the commitment to a VMP (C-OFF-12) to reduce the vessel collision risk to Negligible levels, no EPS will be injured. As such, an EPS licence for injury is unlikely to be necessary.

### Impact 10: Changes to Prey

11.7.437 Marine mammals and basking sharks are dependent on prey for survival. As a result, there is the potential for indirect effects on marine mammals or basking sharks to occur as a result of impacts on their prey species or the habitats that support them. The key prey species for the receptors within this assessment are presented in Table 11.49.

*Magnitude of Impact*

11.7.438 Potential impacts on prey species during the operations and maintenance phase of the Proposed Development are described in **Volume 2, Chapter 10: Fish and Shellfish Ecology** of the Offshore EIAR and include:

- Increased risk of introduction and/or spread of marine INNS;
- Long term habitat disturbance;
- Colonisation of hard substrates;
- EMF effects arising from cables.

11.7.439 Potential impacts on prey species are assessed in **Volume 2, Chapter 10: Fish and Shellfish Ecology** of the Offshore EIAR, which concluded there will be no significant effects arising from the Proposed Development on the species listed in Table 11.49 during the operations and maintenance phase providing that the embedded commitments are implemented.

11.7.440 The impact to all marine mammal and basking shark receptors from changes to prey species is considered to be highly localised, to occur relatively frequently throughout the operations and maintenance phase, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species

11.7.441 The impact is therefore predicted to be of local spatial extent, short term duration and intermittent. The magnitude is assessed as Negligible.

*Sensitivity of Receptor*

**Marine Mammals**

11.7.442 Marine mammal receptors sensitivity to changes in prey is described in paragraph 11.7.392 to 11.7.393. The sensitivity of the receptors is Low.

**Basking Shark**

11.7.443 Basking shark sensitivity to changes in prey is described in Section 11.7.394 to 11.7.396. The sensitivity of the receptor is Low.

*Significance of Effect*

11.7.444 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.53.

11.7.445 The magnitude of impact is deemed to be Negligible for changes to prey (Table 11.53). The sensitivity of the receptor is Low for changes to prey. The effect will, therefore, be of Negligible significance, which is not significant in EIA terms.

Table 11.53 Significance of Impact 10: Changes to Prey (O&M)

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | Low | **Negligible** |
| Bottlenose dolphin | Negligible | Low | **Negligible** |
| Risso's dolphin | Negligible | Low | **Negligible** |
| Atlantic white-sided dolphin | Negligible | Low | **Negligible** |
| White-beaked dolphin | Negligible | Low | **Negligible** |
| Minke whale | Negligible | Low | **Negligible** |
| Humpback whale | Negligible | Low | **Negligible** |
| Harbour seal | Negligible | Low | **Negligible** |
| Grey seal | Negligible | Low | **Negligible** |
| Basking shark | Negligible | Low | **Negligible** |

### *Secondary Mitigation and Residual Effect*

11.7.446 The significance of the effect of changes to prey for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.447 This impact is not direct disturbance to EPS, hence it is not applicable.

### Impact 11: Entanglement Risk With Mooring Lines and Cables

11.7.448 Floating OWFs and other marine renewable energy devices are held in place and attached to the seabed by mooring lines and anchors to ensure they maintain a fixed position on or within the water column (Garavelli, 2020, Copping et al., 2020). Furthermore, the inter-array cables (also known as dynamic cables) for floating offshore wind have floating components that allows them to move with the tidal current and floating turbine (Taninoki *et al*., 2017). Moorings and dynamic cables associated with the operation of floating wind turbines have the potential to entangle marine mammals and basking sharks within the Proposed Development. Please refer to Table 11.18 for detailed worst-case scenario parameters for the Proposed Development used in this assessment.

11.7.449 Indirect entanglement, resulting from lost, abandoned or discarded fishing equipment, could exacerbate primary entanglement, which stems from sub-surface infrastructure of offshore wind farms. This combined effect increases the risk of entanglement around moorings and dynamic cables if marine mammals and basking sharks are bycaught in drift nets and/or lost or discarded fishing gear snagged on moorings and dynamic cables (Benjamins *et al*., 2014). Derelict fishing gear and nets wrapped around the offshore wind structures could potentially increase spatial impact ranges (considering derelict nets could be tens of metres in width) and impact a variety of species, including marine mammals and sharks, resulting in relatively high bycatch rates locally.

11.7.450 The entanglement risk of marine mammals and basking sharks with marine renewable energy devices depend on the physical parameters of the mooring systems and depth, array and power cables (Harnois *et al*., 2015, Copping *et al*., 2020). Taut mooring lines are likely to have the lowest relative risk of entanglement, with higher risk being catenary moorings due to greater tension in the mooring line (Harnois *et al*., 2015).

11.7.451 Three mooring configurations are being considered for the Proposed Development: catenary, semi-taut and taut (Table 11.18). The worst-case scenario is considered to be for catenary moorings, as the risk of entanglement is higher. Therefore, the impact assessment for the risk of injury resulting from entanglement with mooring lines or cables, including secondary interactions with derelict fishing gears for the Proposed Development, is based upon the catenary mooring system.

### *Magnitude of Impact*

11.7.452 A study conducted by Benjamins *et al*. (2014) on the relative risk assessment of entanglement from offshore wind developments found that the likelihood of an encounter between marine animals and marine renewable energy mooring systems and subsea cables is dependent on the animal's size and behaviour. It concluded that entanglement with moorings and dynamic cables associated with offshore wind is estimated to be a low risk to cetaceans and pinnipeds, with basking sharks having a greater potential risk and baleen whales considered to be more at greater risk due to their migratory patterns, size and feeding behaviours.

11.7.453 Most research focuses on injury and mortality caused by entanglement with fishing gear or submarine telecommunications cables which contrary to marine renewable energy mooring lines and cables, have a loose end or loop that could entangle an animal (Copping *et al*., 2020). The main risk is likely to be animal entanglement in derelict fishing gear (secondary entanglement) which becomes attached to marine renewable energy moorings and poses an entanglement risk for a wide range of species (Benjamins *et al*., 2014; Garavelli, 2020).

11.7.454 In addition to mooring configurations, entanglement risks associated with offshore wind development also vary substantially based on factors such as WTG spacing, array layout and diameters of mooring lines and/or dynamic cables (FERC, 2010; Benjamins *et al*., 2014; Harnois *et al*., 2015). Regardless of the mooring line designs, any mooring or dynamic cable structures for the Proposed Development will be set up to reduce the potential for creating any loop that could entangle large-sized marine wildlife like marine mammals and basking sharks.

11.7.455 Little is known about the distribution and abundance of derelict fishing gear in Scottish waters, and its extent being snagged and retained in mooring or cabling associated with offshore wind development. Therefore, the relative risk and likelihood of secondary entanglement of marine mammals and basking sharks under such conditions is largely unknown. Given the slow rate at which the snagged fishing gear (e.g., nets and lines) might decay, the secondary impact could be substantial, although further studies are required to quantify the level of risk, with best available data being used in this assessment.

11.7.456 The Proposed Development will utilise large diameter lines to create a mooring systems, with a maximum diameter of 350 mm. Cables will have a maximum diameter of 220 mm. The risk of entanglement is considered low as they are of a large enough diameter to preclude entanglement and marine mammals are likely to be able to detect them either through echolocation (odontocetes), vibration detected through vibrissae (pinnipeds) or acoustic detection (Maxwell *et al*. 2022, Benjamins *et al*. 2014).

11.7.457 The embedded commitments includes the commitment to risk-based adaptive approach to the inspections of the mooring lines and cables present in the water column as part of the EMP. Considering the localised spatial extent (within the Aspen OWF only) and moderate duration of the potential impact (35 years), the entanglement impact, with the implementation of Embedded Mitigation as part of the EMP, is considered to affect a small proportion of the population, and is not likely to affect the population trajectory of basking sharks for all WTG foundation designs, as any potential impact will be of short term duration, intermittent and reversible.

11.7.458 The magnitude of primary entanglement to marine mammals and basking sharks is considered during the operations and maintenance phase of the Proposed Development is assessed as Negligible when considering the mooring configuration resulting in the worst-case scenario (i.e., semi-submersible foundation with catenary moorings).

11.7.459 The magnitude of secondary entanglement to marine mammals and basking sharks is considered during the operations and maintenance phase of the Proposed Development is assessed as Low when considering the mooring configuration resulting in the worst-case scenario (i.e., semi-submersible foundation with catenary moorings).

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.460 Marine mammals can suffer from injury, and in some cases, mortality as a result of entanglement (Northridge *et al.,* 2010; Cassoff *et al.,* 2011; Benjamins *et al.,* 2014; Ryan *et al.,* 2016; MacLennan *et al.,* 2021). Frequent entanglement events can threaten survival and negatively impact energy consumption. The resulting physiological stress and disturbance may also reduce reproductive success, potentially leading to long-term population declines and serious conservation concerns (Musick, 1997; van der Hoop *et al.,* 2017).

11.7.461 Baleen whales (such as minke and humpback whales) are particularly susceptible to entanglement due to their large size and feeding behaviours (Northridge *et al.,* 2010; Cassoff *et al.,* 2011; Benjamins *et al.,* 2014; Ryan *et al.,* 2016; Basran *et al.,* 2019; MacLennan *et al.,* 2021; Robinson *et al.,* 2023). However, evidence has found that harbour porpoise, dolphin species and seal species are also susceptible to entanglement, indicating that all marine mammal species face some level of risk (Allen *et al.,* 2012; Benjamins *et al.,* 2014).

11.7.462 There is currently a lack of information on the frequency of occurrence of entanglement as a source of marine mammal mortality, with best available data being used in this assessment. Furthermore, even less is known entanglement of marine mammals in moorings or cables of any kind, with the majority of recorded cases being entanglement in fishing gear (Benjamins *et al.,* 2014).

11.7.463 Cases of strandings as a result of entanglement reported to SMASS are generally low. Prior to 2014, fewer than five cases of strandings as a result of entanglement were reported per year (SMASS Reports 2005-2019 as cited by MacLennan *et al.,* 2021). However, between 2015 and 2018 an increasing trend was observed with 18 cases in 2018. This was followed by a small decrease in 2019 where 15 cases were reported. Between 2020 and 2022, a decreasing trend in entanglement cases has continued to be observed (Davison and ten Doeschate, 2021; SMASS, 2023; Brownlow *et al.,* 2024).

11.7.464 In 2020, three minke whales were reported as entanglement cases, while two grey seals were reported as entangled or as having lesions suggestive of previous entanglement. In 2021, a total of eight entanglement cases were recorded, including two humpback whales, one minke whale, two Risso's dolphins and two indeterminate baleen species, (SMASS, 2023). Six cases of entanglement were reported within the 2022 SMASS report, four minke whales and two grey seals (Brownlow *et al.,* 2024). The most recent SMASS report for 2023 had an increase in reported entanglement cases, with 15 cetacean cases and two seal cases (Brownlow *et al.,* 2024). Cases included one harbour porpoise, two humpback whales, eight minke whales, two Risso's dolphins, one harbour seal, one grey seal and two undetermined dolphin species. It is crucial to note that the SMASS reports do not differentiate between entanglement in fishing gear (by-catch) and entanglement by other causes such as in rope or discarded fishing gear/marine litter.

11.7.465 According to the most recent CSIP report, one incident of marine debris entanglement was recorded in 2022 (CSIP, 2023). However, the species was identified as a Sowerby's beaked whale which is not included within this assessment. No incidences of marine debris entanglement were reported on 2021 (CSIP, 2022). Between 2018 and 2020, one incidence of marine debris entanglement was recorded per year. Minke whales were recorded in two of the cases, while the other was identified as a Sowerby's beaked whale (CSIP, 2019; 2020; 2021).

11.7.466 While there is evidence that mortality from entanglement can and does occur, it is not considered to be a key source of mortality in marine mammals highlighted from post-mortem examinations. However, it is important to note that strandings data are biased to those carcasses that wash ashore for collection and therefore may not be representative. Furthermore, post-mortems are not undertaken for many carcasses, further reducing the representativity of strandings data. Therefore, despite a seemingly low number of accounts of strandings due to entanglement across Scotland each year (SMASS Reports 2005-2019 as cited by MacLennan *et al.,* 2021; Davison and ten Doeschate, 2021; SMASS, 2023; Brownlow *et al.,* 2024), entanglement is now the largest identified cause of anthropogenic mortality in baleen whales in Scottish waters (Davison *et al.,* 2020), with minke and humpback whales being the cetacean species most reported entangled since 1992.

11.7.467 Based on the above and given the fact that entanglement can potentially result in death, the sensitivity of all marine mammal receptors to entanglement is assessed as High.

### Basking Shark

11.7.468 Benjamins *et al.* (2014), estimated basking sharks to have a moderate risk of entanglement, based on a modelling study of relative entanglement risk from offshore renewable development.

11.7.469 Basking sharks have relatively poor eyesight and lateral eye placement on the head (McComb *et al.,* 2009), making it difficult for them to detect mooring lines or cables visually, in particular in low-light conditions. However, basking sharks are thought to be electroreceptive and therefore able to detect metallic moorings or electrical elements of dynamic cables at close range (Haine *et al.,* 2001), or turbulence in the water column generated by the movement of mooring and/or dynamic cables using their lateral line system, which consists of flow sensors for motion detection (Popper *et al.,* 2014). However, there is a possibility that as these filter-feeders swim through the water column with their mouth open, they expose themselves to becoming entangled across the mouth (Knowlton and Kraus, 2001; Johnson *et al.,* 2005). The entanglement risk during feeding for basking sharks, is however, estimated to be lower compared to that of lunge-feeding baleen whales (Benjamins *et al.,* 2014).

11.7.470 Comparatively large body appendages in basking sharks may also make this species more susceptible to entanglement. However, basking sharks are flexible and therefore may be able to escape entanglement more easily as compared with more rigid animals such as large whales (Benjamins *et al.,* 2014).

11.7.471 Evidence of basking shark entanglement in ropes associated with stationary fishing gear has been recorded (Lien and Fawcett, 1986; Francis and Duffy, 2002; BBC, 2012). One case of entanglement in basking sharks was recorded by SMASS in 2019, however no cases have been recorded since (Davison *et al.,* 2020; Davison and ten Doeschate, 2021; SMASS, 2023; Brownlow *et al.,* 2024). There are no records of basking shark entanglement by CSIP between 2018 and 2022 (CSIP, 2019; 2020; 2021; 2022; 2023).

11.7.472 Based on the above, basking sharks are estimated to be of moderate vulnerability, limited recoverability and reasonable adaptability to the impact of entanglement, and are of very high value. Therefore, the sensitivity of basking sharks to entanglement risks is considered to be Medium.

*Significance of Effect*

11.7.473 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.54 and Table 11.55. The magnitude of impact is deemed to be Negligible for primary entanglement risk (Table 11.54) and Low for secondary entanglement with mooring lines and cables (Table 11.55).

11.7.474 The sensitivity of the receptor is High for entanglement risk with mooring lines and cables, with the exception of basking sharks which have Medium sensitivity. The effect will, therefore, be of Minor significance with the exception of basking sharks for primary entanglement, which is Negligible significance, which is not significant in EIA terms.

Table 11.54 Significance of Impact 11: Primary Entanglement Risk With Mooring Lines and Cables

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | High | Minor |
| Bottlenose dolphin | Negligible | High | Minor |
| Risso's dolphin | Negligible | High | Minor |
| Atlantic white-sided dolphin | Negligible | High | Minor |
| White-beaked dolphin | Negligible | High | Minor |
| Minke whale | Negligible | High | Minor |
| Humpback whale | Negligible | High | Minor |
| Harbour seal | Negligible | High | Minor |
| Grey seal | Negligible | High | Minor |
| Basking shark | Negligible | Medium | Negligible |

Table 11.55 Significance of Impact 11: Secondary Entanglement Risk With Mooring Lines and Cables

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | High | Minor |
| Bottlenose dolphin | Low | High | Minor |
| Risso's dolphin | Low | High | Minor |
| Atlantic white-sided dolphin | Low | High | Minor |
| White-beaked dolphin | Low | High | Minor |
| Minke whale | Low | High | Minor |
| Humpback whale | Low | High | Minor |
| Harbour seal | Low | High | Minor |
| Grey seal | Low | High | Minor |
| Basking shark | Low | Medium | Minor |

*Secondary Mitigation and Residual Effect*

11.7.475 The significance of the effect of entanglement risk with mooring lines and cables for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.476 It is expected that, with the commitment to an EMP (C-OFF-47) to reduce the risk of entanglement to Negligible levels, no EPS will be injured, and therefore it is expected that an EPS licence is unlikely to be required.

## Impact 12: Noise Related Impacts Associated With Floating Foundations

11.7.477 Due to the relatively low sound levels during O&M of OWFs when compared to construction (especially if impact pile driving is applied), there has been less concern regarding the impacts on marine mammals (see reviews Madsen *et al*., 2006; Thomsen *et al*., 2006 ; Gill *et al*., 2012; Thomsen *et al*., 2015 as cited in Stöber and Thomsen, 2021), despite the longer duration (35 years O&M compared to four years construction for the Proposed Development). The main source of underwater noise from floating OWFs comes from the floating turbines and mooring lines. Based on a literature review of operational underwater noise from floating turbines and mooring lines, it is expected that the underwater noise levels are below the injury ranges for marine mammals and basking sharks, based on Southall *et al.* (2019) and Popper *et al.* (2014) criteria, respectively. Taking this into consideration, the risk of injury (PTS) to marine mammals from noise related impacts associated with floating foundations is Negligible. As such, this section focuses on the risk of disturbance to marine mammals and basking shark as a result of operational noise.

### *Magnitude of Impact*

**Floating Turbines**

11.7.478 A study by Risch *et al*. (2023) compared the operational noise produced by two floating OWFs in Scottish waters - Kincardine and Hywind Scotland. Data was collected at Kincardine floating wind farm from November 2021 to January 2022 based on five 9.5 Megawatt (MW) WTGs, geared, semi-submersible foundations. Additionally, data was collected at the Hywind Scotland OWF from May to June 2022, on 6 MW WTGs, direct-drive, spar-buoy foundations. At both wind farms, F-POD autonomous echolocation click detectors were used to monitor the presence of harbour porpoise.

11.7.479 Source levels for both operational turbines increased with wind speeds. At a wind speed of 15 m/s, operational noise levels were about 3 dB higher at Kincardine (148.8 dB re 1 µPa) compared to Hywind Scotland (145.4 dB re 1 µPa), potentially due to differences in power, technologies (gearbox vs. direct drive), and mooring structures. Furthermore, both wind farms emitted continuous noise below 200 Hz. Median one-third octave band levels below 200 Hz ranged between 95 and 100 dB re 1 µPa at approximately 600 m from the nearest turbine, comparable to levels from fixed offshore wind turbines at similar distances (Tougaard *et al.*, 2020, Stöber and Thomsen, 2021, Risch *et al.*, 2023).

11.7.480 Due to the location of the Proposed Development in the North Sea, it is expected that the ambient noise levels are comparable to those assessed in which underwater noise generation was assessed as part of the Kincardine and Hywind projects, which utilised a 100 dB contour to approximate median ambient noise levels (Risch *et al.,* 2023). A study by Merchant *et al*. (2016) measured underwater ambient noise levels in different locations in the North Sea with values ranging from 80 to 120 dB re 1µPa, while Robinson *et al*. (2022) reporting 100 – 110 dB re 1µPa in the Moray Firth.

11.7.481 Modelling reports have shown that basking sharks are expected to experience only limited impacts from operational wind turbines. For example, assessments at Caledonia OWF indicated that both recoverable injury and TTS ranges were predicted to be less than 50 m from bottom-fixed turbine foundations. Further modelling estimated that the onset of injury thresholds for basking sharks would require continuous exposure within 20 m of the source over a 12-hour period (Caledonia Offshore Wind Farm Ltd, 2024).

11.7.482 The noise levels for floating turbines at the Proposed Development are estimated at an upper level of 132 dB re 1µPa at 750 m (**Volume 3, Appendix 3.1: Underwater Noise Technical Report**).

**Mooring Lines**

11.7.483 Floating OWFs are kept in position by mooring lines designed to remain under continuous tension. However, these lines must also tolerate motion caused by waves, which can introduce temporary slack. When the slack is suddenly taken up again, typically during strong surface movements, sharp impulsive noises may occur. The sound energy generated via the rapid reapplication of tension in mooring lines is commonly referred to as 'cable snapping' (Liu, 1973).

11.7.484 Research on floating OWFs, such as Kincardine and Hywind Scotland, found no clear evidence of intensive, impulsive 'snapping' noises. Instead, the acoustic environment was characterised by brief, non-impulsive noises, including sounds described as 'rattles', 'bangs' and 'creaks' (Burns *et al.,* 2022). These momentary events typically lasted about one second and had a frequency range from 10 to 48 kHz. Risch *et al.* (2023) further determined these transient sounds could not be considered as impulsive, and thus the appropriate threshold for marine mammals would be non-impulsive frequency weighted noise threshold values in order to determine auditory injury risk.

11.7.485 Burns *et al.* (2022), following guidance from NMFS (2018), applied non-impulsive noise thresholds when evaluating the potential for TTS-onset. Using these thresholds Burns *et al.* (2022) were able to determine potential effect ranges for various auditory groups, with the greatest level of impact being on VHF species (harbour porpoise), where an individual would need to remain within 50 meters of the source for a full 24-hour period to reach the TTS-onset threshold. For basking sharks, the impact ranges for snapping noise from mooring lines are expected to be small, with noise levels generally below the injury threshold criteria (Martin *et al.,* 2011; Xodus, 2015).

### Summary of Magnitude

11.7.486 During the operational phase of the Proposed Development, the impact of noise associated with floating foundations are expected to be confined to the Aspen Array Area. The spatial reach of the impact is highly limited, and it is unlikely to cause widespread avoidance behaviour among marine mammals and basking sharks. As a result, any disturbance would likely involve only a small segment of the local population, with no anticipated consequences for overall population trends or long-term viability. This corresponds to a Low magnitude of impact.

11.7.487 However, while the area affected remains small, the possibility of the noise to be regular and persistent means that marine mammals and basking sharks could experience intermittent disturbance throughout the operational lifespan of the wind farm, which is estimated to be around 35 years. Taking into account the extended duration and recuring nature of the sound exposure, a precautionary approach has been adopted. Consequently, the overall magnitude of impact has been assessed as Medium, to reflect these longer-term considerations.

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.488 Risch *et al.* (2023) reported that operational noise was primarily concentrated below 200 Hz. This low frequency noise is outside of the peak sensitivity ranges of harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW) (Southall *et al*., 2019), with hearing sensitivity of these receptors being relatively poor below 1 kHz (Southall *et al.,* 2007). Thus, it is expected that disturbance at this frequency would result in little impact to vital rates or behavioural changes. In addition, turbine noise is thought to have no significant masking effects on harbour porpoise, with any potential masking being limited to a very small range (Lucke *et al*., 2007). This is likely to be similar for dolphin species. There is an overlap between the frequency range of this operational noise and the vocalisations of seal species, however, seal vocalisations are more broadband, and therefore the effect of masking is expected to be minor (Madsen *et al*., 2006).

11.7.489 Despite this, Risch *et al*. (2023) observed some disturbance in harbour porpoise at both floating OWF locations. The recording site nearest to the turbine detected fewer harbour porpoise vocalisations compared to the site further away. This potentially indicates displacement or reduced vocalisations as a result of the operational turbines. However, it is important to consider that these wind farms have only been operational for a short period of time. Therefore, habituation to turbine noise by harbour porpoise may occur over time.

11.7.490 As floating foundations for OWFs are relatively novel, there is limited information currently available on the noise related impacts associated with turbines based on floating foundations. The findings presented by Risch *et al*. (2023) suggest that operational noise produced by floating OWFs is similar to that from fixed OWFs. Therefore, marine mammal responses to operational noise from turbines with fixed foundations can be used as a proxy within this assessment.

11.7.491 Studies on fixed foundation OWFs have observed that odontocetes and seal species are likely to show initial avoidance to the OWF area, followed by habituation of the operational noise and possibly attraction to OWFs as feeding grounds (Vella *et al.,* 2001). For example, long-term monitoring at the Horns Rev and Nysted OWFs in Denmark showed that both harbour porpoise and harbour seals were sighted regularly within the operational OWF, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.*, 2008). This supports the prediction made by Risch *et al*. (2023) that occurrence patterns of harbour porpoise may change as the Kincardine and Hywind Scotland floating OWFs mature.

11.7.492 The low frequency noise produced by operational OWFs is more likely to overlap with the hearing range of LF cetaceans such as minke and humpback whales. Communication signals between minke whales have been found to be below 2 kHz (Edds-Walton, 2000; Mellinger *et al*., 2000; Gedamke *et al*., 2001; Risch *et al*., 2013; 2014). Tubelli *et al*. (2012) estimated the hearing frequency range in minke whales to extend from 30 Hz to 7.5 kHz up to 100 Hz and 25 kHz. While, the hearing frequency range in humpback whales has been estimated as between 15 Hz and 3 kHz or between 200 Hz and 9 kHz (Tubelli *et al*., 2018). Despite this, there is a lack of studies on disturbance of LF cetaceans as a result of low frequency noise (e.g. wind turbine operational noise).

11.7.493 A modelling study by Thomsen *et al*. (2023) assessed TTS on LF cetaceans over a 24-hour period from a 10 MW and 20 MW turbine. Although the study did not address disturbance, the likelihood of cumulative TTS was considered negligible for the 10 MW turbine, and for the 20 MW turbine impact ranges extended up to approximately 700 m for LF cetaceans. Therefore, for cumulative TTS onset to occur, the individual would have to be within 700 m of the turbine for 24 hours, which is unlikely as the minke whale is a highly mobile species. Although behavioural disturbance is likely to occur at distances greater than TTS onset, individual variation in behavioural responses to underwater noise is expected to occur. Individual variation in behavioural responses is likely attributed to a host of contextual factors such as behavioural and reproductive state of the receptor, as discussed by Ellison *et al*. (2012) and Southall *et al*. (2019), and is better reflected in the threshold parameters updated by Southall *et al*. (2021).

11.7.494 Due to the overlap of hearing frequency between baleen whales and operational noise, there may be a potential for masking impacts. However, the impacts of underwater noise from operational OWFs are very small relative to other anthropogenic and natural noise sources within the environment, and there is little evidence to suggest significant impacts on baleen whales (Madsen *et al*., 2006).

11.7.495 Based on the above, harbour porpoises, dolphin species and seals are considered to be of high adaptability, high tolerance, have high recoverability, and are of very high value. The sensitivity of these receptors is Negligible.

11.7.496 Based on the above, minke and humpback whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of very high value. The sensitivity of these receptors is Low.

Basking Shark

11.7.497 As detailed in sections 11.7.87 to 11.7.90, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to underwater noise, and are of very high value. Basking sharks are highly mobile and have a wide distribution within Scottish waters. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.498 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.56Table 11.56.

11.7.499 The magnitude of impact is deemed to be Medium for noise related impacts associated with floating foundations (Table 11.56). The sensitivity of the receptor is Low or Negligible for noise related impacts associated with floating foundations. The effect will, therefore, be of Negligible to minor significance, which is not significant in EIA terms.

Table 11.56 Significance of Impact 12: Noise Related Impacts Associated With Floating Foundations

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Medium | Negligible | Negligible |
| Bottlenose dolphin | Medium | Negligible | Negligible |
| Risso's dolphin | Medium | Negligible | Negligible |
| Atlantic white-sided dolphin | Medium | Negligible | Negligible |
| White-beaked dolphin | Medium | Negligible | Negligible |
| Minke whale | Medium | Low | Minor |
| Humpback whale | Medium | Low | Minor |
| Harbour seal | Medium | Negligible | Negligible |
| Grey seal | Medium | Negligible | Negligible |
| Basking shark | Medium | Low | Minor |

### *Secondary Mitigation and Residual Effect*

11.7.500 The significance of the effect of noise related impacts associated with floating foundations for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.501 The assessment of potential from noise related impacts associated with floating foundations (operational noise) has determined that any associated disturbance is unlikely to hinder the ability to maintains the species FCS. As such, the activity is considered to meet the requirements of EPS test 3. Consequently, it is expected that an EPS licence is unlikely to be necessary.

## Impact 13: Collision Risk With Floating Foundations

11.7.502 The potential for collisions between marine mammals and basking sharks and moving vessels has long been a concern in EIAs related to offshore renewable energy projects, as such incidents can lead to injury or mortality. Recent studies have shifted focus towards understanding collision risks associated with marine mammals and basking sharks surrounding renewable marine energy infrastructure, particularly around tidal energy development (Onoufriou *et al.,* 2021). While to date there are no confirmed incidents involving marine mammals or basking sharks collision with renewable marine energy infrastructure (Copping *et al.,* 2020), the rapid growth of offshore floating wind technology requires the reassessment of potential risks. Specifically, attention is needed to evaluate interactions of marine mammals and basking sharks with the substructure of floating wind farms as they become more widespread.

### *Magnitude of Impact*

11.7.503 The magnitude of impact resulting from marine mammal and basking shark collisions with floating WTG substructures is expected to vary based on both the species frequenting the development areas and the physical dimensions of the floating WTG substructure. Each semi-submersible substructure will be comprised of three up to 16 m diameter vertical tubes within a frame which has a maximum total length of 125 m and width of 110 m, with a thickness of up to 40m, approximately 20m of which will be submerged.

11.7.504 The underwater portion of the WTGs represents the area with the highest potential for interactions with marine mammals and basking sharks. Unlike fixed turbines, floating turbines are subject to movement due to their mooring systems. Under normal operating conditions, each platform may move vertically by up to 90 m from the central anchor point. In extreme weather events, lateral movements may extend to a radius of 500 m. However, studies have shown that cetaceans such as dolphins tend to be less active and less detectable in these areas during and after storms (Fandel *et al.,* 2020), which may lower the probability of interactions during such periods. Additional, vertical movement of the structures, up to 30 m, is a normal feature of their operations, introducing a dynamic element to the spatial risk of collision. This motion, though present, is typically slow and unlikely to contribute significantly to injury.

11.7.505 When viewed within the broader context of the marine environment, the spatial influence of the turbine array remains relatively limited. While the substructure occupies a substantial amount of space locally, their overall footprint represents only a small portion of the habitat available to the receptors within the respective MUs. As such, any potential impacts from collision risk with floating foundations are expected to be geographically constrained and reversible, occurring only during the operational lifespan of the Proposed Development.

11.7.506 For species which rely on echolocation, harbour porpoise, bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin, the probability of collision is considered extremely low and very unlikely to affect the population trajectory. The magnitude is therefore Negligible.

11.7.507 Humpback whales and basking sharks display no indication that the area within the Aspen Array Area is utilised as foraging, reproductive and/or resting grounds, hence presence within the Aspen Array Area is unlikely resulting in an extremely low probability of collision and very unlikely effect on the population trajectory. The magnitude is therefore Negligible.

11.7.508 Grey and harbour seals are also unlikely to be affected, as baseline data indicates minimal interaction within the Aspen Array Area, and therefore the magnitude of impact is also assessed as Negligible.

11.7.509 However, a precautionary approach is warranted for minke whale, given the Proposed Developments proximity to the Southern Trench MPA. Although collisions remain unlikely, the possibility of impact on a small portion of the population justifies a conservative classification of Low impact magnitude for minke whale.

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.510 As floating foundations for OWFs are relatively novel, fixed foundations have been used as a proxy for the collision risk with floating foundations, and the sensitivity of marine mammals to collision risks in this assessment. Studies on tidal turbines are also included to provide an insight into the implications of dynamic structures on collision risk. However, it is important to note that concerns related to collision risk for tidal turbines are much greater than those for floating foundations due to the presence of submerged rotating blades in tidal turbines compared to fewer submerged moving parts in floating foundations.

11.7.511 The risk of marine mammals colliding with floating foundations is likely dependent on the ability to detect them, the animal's behaviour and be species specific.

11.7.512 Despite there being limited research available on the subject, evidence from a large range of practical experience suggests that the risk of collision with OWF foundations is considered to be low or non-existent for all marine mammal species (Wilson *et al.,* 2007; Wilhelmsson *et al.,* 2010; Wawrzynkowski *et al.,* 2025).While this evidence is based on fixed foundations, the collision risk with floating foundations is also considered to be low (Wawrzynkowski *et al.,* 2025)

11.7.513 As mentioned above, echolocating marine mammals (including harbour porpoise, bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin) will be able to locate and identify objects in their path. Palmer *et al.* (2021) highlighted the ability of harbour porpoise to detect and avoid operational tidal turbines. This is supported by a study undertaken by Gillespie *et al*. (2021) in northern Scotland.

11.7.514 Similarly, a study observing the movements of harbour seals around a single operational tidal turbine in Strangford Narrows, Northern Ireland (Sparling *et al.,* 2017) found a degree of local avoidance to the turbine. These types of behavioural responses serve to reduce collision risks associated with these tidal turbines. Harbour seals have also been reported to enter operational wind farms for foraging (Russell *et al*., 2014).

11.7.515 Minke and humpback whales have been reported to collide with vessels and structures within marinas during lunge feeding, which might indicate that during these behaviours they do not detect structures around them. Wilson *et al* (2007) highlight the risk of collision with floating structures with little being known on the nature of injuries should contact occur.

11.7.516 The greatest concern regarding the spatial overlap between marine mammal species and floating OWFs is the risk of entanglement with mooring lines and cables. This risk has been assessed above in paragraphs 11.7.460 to 11.7.467.

11.7.517 Based on the above, harbour porpoises, dolphins and seals are considered to be of low vulnerability, high recoverability and adaptability, and are of very high value. The sensitivity of the receptor is Negligible. While minke and humpback whales are conservatively considered to have Low sensitivity.

Basking Shark

11.7.518 There is currently very limited information available as to the collision risk of basking sharks with marine infrastructure, such as floating foundations.

11.7.519 The greatest concern regarding the spatial overlap between basking sharks and floating OWFs is the risk of entanglement with mooring lines and cables. This risk has been assessed above in paragraphs 11.7.468 to 11.7.472.

11.7.520 Due to the lack of information available on the collision risk of basking sharks with marine infrastructure, marine mammal receptors have been used as a proxy for this assessment. Basking sharks are expected to have a similar sensitivity to the marine mammal receptors due to their large size and filter-feeding behaviour. Therefore, basking sharks are considered to be of low vulnerability, high recoverability and adaptability, and are of very high value. The sensitivity of the receptor is Negligible.

*Significance of Effect*

11.7.521 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.57.

11.7.522 The magnitude of impact is deemed to be Negligible for collision risk with floating foundations for all marine mammals and basking sharks, with the exception of the minke whale for which the magnitude is Low (Table 11.57). The sensitivity of the receptor is Negligible for collision risk with floating foundations, with the exception of the minke whale for which the sensitivity is Low. The effect will, therefore, be of Negligible significance, except for the minke whale, which is Minor, which is not significant in EIA terms.

Table 11.57 Significance of Impact 13: Collision Risk With Floating Foundations

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | Negligible | Negligible |
| Bottlenose dolphin | Negligible | Negligible | Negligible |
| Risso's dolphin | Negligible | Negligible | Negligible |
| Atlantic white-sided dolphin | Negligible | Negligible | Negligible |
| White-beaked dolphin | Negligible | Negligible | Negligible |
| Minke whale | Low | Low | Minor |
| Humpback whale | Negligible | Low | Negligible |
| Harbour seal | Negligible | Negligible | Negligible |
| Grey seal | Negligible | Negligible | Negligible |
| Basking shark | Negligible | Negligible | Negligible |

#### *Secondary Mitigation and Residual Effect*

11.7.523 The significance of the effect of collision risk with floating foundations for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

#### *EPS Consideration*

11.7.524 The risk of an EPS being injured via collision with floating foundations is considered to be highly unlikely, and thus an EPS licence for injury is unlikely to be required.

### Impact 14: Habitat Loss/Change

11.7.525 The physical presence of the Aspen Array Area has the potential to displace marine mammals and basking sharks from the region as a result of habitat loss.

*Magnitude of Impact*

11.7.526 O&M activities, including cable reburial, repairs works and other interventions that disturb the seabed, have the potential to cause temporary habitat loss and associated changes in prey availability for marine mammals and basking sharks. While these activities are typically localised and infrequent, they may lead to short-term disruptions in benthic communities, which can influence the distribution and abundance of key prey species such as fish. However, temporary habitat loss is not considered as primary pressure on marine mammals and basking sharks, as the expected effects are indirect, mediated through potential changes in the availability of prey rather than the physical displacement of animals. The impact of temporary habitat loss on prey species is considered in **Volume 2, Chapter 10: Fish and Shellfish Ecology** with its potential impact on marine mammals assessed Impact 10: Changes to Prey.

11.7.527 The scale and frequency of seabed disturbance during the operations and maintenance phase are expected to be significantly lower than those associated with the construction phase. Correspondingly, impacts on prey species from long-term habitat loss have been assessed as Negligible to Minor in terms of ecological significance, which are not significant in EIA terms (See **Volume 2, Chapter 10: Fish and Shellfish Ecology**). These impacts are expected to be long-term for the duration of the operational phase and of local spatial extent, limited to the areas directly affected.

11.7.528 Furthermore, the area surrounding the Aspen Array Area does not represent unique or ecologically critical habitat for any of the marine mammal or megafauna species assessed. The habitat types are characteristic of the wider regional marine environment and are not limited in their distribution to the vicinity of the development. As such, the environmental conditions and prey resources available within the Aspen Array Area are expected to be replicated across broader areas within the relevant MUs for each species.

11.7.529 Habitat loss as a result of the physical presence of marine infrastructure will primarily impact benthic habitats (Wawryznkowski *et al.,* 2025; Horwath *et al.,* 2020). However, this loss can extend to pelagic habitat loss which is expected to have some impacts on marine mammals and basking sharks, through the loss or changes in the availability of prey species. Nevertheless, these impacts are likely to be relatively small and result in minimal impacts to these receptor species.

11.7.530 The introduction of man-made structures, such as midwater and surface structures used in floating OWFs, can create new habitats in a phenomenon often referred to as the 'reef effect' and may act as fish aggregation devices (Wawryznkowski *et al.,* 2025; Karlsson *et al.,* 2022; Bergström *et al.,* 2014; Degraer *et al.,* 2020; Clausen *et al.,* 2021). These habitats enhance habitat complexity, increasing diversity and abundance. In turn, this may have a positive impact on marine mammals and basking sharks through the attraction of prey species.

11.7.531 Therefore, the magnitude of impact from operation-phase habitat loss is considered to be Low for marine mammal and basking sharks.

### *Sensitivity of Receptor*

11.7.532 As described above, there is potential for an indirect of habitat loss on marine mammals and basking sharks through the loss or changes in the availability of prey species. Marine mammal and basking shark sensitivity to changes in prey is described in Impact 10: Changes to Prey. Based on this assessment, the sensitivity of all receptors is Low.

### *Significance of Effect*

11.7.533 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.58.

11.7.534 The magnitude of impact is deemed to be Low for habitat loss/change (Table 11.58). The sensitivity of the receptor is Low for habitat loss/change. The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.58 Significance of Impact 14: Habitat Loss/Change

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

### *Secondary Mitigation and Residual Effect*

11.7.535 The significance of the effect of habitat loss/change for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.536 This impact assessment has concluded that habitat loss/change will not be detrimental to maintain the species FCS and therefore passes the EPS test 3. Consequently, it is expected that an EPS licence is unlikely to be necessary.

## Impact 15: Physical Barrier Effects

11.7.537 Within the Aspen Array Area the presence of array infrastructure has the potential to displace marine mammals and basking sharks by creating a barrier effect, whereby the regular movements of a species are impacted by the presence of the wind farm (Onoufriou *et al.,* 2021). Barrier effects can also be present in the form of a reduction of access to areas which were once used by marine mammals for particular behaviours.

### *Magnitude of Impact*

11.7.538 Marine mammal species such as harbour porpoise, grey and harbour seals have been observed in and around operational OWFs (Hastie *et al.,* 2016; Fernandez-Betelu *et al.,* 2021; Iorio-Merlo *et al.,* 2023). However, whilst minke whales have been recorded near offshore oil and gas infrastructure in the central North Sea (Delefosse *et al.,* 2018), it is still unclear whether baleen whales and basking sharks can effectively navigate turbine arrays, particularly in floating OWFs where mooring lines and cables extend throughout the water column.

11.7.539 Long-term monitoring of operational wind farms including the UK, Denmark and the Netherlands (Moray Firth, Horns Rev, Nysted and Egmond aan Zee) has shown that harbour porpoise and seals continue to use these areas, with some studies even reporting increased harbour porpoise activity within the arrays (Scheidat *et al.,* 2011). Movement data from tagged seals has shown they often travel between turbines in a grid-like pattern, indicating foraging behaviour (Russell *et al*., 2014). Multiple reviews have concluded that operational windfarms do not present a significant barrier to movement (Madsen *et al.,* 2006; Teilmann *et al.,* 2006a; 2006b; Brasseur *et al.,* 2012; Wawrzynkowski *et al*., 2025). Additionally, the Proposed Development's export cable will be buried or protected, so it is not expected to impede animal passage.

11.7.540 Given the known ability of certain marine mammal species to navigate around offshore anthropogenic structures, the possibility of the physical barrier effect at the Proposed Development are not expected to adversely affect harbour porpoise, white-beaked dolphin, bottlenose dolphin, Atlantic white-sided dolphin, Risso's dolphin, grey seal and harbour seal. Accordingly, the physical barrier effect magnitude for these species is assessed as Low. However, due to the remaining uncertainties around the responses of baleen whales and basking sharks to floating OWFs, a Medium magnitude of impact is assigned for minke whales, humpback whales and basking sharks.

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.541 To date, no studies have reported any physical barrier effects from floating OWFs on marine mammal species. However, due to the dynamic nature of floating OWFs, they do have the potential to yield different and potentially greater barrier effects than fixed foundations. Wawrzynkowski *et al.* (2025) conducted a generalised impact assessment of the biological effects of floating OWFs, concluding that physical barrier effects would have a low effect on all marine mammal species.

11.7.542 As floating foundations for OWFs are relatively novel, fixed foundations have been used as a proxy for the impacts of barrier effects, and the sensitivity of marine mammals to barrier effects in this assessment. Studies on tidal turbines are included to provide an insight into the implications of dynamic structures on marine mammal behaviour.

11.7.543 A study by Palmer *et al.* (2021), found significant avoidance of harbour porpoises to operational tidal turbines. The study demonstrated that harbour porpoise were able to detect and avoid turbines, with avoidance behaviour increasing with turbine number. However, while operational tidal turbines did lead to a significant reduction in harbour porpoise presence, both harbour porpoise and dolphin species were still detected in the vicinity suggesting these species were not avoiding the area entirely. Sparling *et al.* (2017) observed the movements of harbour seals around a single operational tidal turbine in Strangford Narrows, Northern Ireland. They found that while there was some degree of avoidance of the turbine, it did not prevent transit of the seals through the channel and therefore did not result in a barrier effect.

11.7.544 Studies of marine mammal activity around fixed marine infrastructures, such as fixed foundation OWFs, reported regular sightings and acoustic detections of dolphins, porpoises and pinnipeds (Scheidat *et al.,* 2011; Todd *et al.,* 2016; Vallejo *et al.,* 2017; Clausen *et al.,* 2021; Russell *et al.,* 2016). This suggests that barrier effects are not an issue for these marine mammal species, with both Russell *et al.* (2016) and Vallejo *et al.* (2017) observing no displacement of harbour seals and harbour porpoise during the operation of several OWFs within the UK.

11.7.545 Marine infrastructures, such as floating foundations, often act as artificial reef structures, in turn attracting possible prey species and marine mammals as a result (Wawryznkowski *et al.,* 2025; Karlsson *et al.,* 2022; Bergström *et al.,* 2014; Degraer *et al.,* 2020; Clausen *et al.,* 2021).

11.7.546 Barrier effects may have a greater impact on migratory species, such as humpback and minke whales. While there is currently very limited data available as to how anthropogenic infrastructures may alter migration routes, an increase in the total distance of a migratory route due to displacement resulting from the presence of marine infrastructure may increase energetic costs (Braithewaite *et al.,* 2015). This, in turn, has been found to have negative implications on survival, reproduction and calf growth. As the annual movements and migration patterns of both humpback and minke whales in the UK is not yet fully understood, it is difficult to predict if or how the Proposed Development may cause these baleen whales to deviate from their optimum migration routes.

11.7.547 Based on the above, harbour porpoise, dolphin species and seals are considered to be of low vulnerability, high recoverability and adaptability, and are of very high value. The sensitivity of the receptor is Negligible.

11.7.548 Based on the above, humpback and minke whales are considered to be of moderate vulnerability, high recoverability and adaptability, and are of very high value. The sensitivity of the receptors is Low.

### Basking Shark

11.7.549 Basking sharks are highly mobile and are distributed widely across Scottish waters (Paxton *et al.,* 2014). While there are currently no studies of basking shark activity around marine infrastructures, the migratory pathways of basking sharks primarily span across the west coast of Scotland (such as around the Firth of Clyde), the Irish Sea including waters off the Isle of Man, and the western English Channel (Sims *et al.,* 2003; Solandt and Chassin, 2013; Cornwall Wildlife Trust, 2020). Therefore, it is unlikely that the presence of the Proposed Development will have an impact on the migratory route of basking sharks.

11.7.550 Based on the above, basking sharks are considered to be of low vulnerability, high recoverability and adaptability to physical barrier effects, and are of very high value. The sensitivity of the receptor is Negligible.

### *Significance of Effect*

11.7.551 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.59.

11.7.552 The magnitude of impact is deemed to be Low for all marine mammals and basking sharks, except for minke and humpback whales for which is Medium for physical barrier effects (Table 11.59). The sensitivity of the receptor is Negligible for all marine mammals and basking sharks, except for minke and humpback whales for which is Low for physical barrier effects. The effect will, therefore, be of Negligible significance for all marine mammals and basking sharks, except for minke and humpback whales for which is Minor, which are not significant in EIA terms.

Table 11.59 Significance of Impact 15: Physical Barrier Effects

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Negligible | **Negligible** |
| Bottlenose dolphin | Low | Negligible | **Negligible** |
| Risso's dolphin | Low | Negligible | **Negligible** |
| Atlantic white-sided dolphin | Low | Negligible | **Negligible** |
| White-beaked dolphin | Low | Negligible | **Negligible** |
| Minke whale | Medium | Low | **Minor** |
| Humpback whale | Medium | Low | **Minor** |
| Harbour seal | Low | Negligible | **Negligible** |
| Grey seal | Low | Negligible | **Negligible** |
| Basking shark | Low | Negligible | **Negligible** |

### *Secondary Mitigation and Residual Effect*

11.7.553 The significance of physical barrier effects for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

### *EPS Consideration*

11.7.554 This impact assessment has concluded that the effect of a physical barrier will not be detrimental to maintain the species FCS and therefore passes the EPS test 3. Consequently, it is expected that an EPS licence is unlikely to be necessary.

## Impact 16: EMF Impacts on Other Megafauna

11.7.555 The transmission of electrical current through subsea infrastructure, namely inter-array, interconnector and export cables within the Proposed Development has the potential to emit a localised EMF. These EMFs could potentially influence basking sharks, which are an electroreceptive fish species. The extent of the impact can vary based on species-specific sensitivity and strength of the EMF, but existing research indicates that elasmobranchs may alter their behaviour or exhibit avoidance responses near EMF-emitting sources (Gill and Kimber, 2005).

11.7.556 The inter-array cabling between WTGs will consist of dynamic high voltage alternating current (HVAC), each potentially up to 220 mm in diameter depending on the cable composition and voltage level, with a maximum rated capacity of 72.5 kV and a maximum total length at site of 300 km. As for the export cable, a maximum of four static HVAC cables are proposed, with diameters reaching 350 mm, a maximum operating voltage of 275 kV, and a maximum total offshore cable length of 580 km buried at 1.5 m depth.

### *Magnitude of Impact*

11.7.557 EMFs generated by subsea power cables are known to diminish rapidly with distance, following an inverse square relationship both vertically and horizontally from the cable source. Typically, magnetic field strength falls to negligible levels within approximately 10 meters from the cable (Normandeau Associates Inc. *et al.,* 2011). While shallow burial or external cable protection does not decrease the inherent strength of the EMF, it increases the distance between the cable and nearby receptors, effectively lowering their exposure.

11.7.558 Research has identified that elasmobranchs may respond to induced electric fields in the range of 400 to 1,000 microvolt per metre (μV/m) (CMACS, 2015), with such field intensities likely to occur within one to two meters of the seabed for cables buried at standard depths Gill and Taylor, 2001; Kimber *et al.,* 2011; Kalmijn, 1982). For deeper burial, the field intensity at the seabed would be correspondingly lower.

11.7.559 Tricas and Gill (2011) noted that the sensitivity of elasmobranchs to electric fields was highest at frequencies of 1-10 Hz, with a broader response frequency range of 0.01-25 Hz where fields intensities of 10 times or greater were required to elicit a reaction. This suggests that weak fields such as those generated by offshore wind AC cables are likely to be mostly undetectable.

11.7.560 There is limited understanding of the EMF impacts of cables suspended in the water column, with the lack of buffer (i.e. sediment) between cables and marine organisms resulting in a greater interaction and impact compared to buried cables (Gill and Desender, 2020; Hutchison *et al*., 2020a). More work needs to be done to understand attraction or aversion impacts of suspended cables, particularly on pelagic species (Taormina *et al*., 2018).

11.7.561 To mitigate the potential impacts a detailed CaP (C-OFF-04, Table 11.16) will be implemented as part of the Proposed Development embedded commitments. These measures will include cable burial and/or the implementation of cable protection measures (**Volume 1, Chapter 3: Project Description, Sections 3.5 and 3.6**). These actions will be carried out in accordance with management plans, including the CaP, to reduce the impact of EMF emissions on surrounding environments and organisms. In instances where cables cannot be buried, as such with dynamic inter-array cables between WTGs, regularly monitoring the inter-array cables for deterioration allows for early detection and repair of any damage, maintaining the cable shielding and reducing the duration and extent of EMF emission.

11.7.562 Given these considerations, it is anticipated that any EMF-related impacts on basking sharks will be limited, affecting only a small segment of the population. Thus, interactions are expected to be brief, sporadic, and reversible. Accordingly, the overall magnitude of EMF impact during the Operations and Maintenance phase of the Proposed Development is considered Low for basking sharks.

### *Sensitivity of Receptor*

#### Basking Shark

11.7.563 Electromagnetic detection has been well documented in elasmobranchs and is thought to be used for both navigation and prey detection (Meyer *et al.,* 2005; Hart and Colin, 2015; Hutchison *et al.,* 2020b). Shark species generally detect voltage gradients (about 5 nanovolts per metre, nV/m) and biopotentials of their prey (0.001 to 0.5V) at distances of up to 0.5 m (Hart and Collin, 2015). Basking sharks use passive electroreception, using the electrosensory pores focussed on its snout to detect the weak electric fields produced by zooplankton prey (up to 0.1 V/m; Kempster and Colin, 2011). It is thought that if basking sharks are able to detect these signals, they are also able to detect electric fields at the benchmark level of 1 V/m.

11.7.564 Currently very little is known about the direct impact of changing electric fields on basking sharks. Gill and Kimber (2005) found that electric fields may cause either an attraction or avoidance response in shark species. This supported previous findings by Kalmijn (1982) who suggested that electric fields in the range of 0.005 to 1 mV/cm attracted elasmobranchs, while electric fields over 10mV/cm led to an avoidance response.

11.7.565 Very little information is also currently available regarding the detection of magnetic fields by basking sharks. Meyer *et al.* (2005) found that other shark species were attracted to magnetic fields ranging from 25 to 100 mT in strength.

11.7.566 There is currently very little direct evidence on the impacts of EMF on basking sharks, particularly the potential impacts of anthropogenic EMFs. However, if other elasmobranch species are a good proxy for basking sharks, then they may be attracted or repelled by fields depending on strength. Studies conducted on other elasmobranch species have found the degree of responsiveness varies among species, sex, age classes, and depends on the strength of EMFs (Normandeau Associates Inc. *et al.,* 2011). It is currently unknown whether elasmobranchs respond positively, negatively or neutrally to EMF emissions (Gill and Taylor, 2001; Gill *et al.,* 2009), particularly from dynamic cables on pelagic species (Taormina *et al.,* 2018).

11.7.567 As the vulnerability, recoverability and adaptability of basking sharks to EMF impact is largely unknown, a precautionary approach has been adopted and the sensitivity of basking sharks to EMF is assessed as Medium.

### *Significance of Effect*

11.7.568 A summary of the impact magnitude, receptor sensitivity and significance of effect for other megafauna receptors is presented in Table 11.60.

11.7.569 The magnitude of impact is deemed to be Low for EMF impacts (Table 11.60). The sensitivity of the receptor is Medium for EMF impacts. The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.60 Significance of Impact 16: EMF Impacts on Other Megafauna

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Basking shark | Low | Medium | Minor |

### *Secondary Mitigation and Residual Effect*

11.7.570 The significance of the effect of EMF impacts on basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of basking sharks.

### *EPS Consideration*

11.7.571 It is expected that, with the commitment to a CaP (C-OFF-04; Table 11.16) to reduce the risk of EMF impacts to Negligible levels, no EPS will be injured, and therefore it is expected that an EPS licence is unlikely to be required.

## Decommissioning

11.7.572 This section presents the assessment of impacts arising from the Decommissioning phase of the Project.

## Impact 17: Vessel Disturbance

### *Magnitude of Impact*

11.7.573 Vessel traffic during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase as decommissioning activities will mostly be a reversal of the installation process (Table 11.18). The type of decommissioning vessels available at the time of decommissioning is unknown. Therefore, the worst-case assumption is that the same number of vessels present and trips as during the construction phase.

11.7.574 As stated in paragraph 11.7.289, the area surrounding the Proposed Development, in particular the OTC Corridor, already experiences a low-moderate level of vessel traffic. Therefore, the increase in vessel activity as a result of decommissioning is not considered a novel impact for the marine mammals or other megafauna present in the area.

11.7.575 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 $km^2$). Comparatively, vessel traffic in the Study Area averages one vessel per day (see **Volume 2, Chapter 14: Shipping and Navigation**).

11.7.576 As discussed in paragraph 11.7.305, the magnitude of any impact will be further reduced with the implementation of a VMP (C-OFF-12), Scottish Marine Wildlife Watching Code (C-OFF-45) and Basking Shark Code of Conduct (C-OFF-54) which state that vessel movements follow predictable routes, controlled speeds and movements and provide guidance on how vessels should behave in the presence of marine mammals and basking sharks .

11.7.577 Therefore, the impact of disturbance to all marine mammal and basking sharks species from vessel activities is considered to result in a small proportion of the population affected, to occur frequently throughout the decommissioning phase, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of embedded commitments.

11.7.578 The impact is predicted to be of local spatial extent and short-term duration. The magnitude is therefore Low.

### *Sensitivity of Receptor*

#### Harbour Porpoise

11.7.579 Harbour porpoise sensitivity to increased vessel disturbance is described in paragraph 11.7.313 to 11.7.318. The sensitivity of the receptor is Low.

#### Bottlenose Dolphin

11.7.580 Bottlenose dolphin sensitivity to increased vessel disturbance is described in paragraph 11.7.319 to 11.7.326. The sensitivity of the receptor is Low.

#### Risso’s Dolphin

11.7.581 Risso’s dolphin sensitivity to increased vessel disturbance is described in paragraph 11.7.327 to 11.7.330. The sensitivity of the receptor is Low.

Atlantic White-sided Dolphin / White-beaked Dolphin

11.7.582 Atlantic white-sided dolphin and white-beaked dolphin sensitivity to increased vessel disturbance is described in paragraph 11.7.331 to 11.7.332. The sensitivity of the receptors is Low.

Minke Whale

11.7.583 Minke whale sensitivity to increased vessel disturbance is described in paragraph 11.7.333 to 11.7.337. The sensitivity of the receptor is Low.

Humpback Whale

11.7.584 Humpback whale sensitivity to increased vessel disturbance is described in paragraph 11.7.338 to 11.7.341. The sensitivity of the receptor is Low.

Harbour and Grey Seals

11.7.585 Harbour and grey seal sensitivity to increased vessel disturbance is described in paragraph 11.7.342 to 11.7.349. The sensitivity of the receptor is Low.

Basking Shark

11.7.586 Basking shark sensitivity to increased vessel disturbance is described in paragraph 11.7.350 to 11.7.352. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.587 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.61.

11.7.588 The magnitude of impact is deemed to be Low for vessel disturbance (Table 11.61). The sensitivity of the receptor is Low for vessel disturbance. The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.61 Significance of Impact 17: Vessel Disturbance

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Low | Low | Minor |
| Risso's dolphin | Low | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | Low | Low | Minor |
| Minke whale | Low | Low | Minor |
| Humpback whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |
| Basking shark | Low | Low | Minor |

*Secondary Mitigation and Residual Effect*

11.7.589 The significance of the effect from vessel disturbance to marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.590 It is expected that, with the commitment to a VMP (C-OFF-12) and adherence to the Basking Shark Code of Conduct (C-OFF-54) and Scottish Marine Wildlife Watching Code (C-OFF-45) to reduce the disturbance to Negligible levels, no EPS will be injured. Further the assessment of impacts resulting from vessel disturbance has determined that any associated disturbance is unlikely to hinder the ability to maintains the species FCS. As such, the activity is considered to meet the requirements of EPS test 3. Consequently, it is expected that an EPS licence is unlikely to be necessary.

### Impact 18: Vessel Collision Risk

*Magnitude of Impact*

11.7.591 Vessel traffic during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase, as decommissioning activities will mostly be a reversal of the installation process (Table 11.18). The type of decommissioning vessels available at the time of decommissioning is unknown. Therefore, the worst-case assumption is that the same number of vessels present and trips as during the construction phase.

11.7.592 As stated in paragraph 11.7.289, Aspen Array Area experiences low vessel traffic density (with the exception of two areas) and the OTC corridor has low-moderate vessel traffic density, with a density hotspot close to Aberdeen.. Vessel movements will be within the Aspen Array Area or along the OTC Corridor and will follow existing shipping routes to/from ports. Therefore, the increase in vessel activity as a result of the decommissioning phase is not considered a novel impact for the marine mammals or basking sharks present in the area and it is not expected that vessels activities during the decommissioning phase would increase the risk of injury due to vessel collision.

11.7.593 Marine mammals and basking sharks are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.7.361, the implementation of embedded commitments, including a VMP (C-OFF-12), adherence to the Scottish Marine Wildlife Watching Code (C-OFF-45) and the Basking Shark Code of Conduct (C-OFF-54) will advise that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will reduce the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout decommissioning activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.7.594 Furthermore, all marine mammal species and basking sharks are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality, as highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2023).

11.7.595 The impact of injury to all marine mammal species and basking sharks from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the decommissioning phase, the effect is unlikely to occur given implementation of embedded commitments, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory.

11.7.596 The impact for marine mammals and basking sharks is therefore predicted to be of local spatial extent, short term duration and intermittent. The magnitude is therefore Negligible.

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.597 Marine mammal receptors sensitivity to vessel collision risk is described in paragraph 11.7.369 to 11.7.377. The sensitivity of the receptors is High.

#### Basking Shark

11.7.598 Basking shark sensitivity to vessel collision risk is described in paragraph 11.7.378 to 11.7.381. The sensitivity of the receptor is High.

### *Significance of Effect*

11.7.599 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.62.

11.7.600 The magnitude of impact is deemed to be Negligible for vessel collision risk (Table 11.62). The sensitivity of the receptor is High for vessel collision risk. The effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.62 Significance of Impact 18: Vessel Collision Risk

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | High | Minor |
| Bottlenose dolphin | Negligible | High | Minor |
| Risso's dolphin | Negligible | High | Minor |
| Atlantic white-sided dolphin | Negligible | High | Minor |
| White-beaked dolphin | Negligible | High | Minor |
| Minke whale | Negligible | High | Minor |
| Humpback whale | Negligible | High | Minor |
| Harbour seal | Negligible | High | Minor |
| Grey seal | Negligible | High | Minor |
| Basking shark | Negligible | High | Minor |

*Secondary Mitigation and Residual Effect*

11.7.601 The significance of the effect of vessel collision risk to marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.602 It is expected that, with the commitment to a VMP (C-OFF-12), Scottish Marine Wildlife Watching Code (C-OFF-45) and the Basking Shark Code of Conduct (C-OFF-54) to reduce the vessel collision risk to Negligible levels, no EPS will be injured. As such, an EPS licence for injury is unlikely to be necessary.

### Impact 19: Changes to Prey

11.7.603 Marine mammals and basking sharks are dependent on prey for survival. As a result, there is the potential for indirect effects on marine mammals or basking sharks to occur as a result of impacts on their prey species or the habitats that support them.

11.7.604 The key prey species for the receptors within this assessment are presented in Table 11.49.

*Magnitude of Impact*

11.7.605 Potential impacts on prey species during the decommissioning phase of the Proposed Development are described in **Volume 2, Chapter 10: Fish and Shellfish Ecology** of the Offshore EIAR and include:

- Mortality, injury, behavioural impacts and auditory masking arising from noise and vibration during decommissioning phase;

- Temporary increases in SSC and deposition;
- Direct and indirect seabed disturbance leading to release of sediment contaminants;
- Temporary habitat disturbance;
- Increased risk of introduction and/or spread of marine INNS.

11.7.606 **Volume 2, Chapter 10: Fish and Shellfish Ecology** of the Offshore EIAR concluded that there will be no significant effect arising on fish and shellfish species during the decommissioning phase.

11.7.607 The impact to all marine mammal and basking shark receptors from changes to prey species is therefore considered to have a Negligible magnitude.

### *Sensitivity of Receptor*

#### Marine Mammals

11.7.608 Marine mammal receptors sensitivity to changes in prey is described in paragraph 11.7.392 to 11.7.393. The sensitivity of the receptors is Low.

#### Basking Shark

11.7.609 Basking shark sensitivity to changes in prey is described in paragraph 11.7.394 to 11.7.396. The sensitivity of the receptor is Low.

### *Significance of Effect*

11.7.610 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal and other megafauna receptors is presented in Table 11.63.

11.7.611 The magnitude of impact is deemed to be Negligible for changes to prey (Table 11.63). The sensitivity of the receptor is Low for changes to prey. The effect will, therefore, be of Negligible significance, which is not significant in EIA terms.

Table 11.63 Significance of Impact 19: Changes to Prey

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Negligible | Low | Negligible |
| Bottlenose dolphin | Negligible | Low | Negligible |
| Risso's dolphin | Negligible | Low | Negligible |
| Atlantic white-sided dolphin | Negligible | Low | Negligible |
| White-beaked dolphin | Negligible | Low | Negligible |
| Minke whale | Negligible | Low | Negligible |
| Humpback whale | Negligible | Low | Negligible |
| Harbour seal | Negligible | Low | Negligible |
| Grey seal | Negligible | Low | Negligible |
| Basking shark | Negligible | Low | Negligible |

*Secondary Mitigation and Residual Effect*

11.7.612 The significance of the effect of changes to prey for marine mammals and basking sharks is not significant EIA terms. Therefore, no additional mitigation to the embedded commitments already identified in Table 11.16 are considered necessary. No ecological significant adverse residual effects have been predicted in respect of marine mammals and basking sharks.

*EPS Consideration*

11.7.613 This impact is not direct disturbance to EPS, hence an EPS Licence is not applicable.

## Proposed Monitoring

11.7.614 Monitoring is not proposed for marine mammals and basking sharks as no LSE were predicted during the construction, operations and maintenance and decommissioning phases of the Proposed Development.

## 11.8 Cumulative Effects Assessment

### Cumulative Effects Assessment Methodology

11.8.1 The impacts of the Proposed Development alone are generally limited to areas near the Aspen Array Area and OTC Corridor. However, some impacts may extend over a wider area. Cumulative effects arise when the Proposed Development combines with other projects, affecting the same receptor or group of receptors.

11.8.2 **Volume 1, Chapter 4: Environmental Impact Assessment Methodology** outlines how cumulative effects will be assessed through a Cumulative Effects Assessment (CEA). A screening process has identified relevant plans, projects, and activities to be included.

11.8.3 Figure 11.9 illustrates those relevant to marine mammals and other megafauna, with further details provided in Table 11.64.

11.8.4 The assessment uses the most up-to-date publicly available project parameters for each relevant plan or project.

11.8.5 Different plans and projects may contribute to cumulative effects to varying degrees, depending on their progress and likelihood of operation. A tiered approach is used to weight the assessment accordingly:

- Tier 1: The Proposed Development, combined with projects that have become operational since the baseline characterisation, ongoing operational projects, and those consented but not yet built or under construction.
- Tier 2: All Tier 1 projects, plus those that have submitted a Scoping Report or are awaiting determination following an application.
- Tier 3: All Tier 2 projects, plus those not yet in the planning system but expected to enter soon (e.g., Agreement for Lease (AfL) projects or those in feasibility/early design stages), where sufficient data is available.

11.8.6 The CEA for marine mammals and other megafauna considers the worst-case design scenario for each project, plan, and activity, following the methodology in **Volume 1, Chapter 4: Environmental Impact Assessment Methodology**. Projects were included in the assessment based on a screening range covering both the spatial and temporal scope of the Proposed Development, defined by construction and decommissioning timelines and study area.

11.8.7 For marine mammals and basking sharks, projects were screened into the assessment based on screening criteria outlined in paragraph 11.8.9.

11.8.8 Potential Cumulative Impacts on marine mammal and basking shark receptors have been evaluated using project-specific modelling and other analytical methods.

## Screening Projects

11.8.9 To compile the CEA long list for marine mammals, a species-specific spatial range has been applied to identify relevant offshore projects to screen in (noting that only Scottish projects within these MUs were taken forward to the quantitative assessment ). With respect to OWF projects, the species-specific ranges are defined as:

- NS MU for harbour porpoise;
- CGNS MU for white-beaked dolphin, Risso's dolphin, Atlantic white-sided dolphin and minke whale;
- CES and GNS MU for bottlenose dolphin; and
- ES and NC&O SMU for grey and harbour seals.

11.8.10 Humpback whales do not have a defined MU, therefore they are not considered further in this CEA as there are no quantitative assessment of disturbance or densities available to use for any projects considered in the CEA.

11.8.11 For basking sharks, as there are no quantitative assessment of disturbance or densities available to use for any projects considered in the CEA, they are also not considered further in the CEA.

11.8.12 For all other planned offshore projects (e.g. oil and gas projects), the ICES 4a Greater North Sea region was used for screening due to the smaller scale that these projects have in nature in comparison to commercial OWFs. Each project, plan, or activity has then been evaluated and screened in (or out) based on effect-receptor pathways, data reliability, and the temporal and spatial scales involved.

11.8.13 The temporal scope considered in the CEA for marine mammals and basking sharks spans from 2025 to 2032, inclusive. This timeframe facilitates a quantitative assessment of impacts to marine mammals, relative to the species-specific MUs both since the baseline data were compiled prior to the construction of the Proposed Development, and up to a year after the potential construction window for the Proposed Development. The anticipated construction timeline for the Proposed Development is from 2028 to 2031 with piling activities anticipated to occur from 2028 to 2030. It is therefore important to note that while the assessment of magnitude considers the full temporal scope of 2025 to 2032, a greater focus is placed on the proportion of the population that will be potentially impacted by piling at the Proposed Development cumulatively with Tier 1 and 2 projects from 2028 to 2030. The rationale to this approach is that underwater noise from impulsive sound sources (e.g. pile driving) during construction has the greatest potential to impact marine mammal populations, and there is less uncertainty in the timelines of Tier 1 and Tier 2 projects, which gives more confidence (reduces uncertainties) in the CEA.

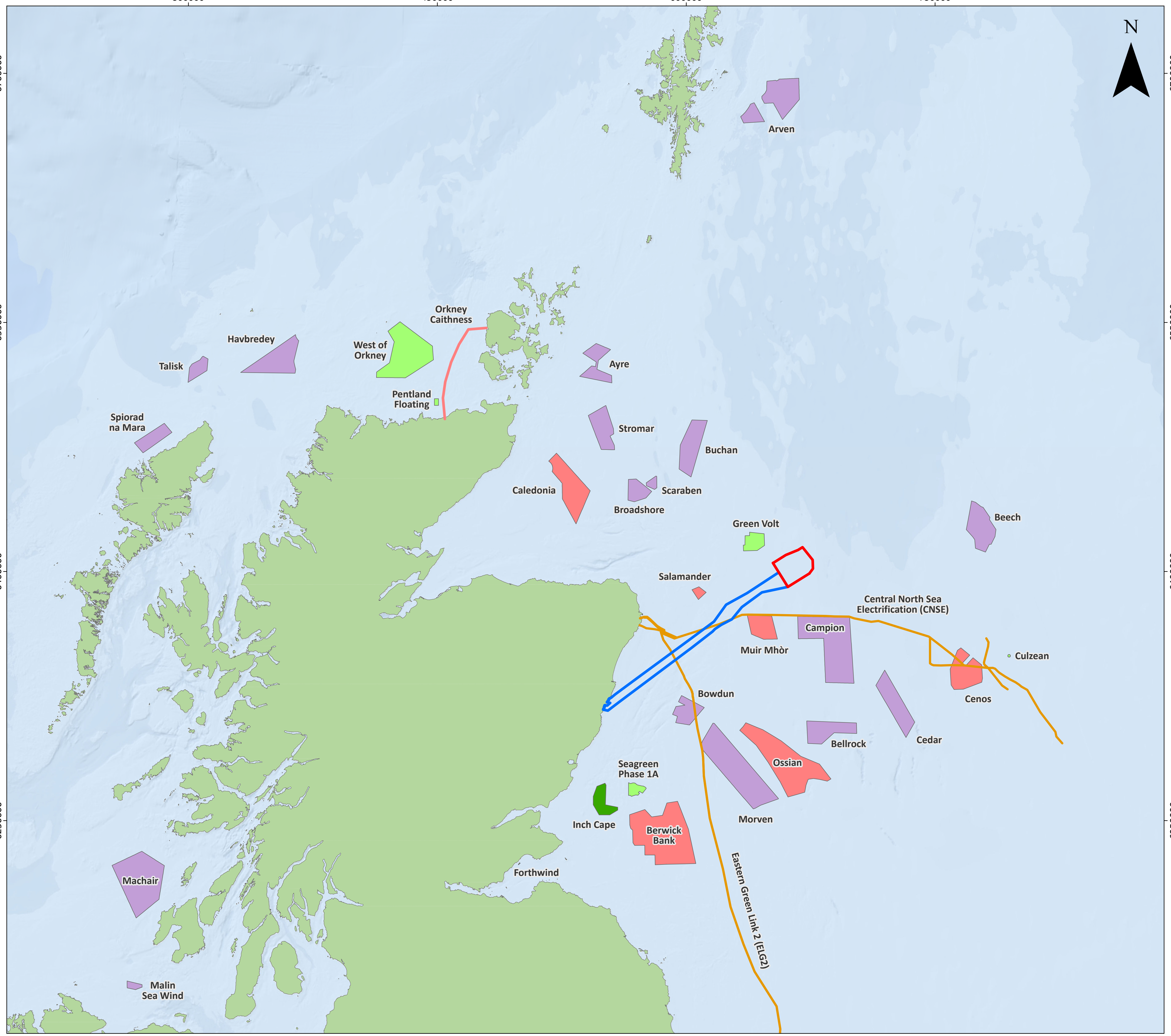
11.8.14 The following types of other projects have the potential to result in cumulative effects on marine mammals:

- Sub-sea cables and pipelines (telecom and power cables);
- OWFs;
- Oil and gas projects; and

- Tidal and wave energy projects.

11.8.15 The following offshore project types were screened out of the list for the marine mammal CEA:

- Projects located outside of the relevant species MU boundary;
- Projects that are already operational (prior to 2024) (given that they are considered to have existing impacts included within the baseline);
- Projects where there is no expected temporal overlap with the construction window of the Proposed Development;
- Projects where the construction timeframe is unknown; and
- Projects not falling into the development types listed in paragraph 11.8.14.




CERULEAN WINDS

# Aspen Offshore Wind Farm

Environmental Impact Assessment

**The Locations of All Offshore Renewable Energy Projects Screened into the Marine Mammal Short List for the Cumulative Impact Assessment**

**Legend**

Aspen Array Area
Offshore Transmission Cable Corridor
**Subsea Cable (Type - Status)**
Power - Proposed
Power - Proposed (Indicative)
**Offshore Wind Farm (Status)**
Concept/Early Planning
In Planning
Consented
Under Construction

**Notes**

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Coordinate System:
WGS 1984 UTM Zone 30N

0 50 100 km
0 25 50 nm

| Scale | Date | Drawn by | Checked by | Approved by |
|---|---|---|---|---|
| 1:2,250,000@A3 | 28/07/2025 | EV | GB | SB |

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GoBe APEM Group

**Figure 11.9**

Figure Reference: ASPEN_MM_Fig11.9_CIAProjects_v3

Table 11.64 Other Plans/Projects Included in the Marine Mammal CEA

| Plan/Project | Summary | Status | Distance From the Aspen Array Area (km) | Distance From OTC Corridor (km) | Construction Dates (if relevant) | Operational by (if Relevant) | Summary of Interaction With Proposed Development |
|---|---|---|---|---|---|---|---|
| Tier 1 | | | | | | | |
| Culzean OWF | Offshore Energy | Consented | 128.5 | 138.8 | 2025 | 2026 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Eastern Green Link 2 (EGL 2) | Power | Consented | 78.90 | 0.00 | 2025-2028 | 2029 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Green Volt OWF | Offshore Energy | Consented | 11.6 | 18.1 | 2025-2027 | 2028 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Inch Cape OWF | Offshore Energy | Under Construction | 161.6 | 43.7 | 2025 | 2026 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Orkney Caithness Interconnector Cable | Subsea Cable | Under Construction | 216 | 194.5 | 2025-2027 | 2028 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Pentland Floating OWF | Offshore Energy | Consented | 222.9 | 203.3 | 2025 | 2026 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |

| Plan/Project | Summary | Status | Distance From the Aspen Array Area (km) | Distance From OTC Corridor (km) | Construction Dates (if relevant) | Operational by (if Relevant) | Summary of Interaction With Proposed Development |
|---|---|---|---|---|---|---|---|
| Seagreen Phase 1A OWF | Offshore Energy | Consented | 148.1 | 45.2 | 2029-2032 | 2033 | Construction phase interacts with the construction phase of the Proposed Development. |
| Tier 2 | | | | | | | |
| Berwick Bank OWF | Offshore Energy | In Planning | 145.2 | 63.6 | 2025-2033 | 2034 | Construction phase interacts with the construction phase of the Proposed Development. |
| Caledonia OWF | Offshore Energy | Concept/Early Planning | 118.4 | 96.7 | 2028-2030 | 2031 | Construction phase interacts with the construction phase of the Proposed Development. |
| Central North Sea Electrification Project | Power | Concept/Early Planning | 17.06 | 0.00 | 2027-2028 | 2029 | Construction phase interacts with the construction phase of the Proposed Development |
| Cenos OWF | Offshore Energy | Concept/Early Planning | 100 | 109 | 2029-2033 | 2034 | Construction phase interacts with the construction phase of the Proposed Development. |

| Plan/Project | Summary | Status | Distance From the Aspen Array Area (km) | Distance From OTC Corridor (km) | Construction Dates (if relevant) | Operational by (if Relevant) | Summary of Interaction With Proposed Development |
|---|---|---|---|---|---|---|---|
| Muir Mhòr OWF | Offshore Energy | In Planning | 20 | 5.7 | 2029-2033 | 2034 | Construction phase interacts with the construction phase of the Proposed Development. |
| Ossian OWF | Offshore Energy | In Planning | 85.6 | 55.7 | 2031 onwards | N/A | Construction phase interacts with the construction phase of the Proposed Development. |
| Salamander OWF | Offshore Energy | In Planning | 44 | 14.1 | 2028-2030 | 2031 | Construction phase interacts with the construction phase of the Proposed Development. |
| West of Orkney OWF | Offshore Energy | In Planning | 238.5 | 227.3 | 2028-2031 | 2032 | Construction phase interacts with the construction phase of the Proposed Development. |
| Tier 3 | | | | | | | |
| Arven OWF | Offshore Energy | Concept/Early Planning | 271.4 | 257.3 | 2030-2033 | 2034 | Construction phase interacts with the construction phase of the Proposed Development. |

| Plan/Project | Summary | Status | Distance From the Aspen Array Area (km) | Distance From OTC Corridor (km) | Construction Dates (if relevant) | Operational by (if Relevant) | Summary of Interaction With Proposed Development |
|---|---|---|---|---|---|---|---|
| Ayre OWF | Offshore Energy | Concept/Early Planning | 150.2 | 145.6 | 2029-3031 | 3032 | Construction phase interacts with the construction phase of the Proposed Development. |
| Beech OWF | Offshore Energy | Concept/Early Planning | 112.9 | 94.3 | 2026-2027 | 2028 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Bellrock OWF | Offshore Energy | Concept/Early Planning | 76 | 81.5 | 2028-2031 | 2032 | Construction phase interacts with the construction phase of the Proposed Development. |
| Bowdun OWF | Offshore Energy | Concept/Early Planning | 19.4 | 88.4 | 2029-2032 | 2033 | Construction phase interacts with the construction phase of the Proposed Development. |
| Broadshore OWF | Offshore Energy | Concept/Early Planning | 80.5 | 84.9 | 2028-2031 | 2032 | Construction phase interacts with the construction phase of the Proposed Development. |
| Buchan OWF | Offshore Energy | Concept/Early Planning | 77 | 71.6 | 2028-2030 | 2031 | Construction phase interacts with the construction phase of |

| Plan/Project | Summary | Status | Distance From the Aspen Array Area (km) | Distance From OTC Corridor (km) | Construction Dates (if relevant) | Operational by (if Relevant) | Summary of Interaction With Proposed Development |
|---|---|---|---|---|---|---|---|
| | | | | | | | the Proposed Development. |
| Campion OWF | Offshore Energy | Concept/Early Planning | 18.7 | 18.7 | 2026-2030 | 2031 | Construction phase interacts with the construction phase of the Proposed Development. |
| Cedar OWF | Offshore Energy | Concept/Early Planning | 73.81 | 76.91 | 2026-2027 | 2028 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Havbredey OWF | Offshore Energy | Concept/Early Planning | 272.5 | 309.9 | 2032-2035 | 2036 | Construction phase interacts with the O&M phase of the Proposed Development. |
| Machair OWF | Offshore Energy | Concept/Early Planning | 280.7 | 409.7 | 2027-2030 | 2031 | Construction phase interacts with the construction phase of the Proposed Development. |
| Malin Sea Wind OWF | Offshore Energy | Concept/Early Planning | 323.6 | 457.1 | 2025-2027 | 2028 | O&M phase interacts with the construction and O&M phases of the Proposed Development. |
| Morven OWF | Offshore Energy | Concept/Early Planning | 44.1 | 93.3 | 2027-2029 | 2030 | Construction phase interacts with the construction phase of |

| Plan/Project | Summary | Status | Distance From the Aspen Array Area (km) | Distance From OTC Corridor (km) | Construction Dates (if relevant) | Operational by (if Relevant) | Summary of Interaction With Proposed Development |
|---|---|---|---|---|---|---|---|
| | | | | | | | the Proposed Development. |
| Scaraben OWF | Offshore Energy | Concept/Early Planning | 81.8 | 83.3 | 2029-2030 | 2031 | Construction phase interacts with the construction phase of the Proposed Development. |
| Spiorad na Mara OWF | Offshore Energy | Concept/Early Planning | 308.3 | 370.7 | 2028-2031 | 3032 | Construction phase interacts with the construction phase of the Proposed Development. |
| Stromar OWF | Offshore Energy | Concept/Early Planning | 115 | 117.3 | 2026-2030 | 2031 | Construction phase interacts with the construction phase of the Proposed Development. |
| Talisk OWF | Offshore Energy | Concept/Early Planning | 312.8 | 360.4 | 2027-2029 | 2030 | Construction phase interacts with the construction phase of the Proposed Development. |

## Cumulative Population Modelling

11.8.16 Cumulative iPCoD modelling was also included in the CEA for the same species as modelled for the Proposed Development alone to compare the projected baseline population with the potential future impacted population taking the cumulative effects of disturbance from piling at multiple OWFs into consideration.

11.8.17 Further details are presented in **Volume 3, Appendix 11.2: iPCoD Modelling Report.**

## Screening Impacts

11.8.18 Certain impacts assessed solely for the Proposed Development are not factored into the marine mammal and basking shark CEA due to several factors:

- The impacts are highly localised in nature;
- Existing management and mitigation measures (embedded commitments) implemented at the Proposed Development and other projects will effectively diminish the likelihood of these impacts; and/or
- The potential significance of the impact from the Proposed Development alone has been evaluated as Negligible (due to Negligible or Low conclusion for magnitude of impact).

11.8.19 The impacts excluded from the marine mammal and basking sharks CEA for these reasons are:

- Auditory injury (PTS): Activities such as pile driving and UXO clearance may lead to PTS, but embedded commitments proposed will minimise injury risk to marine mammals and basking sharks to negligible levels, as mandated by EPS legislation. Other construction activities and geophysical surveys will have an extremely localised spatial extent and therefore represent a minimal risk of injury with the implementation of embedded commitments;
- Disturbance from underwater noise from UXO: It is expected that, where practicable, all projects will conduct low-order deflagration for their UXO campaigns as recommended by UK Government (2025) in the joint position statement and due to these techniques being 100% successful for other projects (Ocean Winds, 2024). In addition, it is expected that the UXO detonation would elicit a startle response and very short duration behavioural response that would not be expected to cause widespread and prolonged displacement (JNCC, 2020). As the significance of UXO clearance is negligible due to the duration of the impact being very short, it is considered unlikely that there will be potential for cumulative impacts;
- Disturbance from underwater noise from other construction activities: When considering noise from other (non-piling) construction activities, it is likely to be similar to the ambient noise levels, highly localised and the associated disturbance impact will be primarily dominated by underwater noise from vessels for non-piling works;
- Vessel collision risk: It is anticipated that all offshore energy projects will adopt a VMP or adhere to guidelines to further reduce the already minimal risk of vessel collisions with marine mammals and basking sharks;

- Vessel disturbance: Similar to collision risk, it is expected that all offshore energy projects will implement a VMP or adhere to best practice recommendations to mitigate the potential of disturbance to marine mammals and basking sharks;
- Changes to prey: Changes in prey availability are expected to be highly localised across all projects;
- Collision risk with floating foundations: The Project alone assessment has assessed the magnitude of this impact as Negligible or Low due to it being highly unlikely and highly localised across floating offshore projects;
- Habitat loss/change: Habitat loss/change is considered to be temporary, take place only during construction and have a highly localised effect to the floating offshore projects;
- Physical barrier effects: This impact is expected to be highly localised across floating projects;

11.8.20 The impacts considered in the marine mammal and basking sharks CEA are:

- Disturbance from underwater noise from piling (Construction);
- Disturbance from underwater noise from geophysical surveys (Construction);
- Entanglement risk with mooring lines and cables (O&M);
- Noise related impacts associated with floating foundations (O&M); and
- EMF impacts on other megafauna (O&M).

## Worst-case Design Scenario Cumulative Effects Assessment

11.8.21 The marine mammal and other megafauna CEA has been undertaken with respect to the details provided in **Volume 1, Chapter 3: Project Description**. A 'worst-case' design scenario has been selected for each cumulative effect which would lead to the greatest impact for all receptors or receptor groups, when selected from a range of values. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within **Volume 1, Chapter 3: Project Description** (e.g., different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

11.8.22 Table 11.65 presents the worst-case design scenario for each cumulative impact associated with the marine mammal CEA, along with justification.

Table 11.65 Worst-case Design Scenarios With Respect to the Marine Mammal CEA

| Cumulative Impact | Worst-case Design Scenario |
|---|---|
| Construction | |
| Disturbance from underwater noise from piling and geophysical surveys. | Outcome of the CEA will be highest when the greatest number of projects are undertaking activities that generate underwater noise concurrently. |
| O&M | |
| Entanglement risk with mooring lines and cables | Outcome of the CEA will be highest when the greatest number of projects with mooring lines and cables for floating turbines are operational concurrently. |
| Noise related impacts associated with floating foundations | Outcome of the CEA will be highest when the greatest number of projects with floating turbines are operational concurrently. |
| EMF impacts on other megafauna | Outcome of the CEA will be highest when the greatest number of projects with floating turbines are operational concurrently. |

## Cumulative Effect Assessment Methodology for Disturbance to Marine Mammals From Underwater Noise

11.8.23 For the Proposed Development, an indicative number of animals disturbed per day has been taken as the maximum number calculated within the alone assessments.

11.8.24 For all other offshore projects, species-specific densities within the corresponding SCANS-IV (Gilles *et al*., 2023) survey blocks, or SCANS-III (Hammond *et al.,* 2021) when SCANS-IV block densities were not available, for each cetacean species have been used for calculation of the maximum indicative number of animals disturbed per day. The only exception is the bottlenose dolphin assessment for the CES MU, which used densities based on Cheney *et al*. (2024) and SCANS-III (Hammond *et al.,* 2021). While for seal species, the indicative numbers of seals disturbed per day have been calculated from at-sea densities derived from Carter *et al*. (2022).

11.8.25 Project-specific impact ranges of underwater noise disturbance have been defined using the maximum number of animals predicted to be disturbed per day for projects with a quantitative assessment or using a fixed EDR approach for projects without a publicly available quantitative assessment. In addition, if a project excluded a species from assessment in their EIAR, that species was not considered in this CEA for that project. It is important to note that this approach is highly precautionary given the high level of uncertainty and assumptions within this assessment, as described in further detail below.

11.8.26 The EDR threshold parameters used to assess the number of animals potentially disturbed from offshore projects are:

- A 26 km EDR for piling of all fixed OWF projects in UK waters based on guidance from JNCC (2020) for unabated pile driving of a monopile, and an impact area of 2,123.72 $km^2$;
- A 26 km EDR for UXO clearance based on the high order detonation of UXOs only (JNCC, 2020), and an impact area of 2,123.72 $km^2$;

- A 15 km EDR for piling of all floating OWF projects in UK waters based on guidance from JNCC (2020) for unabated pile driving of a pin piles, and an impact area of 706.9 $km^2$;
- A 12 km EDR for seismic surveys and an impact area of 1,759 km2 as per JNCC (2020) advice; and
- A 5 km EDR for subsea cabling based on guidance from JNCC (2020) (assuming that only geophysical surveys will be undertaken) and an impact area of 78.5 $km^2$.

11.8.27 In the absence of a recommended methodology to quantitatively assess the impact from seismic surveys, a highly precautionary approach has been taken. This has resulted in an unrealistic scenario because it assumes that seismic airguns would be continuously firing within the survey day, when they are required to be turned off at the end of each survey line when the vessel turns (turns can take 2-3 hours and several can occur in a single day). This is exemplified by a review of seismic surveys undertaken within UK waters during 2018, which showed that airguns only operated for 52% of the time during potential survey days (BEIS, 2020).

11.8.28 Seismic surveys have been considered as Tier 3 projects as the potential number of seismic surveys that could be undertaken is unknown. Based on the size of the Celtic and Greater North Seas MU and its location, it has been assumed that there could be four seismic surveys occurring on any given day in the North Sea (to account for concurrent surveys in the northern and southern North Sea in both UK waters and those of neighbouring North Sea nations) and one in the Irish Sea. Given the much smaller CES MU for bottlenose dolphin, it was assumed that no seismic surveys would take place in this CES MU for the purpose of the CEA.

11.8.29 Given that the MUs for seals are smaller than that for cetaceans, the CEA for both harbour and grey seals has incorporated only two seismic survey operations within their respective MUs at any one time. To estimate the number of harbour and grey seals predicted to be disturbed, the average densities across the respective SMUs were calculated.

11.8.30 To estimate the number of cetaceans predicted to be disturbed from seismic surveys, the average density across the seas in which they are assumed to occur was calculated using the abundance of the corresponding SCANS-IV survey blocks and is presented in Table 11.66, below.

Table 11.66 Summary of Parameters Used to Predict the Number of Cetaceans to be Disturbed From Seismic Surveys

| Receptor | Assumed Location of Seismic Survey | Abundance | Area ($km^2$) | Density ($animals/km^2$) |
|---|---|---|---|---|
| Harbour porpoise | North Sea | 346,601 | 680,487 | 0.51 |
| Bottlenose dolphin | Greater North Sea | 2,022 | 639,886 | 0.003 |
| Risso's dolphin | North Sea | 12,262 | 1,568,078 | 0.008 |
| Atlantic white-sided dolphin | North Sea | 18,128 | 1,568,078 | 0.012 |
| White-beaked dolphins | North Sea | 43,951 | 1,568,078 | 0.028 |
| Minke whale | North Sea | 20,118 | 1,568,078 | 0.014 |

## Assumptions and Precaution Within the Cumulative Effects Assessment

11.8.31 Certain assumptions need to be made when undertaking a CEA, particularly on such large spatial scales; consequently, significant levels of precaution/conservatism within this CEA will result in the estimated effects being unrealistic. The areas of precaution/conservatism in the assessment are:

- Assumption that floating offshore wind projects will involve piling given a lack of information on anchoring systems that will be used;
- Number of developments assumed to be active at one time is unrealistic given availability of construction vessels worldwide;
- Inclusion of lower tier developments (Tier 3) with a lack of publicly available information. By including projects that have either no consent, or no submitted information on construction activities relevant to the EDRs applied, the maximum case scenarios have to be assumed as per the fixed EDR approach, in the absence of project-specific information;
- Assumption that pile driving could happen at any time during the construction period as exact timings are unknown. This creates an assumption that noisy activities will occur over consecutive years where in reality for most projects, it will be a year for each, this results in disturbance levels far greater than would ever occur in reality;
- Assumption that there is no spatial overlap in impact footprints between individual activities when summing across concurrent activities. This is highly unrealistic considering the proximity of some of the offshore windfarm projects to each other;
- Assumption that all offshore windfarm projects will install monopiles as a worst-case scenario is highly precautionary. Project Design Envelope for most offshore windfarms also includes pin piles as a foundation option which have 15 km EDR instead of 26 km EDR as per JNCC (2020) guidance, and therefore would disturb fewer animals;

- The duration and timelines for other offshore projects are worst-case scenarios and the true period of piling activity will likely be shorter for each project;
- Assumption that the EDRs can be applied across all species. The EDRs were developed for harbour porpoise and there is no advice available for other marine mammal species. This is considered conservative because the species in this assessment typically show less of a disturbance response compared to harbour porpoise.
- EDRs are based on published ranges where the bulk of the effect had been detected. Therefore, they are not equivalent to 100% deterrence or disturbance ranges from the area, nor are they seen to represent the limit range at which effects have been detected. For example, pile driving at the first seven large-scale offshore windfarms in the German Bight (including monopiles and piling without noise abatement) found declines in porpoise out to only 17 km (Brandt *et al*., 2018). Furthermore, acoustic monitoring during piling at Gemini offshore windfarm in the Netherlands (7.5 m monopiles) showed that the avoidance distance of harbour porpoises was in the range of 10-20 km (Geelhoed *et al*., 2018). There is also evidence of impact ranges decreasing over the period of pile installation at offshore windfarm sites. For example, in the Moray Firth, Graham *et al*. (2019) reported a 50% probability of harbour porpoises to respond within 7.4 km from the location of the first pile driven, which decreased to 1.3 km from the location of the last pile driven. This suggests individuals may, to some degree, habituate to piling activities over time.
- In the absence of site-specific underwater noise modelling outputs for all the projects included in the cumulative assessment, using the 26 km EDR has been identified as the best approach. However, caution should be applied when making direct comparisons across projects where numbers of disturbed animals have been derived from underwater noise modelling, as compared to the EDR approach, as these are not directly comparable.

## Construction Cumulative Effects Assessment

### Impact 1: Disturbance From Underwater Noise From Piling and Geophysical Surveys

#### *Magnitude of Cumulative Impact*

##### Harbour Porpoise

##### Tier 1

11.8.32 The highest number of harbour porpoises predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2029 and 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.67). The maximum cumulative number of harbour porpoise predicted to be disturbed during the construction phase of the Proposed Development is 12,534 animals (3.62% of the MU population). The number of harbour porpoises predicted to be impacted by the Proposed Development represents 84.98% of this total.

11.8.33 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for harbour porpoise.

### Tier 1 and 2

11.8.34 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.35 The highest number of harbour porpoises predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2029 and 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.67). The maximum cumulative number of harbour porpoise predicted to be disturbed in 2029 and 2030 is estimated as 41,226 animals (11.89% of MU population). The number of harbour porpoises predicted to be impacted by the Proposed Development represents 25.84% of this total.

11.8.36 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for harbour porpoises.

### Tier 1, 2 and 3

11.8.37 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice.

11.8.38 The highest number of harbour porpoises predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2029, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.67). The maximum cumulative number of harbour porpoise predicted to be disturbed in 2029 is estimated as 46,867 animals (13.52% of MU population). The number of harbour porpoises predicted to be impacted by the Proposed Development represents 22.73% of this total.

11.8.39 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for harbour porpoises, which is highly precautionary as it is unlikely that all Tier 3 projects will progress to construction.

### iPCoD Modelling

11.8.40 iPCoD modelling was used to assess if the cumulative disturbance is expected to result in population level impacts (**Volume 3, Appendix 11.2: iPCoD Modelling Report**).

The cumulative iPCoD results for harbour porpoise show that the mean unimpacted population size of harbour porpoise in the NS MU reaches ~97.7% of the size of the un-impacted population mean at the end of the cumulative piling scenario (in 2038), and remains at this size on a stable trajectory, the same as the un-impacted population, over the 12 years after the end of the cumulative piling scenario (up to 2050).

### Conclusion

11.8.41 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. However, the iPCoD modelling shows that the harbour porpoise population trajectory will not be affected by the impact, and the size remains similar (~97.7%) to that of the un-impacted population. Therefore, the magnitude of impact is assessed as Low for harbour porpoises.

Table 11.67 Number of Harbour Porpoise Predicted to be Disturbed per day per Project[6]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | EIAR dose-response | | | | 10,652 | 10,652 | 10,652 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 735 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 47 | 47 | 47 | 47 | | | | | | | | | |
| Green Volt | 1 | EIAR dose-response | 451 | 451 | 451 | | | | | | | | | | |
| Inch Cape | 1 | EIAR dose-response | 302 | | | | | | | | | | | | |
| Orkney Caithness | 1 | Calculated (5 km EDR) | 23 | 23 | 23 | | | | | | | | | | |
| Pentland Floating | 1 | EIAR dose-response | 323 | | | | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 1,882 | 1,882 | 1,882 | 1,882 | | | | | |
| Berwick Bank | 2 | EIAR dose-response | 2,822 | 2,822 | 2,822 | 2,822 | 2,822 | 2,822 | 2,822 | 2,822 | - | | | | |
| Caledonia | 2 | EIAR dose-response | | | | 8,942 | 8,942 | 8,942 | | | | | | | |
| Cenos | 2 | EIAR dose-response | | | | | - | - | 9,529 | 9,529 | 9,529 | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 47 | 47 | | | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 15,579 | 15,579 | 15,579 | - | - | | | | |
| Ossian | 2 | EIAR dose-response | | | | | | | 8,309 | 8,309 | 8,309 | 8,309 | 8,309 | 8,309 | 8,309 |
| Salamander | 2 | EIAR dose-response | | | | 12,336 | - | - | | | | | | | |
| West of Orkney | 2 | EIAR dose-response | | | | 1,349 | 1,349 | 1,349 | - | | | | | | |
| Arven | 3 | Calculated (15 km EDR) | | | | | | 365 | 365 | 365 | 365 | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 199 | 199 | 199 | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 735 | 735 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 424 | 424 | 424 | 424 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 1,271 | 1,271 | 1,271 | 1,271 | | | | | |

[6] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broadshore | 3 | Calculated (15 km EDR) | | | | 199 | 199 | 199 | 199 | | | | | | |
| Buchan | 3 | Calculated (15 km EDR) | | | | 365 | 365 | 365 | | | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 424 | 424 | 424 | 424 | 424 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 424 | 424 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 1,271 | 1,271 | 1,271 | | | | | | | | |
| Scaraben | 3 | Calculated (15 km EDR) | | | | | 365 | 365 | | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 199 | 199 | 199 | 199 | 199 | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 |
| Seismic Survey 3 | 3 | Calculated (12 km EDR) | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 |
| Seismic Survey 4 | 3 | Calculated (12 km EDR) | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 | 231 |
| Total | 1 | # | 1,881 | 521 | 521 | 10,699 | 12,534 | 12,534 | 1,882 | 1,882 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 0.54 | 0.15 | 0.15 | 3.09 | 3.62 | 3.62 | 0.54 | 0.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 4,703 | 3,343 | 3,390 | 36,195 | 41,226 | 41,226 | 38,121 | 22,542 | 17,838 | 8,309 | 8,309 | 8,309 | 8,309 |
| | | % of MU | 1.36 | 0.96 | 0.98 | 10.44 | 11.89 | 11.89 | 11.00 | 6.50 | 5.15 | 2.40 | 2.40 | 2.40 | 2.40 |
| Total | 1,2,3 | # | 5,627 | 6,049 | 7,367 | 40,001 | 46,867 | 45,961 | 41,503 | 25,102 | 19,127 | 9,233 | 9,233 | 9,233 | 9,233 |
| | | % of MU | 1.62 | 1.75 | 2.13 | 11.54 | 13.52 | 13.26 | 11.97 | 7.24 | 5.52 | 2.66 | 2.66 | 2.66 | 2.66 |

Bottlenose Dolphin – CES MU

11.8.42 A key source of precaution in this assessment is that the harbour porpoise EDRs and dose-response curves have been used for bottlenose dolphins, as there is no equivalent for this species. Harbour porpoise have a higher hearing sensitivity than bottlenose dolphins (Southall *et al*., 2019) and are considered to be particularly responsive to anthropogenic disturbance, with multiple studies showing that porpoises respond (e.g. show avoidance and reduced vocalisation) to a variety of anthropogenic noise sources over the range of multiple kilometres (e.g. Brandt *et al*., 2013; Thompson *et al*., 2013; Tougaard *et al*., 2013; Brandt *et al*., 2018; Sarnocinska *et al*., 2020; Thompson *et al*., 2020; Benhemma-Le Gall *et al*., 2021; Benhemma-Le Gall *et al*., 2023).

11.8.43 Studies have shown that dolphin species show comparatively less of a disturbance response from underwater noise compared to harbour porpoise (e.g. Kastelein *et al*., 2006; Stone *et al*., 2017). For example, bottlenose dolphins in the Moray Firth have been shown to remain in the area of elevated noise during both seismic activities and pile installation activities (Fernandez-Betelu *et al*., 2021), which demonstrates a reduced behavioural response (i.e. displacement) compared to harbour porpoise. Considering the above, it can be concluded that using EDRs and dose-response curves derived from studies on harbour porpoise as a proxy for bottlenose dolphins is likely to result in an over-estimate of the number of bottlenose dolphins predicted to experience disturbance.

11.8.44 Furthermore, due to the lack of a SCANS-IV block density for this species, the SCANS-III block density was used which is likely an overestimate of the number of dolphins potentially disturbed by the Proposed Development.

Tier 1

11.8.45 The highest number of bottlenose dolphins within the CES MU predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2025, which does not coincide with the expected pile driving campaign or construction phase of the Proposed Development (Table 11.68). The maximum cumulative number of bottlenose dolphins predicted to be disturbed during the construction phase of the Proposed Development is 9 animals (3.98% of the MU population) in 2028, 2029 and 2030. The number of bottlenose dolphin predicted to be impacted by the Proposed Development represents 55.56% of this total.

11.8.46 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for bottlenose dolphins.

Tier 1 and 2

11.8.47 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.48 The highest number of bottlenose dolphins within the CES MU predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2028, which coincides with the expected pile driving campaign or construction phase of the Proposed Development (Table 11.68). The maximum cumulative number of bottlenose dolphins predicted to be disturbed during the construction phase of the Proposed Development is estimated as 63 animals (27.88% of MU population). The number of bottlenose dolphin predicted to be impacted by the Proposed Development represents 7.94% of this total.

11.8.49 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for bottlenose dolphins.

#### Tier 1, 2 and 3

11.8.50 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only.

11.8.51 The highest number of bottlenose dolphins within the CES MU predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.68). The maximum cumulative number of bottlenose dolphins predicted to be disturbed during the construction phase of the Proposed Development is estimated as 63 animals (27.88% of MU population). The number of bottlenose dolphin predicted to be impacted by the Proposed Development represents 7.94% of this total.

11.8.52 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for bottlenose dolphins, which is considered highly precautionary given the caveats in the assessment approach discussed above, and that it is unlikely that all Tier 3 projects will progress to construction.

#### iPCoD Modelling

11.8.53 iPCoD modelling was used to assess if the cumulative disturbance is expected to result in population level impacts (**Volume 3, Appendix 11.2: iPCoD Modelling Report**).

11.8.54 The cumulative iPCoD results for bottlenose dolphin show that the mean impacted population size of bottlenose dolphins in the CES MU drops to ~91.2% of the size of the unimpacted population mean at the end of the cumulative piling scenario (in 2032, four years after the start of Project piling). After the end of the cumulative piling scenario, the impacted population is predicted to increase to ~93% of the un-impacted population size (by 2038, 6 years after the end of cumulative piling scenario), at which it remains stable up over the remainder of the modelling period (up to 2048). Note that both the un-impacted and impacted population size remains on an increasing population trajectory throughout the modelling period.

11.8.55 It is worth noting that iPCoD modelling assumes that individuals disturbed will not forage for 24h which is unrealistic considering the comparatively reduced behavioural responses by bottlenose dolphin to piling. Therefore, the results from the iPCoD model are likely over precautionary and will over-estimate the true level of disturbance from the Proposed Development cumulatively with other plans and projects.

#### Conclusion

11.8.56 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. Although iPCoD modelling shows that the population size is reduced when compared to the un-impacted population, the trajectory remains increasing, the same as the un-impacted population. Furthermore, the caveats discussed in paragraphs 11.8.42 and 11.8.55 introduce a significant level of precaution in the results. Therefore, the magnitude of impact is assessed as Medium for bottlenose dolphin in the CES MU.

Table 11.68 Number of Bottlenose Dolphin in the CES MU Predicted to be Disturbed per day per Project[7]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | EIAR Dose-response | | | | 5 | 5 | 5 | - | | | | | | |
| Inch Cape | 1 | EIAR dose-response | 8 | | | | | | | | | | | | |
| Pentland Floating | 1 | EIAR dose-response | 6 | | | | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 4 | 4 | 4 | 4 | | | | | |
| Orkney Caithness | 1 | Calculated (5 km EDR) | 7 | 7 | 7 | | | | | | | | | | |
| Eastern Green Link 2 | 1 | Calculated (5 km EDR) | 4 | 4 | 4 | 4 | | | | | | | | | |
| Berwick Bank | 2 | EIAR dose-response | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | - | | | | |
| Caledonia | 2 | EIAR dose-response) | | | | 24 | 24 | 24 | | | | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | 5 | 5 | | | | | | | | | | |
| Salamander | 2 | EIAR dose-response | | | | 25 | - | - | | | | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 3 | 3 | 3 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 1 | 1 | 1 | 1 | | | | | |
| Total | 1 | # | 25 | 11 | 11 | 9 | 9 | 9 | 4 | 4 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 11.06 | 4.87 | 4.87 | 3.98 | 3.98 | 3.98 | 1.77 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 30 | 21 | 21 | 63 | 38 | 38 | 9 | 9 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 13.27 | 9.29 | 9.29 | 27.88 | 16.81 | 16.81 | 3.98 | 3.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2,3 | # | 30 | 21 | 21 | 63 | 42 | 42 | 13 | 10 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 13.27 | 9.29 | 9.29 | 27.88 | 18.58 | 18.58 | 5.75 | 4.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

[7] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

Bottlenose Dolphin – GNS MU

11.8.57 Note that the precautions in the cumulative assessment of bottlenose dolphin in the CES MU, outlined in paragraphs 11.8.42, 11.8.43 and 11.8.44, are also applicable to this assessment.

Tier 1

11.8.58 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2028 (43 animals, 2.13% of the MU population), which coincides with the expected pile driving campaign of the Proposed Development (Table 11.69). The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 93.02% of this total.

11.8.59 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for bottlenose dolphins.

Tier 1 and 2

11.8.60 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.61 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2031 (455 animals, 22.50% of the MU population), which coincides with the construction phase of the Proposed Development, though not the expected pile driving campaign (Table 11.69). The maximum cumulative number of bottlenose dolphins predicted to be disturbed during the pile driving campaign of the Proposed Development is estimated as 261 animals (22.50% of MU population) in 2029 and 2030. The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 15.33% of this total.

11.8.62 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for bottlenose dolphins.

Tier 1, 2 and 3

11.8.63 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice.

11.8.64 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2031 (553 animals, 27.35% of the MU population), which coincides with the construction phase of the Proposed Development, though not the expected pile driving campaign (Table 11.69). The maximum cumulative number of bottlenose dolphins predicted to be disturbed during the pile driving campaign of the Proposed Development is estimated as 447 animals (22.11% of MU population). The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 8.95% of this total.

11.8.65 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for bottlenose dolphins, which is considered highly precautionary given the caveats in the assessment approach discussed above, and that it is unlikely that all Tier 3 projects will progress to construction.

### iPCoD Modelling

11.8.66 iPCoD modelling was used to assess if the cumulative disturbance is expected to result in population level impacts (**Volume 3, Appendix 11.2: iPCoD Modelling Report**).

11.8.67 The cumulative iPCoD results for bottlenose dolphins show that the mean unimpacted population size of bottlenose dolphins in the GNS MU drops to ~94.2% of the size of the unimpacted population at the end of the cumulative piling scenario (in 2038). After the end of the cumulative piling scenario, the impacted population is predicted to continue at a stable trajectory at ~94% of the size of the un-impacted population, for the duration of the modelling scenario (up to 2050).

11.8.68 It is worth noting that iPCoD modelling assumes that individuals disturbed will not forage for 24h which is unrealistic considering the comparatively reduced behavioural responses by bottlenose dolphin to piling. Therefore, the results from the iPCoD model are likely over precautionary and will over-estimate the true level of disturbance from the Proposed Development cumulatively with other plans and projects.

### Conclusion

11.8.69 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. Although iPCoD modelling shows that the population size is impacted when compared to the un-impacted population, the trajectory remains stable after the end of the cumulative piling scenario. Furthermore, the caveats discussed in paragraphs 11.8.42, 11.8.43 and 11.8.55 introduce a significant level of precaution in the results. Therefore, the magnitude of impact is assessed as Medium for bottlenose dolphin in the GNS MU.

Table 11.69 Number of Bottlenose Dolphin in the GNS MU Predicted to be Disturbed per day per Project[8]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | EIAR dose-response | | | | 40 | 40 | 40 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 0 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 3 | 3 | 3 | 3 | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 2 | 2 | 2 | 2 | | | | | |
| Berwick Bank | 2 | EIAR dose-response | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | - | | | | |
| Caledonia | 2 | EIAR dose-response | | | | 39 | 39 | 39 | | | | | | | |
| Cenos | 2 | EIAR dose-response | | | | | - | - | 273 | 273 | 273 | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 2 | 2 | | | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 78 | 78 | 78 | - | - | | | | |
| Salamander | 2 | EIAR dose-response | | | | 59 | - | - | | | | | | | |
| Arven | 3 | Calculated (15 km EDR) | | | | | | 0 | 0 | 0 | 0 | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 2 | 2 | 2 | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 0 | 0 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 22 | 22 | 22 | 22 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 64 | 64 | 64 | 64 | | | | | |
| Broadshore | 3 | Calculated (15 km EDR) | | | | 2 | 2 | 2 | 2 | | | | | | |
| Buchan | 3 | Calculated (15 km EDR) | | | | 0 | 0 | 0 | | | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 22 | 22 | 22 | 22 | 22 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 22 | 22 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 64 | 64 | 64 | | | | | | | | |
| Scaraben | 3 | Calculated (15 km EDR) | | | | | 0 | 0 | | | | | | | |

[8] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Seismic Survey 3 | 3 | Calculated (12 km EDR) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Seismic Survey 4 | 3 | Calculated (12 km EDR) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Stromar | 3 | Calculated (15 km EDR) | | 2 | 2 | 2 | 2 | 2 | | | | | | | |
| Total | 1 | # | 3 | 3 | 3 | 43 | 42 | 42 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 0.15 | 0.15 | 0.15 | 2.13 | 2.08 | 2.08 | 0.10 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 105 | 105 | 107 | 245 | 261 | 261 | 455 | 377 | 273 | 0 | 0 | 0 | 0 |
| | | % of MU | 5.19 | 5.19 | 5.29 | 12.12 | 12.91 | 12.91 | 22.50 | 18.64 | 13.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2,3 | # | 113 | 159 | 225 | 365 | 447 | 383 | 553 | 449 | 281 | 8 | 8 | 8 | 8 |
| | | % of MU | 5.59 | 7.86 | 11.13 | 18.05 | 22.11 | 18.94 | 27.35 | 22.21 | 13.90 | 0.40 | 0.40 | 0.40 | 0.40 |

#### Risso's Dolphin

11.8.70 A key source of precaution in this assessment is that the harbour porpoise EDRs and dose-response curves have been used for Risso's dolphins, as there is no equivalent for this species. Harbour porpoise have a higher hearing sensitivity than Risso's dolphins (Southall *et al.*, 2019) and are considered to be particularly responsive to anthropogenic disturbance, with multiple studies showing that porpoises respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g. Brandt *et al.*, 2013; Thompson *et al.*, 2013; Tougaard *et al.*, 2013; Brandt *et al.*, 2018; Sarnocinska *et al.*, 2020; Thompson *et al.*, 2020; Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023).

11.8.71 Studies have shown that dolphin species show comparatively less of a disturbance response from underwater noise compared to harbour porpoise (e.g. Kastelein *et al.*, 2006; Stone *et al.*, 2017). Considering the above, it can be concluded that using EDRs and dose-response curves derived from studies on harbour porpoise as a proxy for Risso's dolphins is likely to result in an over-estimate of the number of Risso's dolphins predicted to experience disturbance.

##### Tier 1

11.8.72 The highest number of Risso's dolphins predicted to be disturbed across Tier 1 projects between 2025 and 2032 is from 2028 to 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.70). The maximum cumulative number of Risso's dolphins predicted to be disturbed during the construction phase of the Proposed Development is 1,250 animals (10.19% of the MU population) and reflects the disturbance by the Proposed Development alone as no other Tier 1 projects are predicted to act cumulatively during this time period.

11.8.73 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. As a result, the magnitude of impact is assessed as Medium for Risso's dolphins.

##### Tier 1 and 2

11.8.74 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.75 The highest number of Risso's dolphins predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2029 and 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.70). The maximum cumulative number of Risso's dolphins predicted to be disturbed in 2029 and 2030 is estimated as 1,827 animals (14.90% of MU population) in each year. The number of Risso's dolphins predicted to be impacted by the Proposed Development represents 68.42% of this total.

11.8.76 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for Risso's dolphins.

#### Tier 1, 2 and 3

11.8.77 The assessment of Tier 3 projects is very uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice.

11.8.78 The highest number of Risso's dolphins predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.70). The maximum cumulative number of Risso's dolphins predicted to be disturbed in 2030 is estimated as 2,090 animals (17.04% of MU population). The number of Risso's dolphins predicted to be impacted by the Proposed Development represents 59.81% of this total.

11.8.79 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. The magnitude of impact is assessed as Medium for Risso's dolphins, which is considered highly precautionary given the caveats in the assessment approach discussed above, and that it is unlikely that all Tier 3 projects will progress to construction.

Table 11.70 Number of Risso's Dolphin Predicted to be Disturbed per day per Project[9]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | Dose-response | | | | 1,250 | 1,250 | 1,250 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 0 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 0 | 0 | 0 | 0 | | | | | | | | | |
| Orkney Caithness | 1 | Calculated (5 km EDR) | 3 | 3 | 3 | | | | | | | | | | |
| Pentland Floating | 1 | EIAR dose-response | 57 | | | | | | | | | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 0 | 0 | | | | | | | | | |
| Caledonia | 2 | EIAR dose-response | | | | 1 | 1 | 1 | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 455 | 455 | 455 | - | - | | | | |
| West of Orkney | 2 | EIAR dose-response | | | | 121 | 121 | 121 | - | | | | | | |
| Arven | 3 | Calculated (15 km EDR) | | | | | | 50 | 50 | 50 | 50 | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 27 | 27 | 27 | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 0 | 0 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 0 | 0 | 0 | 0 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 0 | 0 | 0 | 0 | | | | | |
| Broadshore | 3 | Calculated (15 km EDR) | | | | 27 | 27 | 27 | 27 | | | | | | |
| Buchan | 3 | Calculated (15 km EDR) | | | | 50 | 50 | 50 | | | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 0 | 0 | 0 | 0 | 0 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 0 | 0 | | | | | | | | | | |
| Havbredey | 3 | Calculated (15 km EDR) | | | | | | | | 21 | 21 | 21 | 21 | | |
| Machair | 3 | Calculated (26 km EDR) | | | 6 | 6 | 6 | 6 | | | | | | | |
| Malin Sea Wind | 3 | Calculated (15 km EDR) | 2 | 2 | 2 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 0 | 0 | 0 | | | | | | | | |

[9] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scaraben | 3 | Calculated (15 km EDR) | | | | | 50 | 50 | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Seismic Survey 3 | 3 | Calculated (12 km EDR) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Seismic Survey 4 | 3 | Calculated (12 km EDR) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Seismic Survey 5 | 3 | Calculated (12 km EDR) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Spiorad na Mara | 3 | Calculated (26 km EDR) | | | | 0 | 0 | 0 | 0 | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 27 | 27 | 27 | 27 | 27 | | | | | | | |
| Talisk | 3 | Calculated (15 km EDR) | | | 21 | 21 | 21 | | | | | | | | |
| Total | 1 | # | 60 | 3 | 3 | 1,250 | 1,250 | 1,250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 0.49 | 0.02 | 0.02 | 10.19 | 10.19 | 10.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 60 | 3 | 3 | 1,372 | 1,827 | 1,827 | 455 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 0.49 | 0.02 | 0.02 | 11.19 | 14.90 | 14.90 | 3.71 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2,3 | # | 88 | 58 | 85 | 1,529 | 2,061 | 2,090 | 585 | 97 | 97 | 47 | 47 | 26 | 26 |
| | | % of MU | 0.72 | 0.47 | 0.69 | 12.47 | 16.81 | 17.04 | 4.77 | 0.79 | 0.79 | 0.38 | 0.38 | 0.21 | 0.21 |

#### Atlantic White-sided Dolphin

11.8.80 A key source of precaution in this assessment is that the harbour porpoise EDRs and dose-response curves have been used for Atlantic white-sided dolphins, as there is no equivalent for this species. Harbour porpoise have a higher hearing sensitivity than Atlantic white-sided dolphins (Southall *et al.*, 2019) and are considered to be particularly responsive to anthropogenic disturbance, with multiple studies showing that porpoises respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g. Brandt *et al.*, 2013; Thompson *et al.*, 2013; Tougaard *et al.*, 2013; Brandt *et al.*, 2018; Sarnocinska *et al.*, 2020; Thompson *et al.*, 2020; Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023).

11.8.81 Studies have shown that dolphin species show comparatively less of a disturbance response from underwater noise compared to harbour porpoise (e.g. Kastelein *et al.*, 2006; Stone *et al.*, 2017). Considering the above, it can be concluded that using EDRs and dose-response curves derived from studies on harbour porpoise as a proxy for Atlantic white-sided dolphins is likely to result in an over-estimate of the number of Atlantic white-sided dolphins predicted to experience disturbance.

##### Tier 1

11.8.82 The highest number of Atlantic white-sided dolphins predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.71). The maximum cumulative number of Atlantic white-sided dolphins predicted to be disturbed during the construction phase of the Proposed Development is 179 animals (0.99% of the MU population). The number of Atlantic white-sided dolphins predicted to be impacted by the Proposed Development represents 99.44% of this total.

11.8.83 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for Atlantic white-sided dolphins.

##### Tier 1 and 2

11.8.84 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.85 The highest number of Atlantic white-sided dolphins predicted to be disturbed across Tier 1 and 2 projects is in 2028, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.71). The maximum cumulative number of Atlantic white-sided dolphins predicted to be disturbed during the construction phase of the Proposed Development is estimated as 180 animals (0.99% of MU population). The number of Atlantic white-sided dolphins predicted to be impacted by the Proposed Development represents 98.89% of this total.

11.8.86 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for Atlantic white-sided dolphins.

#### Tier 1, 2 and 3

11.8.87 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice.

11.8.88 The highest number of Atlantic white-sided dolphins predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2037 is in 2029, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.71). The maximum cumulative number of Atlantic white-sided dolphins predicted to be disturbed during the construction phase of the Proposed Development is estimated as 238 animals (1.31% of MU population). The number of Atlantic white-sided dolphins predicted to be impacted by the Proposed Development represents 74.79% of this total.

11.8.89 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for Atlantic white-sided dolphins, which is considered precautionary given the caveats in the assessment approach discussed above, and that it is unlikely that all Tier 3 projects will progress to construction.

Table 11.71 Number of Atlantic White-sided Dolphin Predicted to be Disturbed per day per Project[10]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | EIAR dose-response | | | | 178 | 178 | 178 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 0 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 1 | 1 | 1 | 1 | | | | | | | | | |
| Orkney Caithness | 1 | Calculated (5 km EDR) | 0 | 0 | 0 | | | | | | | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 1 | 1 | | | | | | | | | |
| Arven | 3 | Calculated (15 km EDR) | | | | | | 11 | 11 | 11 | 11 | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 0 | 0 | 0 | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 0 | 0 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 3 | 3 | 3 | 3 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 8 | 8 | 8 | 8 | | | | | |
| Broadshore | 3 | Calculated (15 km EDR) | | | | 0 | 0 | 0 | 0 | | | | | | |
| Buchan | 3 | Calculated (15 km EDR) | | | | 11 | 11 | 11 | | | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 3 | 3 | 3 | 3 | 3 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 3 | 3 | | | | | | | | | | |
| Havbredey | 3 | Calculated (15 km EDR) | | | | | | | | 17 | 17 | 17 | 17 | | |
| Machair | 3 | Calculated (26 km EDR) | | | 0 | 0 | 0 | 0 | | | | | | | |
| Malin Sea Wind | 3 | Calculated (15 km EDR) | 0 | 0 | 0 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 0 | 0 | 0 | | | | | | | | |
| Scaraben | 3 | Calculated (15 km EDR) | | | | | 11 | 11 | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Seismic Survey 3 | 3 | Calculated (12 km EDR) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

[10] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seismic Survey 4 | 3 | Calculated (12 km EDR) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Seismic Survey 5 | 3 | Calculated (12 km EDR) | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Spiorad na Mara | 3 | Calculated (26 km EDR) | | | | 0 | 0 | 0 | 0 | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 0 | 0 | 0 | 0 | 0 | | | | | | | |
| Talisk | 3 | Calculated (15 km EDR) | | | 17 | 17 | 17 | | | | | | | | |
| Total | 1 | # | 1 | 1 | 1 | 179 | 178 | 178 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 0.01 | 0.01 | 0.01 | 0.99 | 0.98 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 1 | 1 | 2 | 180 | 178 | 178 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 0.01 | 0.01 | 0.01 | 0.99 | 0.98 | 0.98 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 |
| Total | 1,2,3 | # | 8 | 14 | 32 | 221 | 238 | 232 | 29 | 43 | 35 | 24 | 24 | 7 | 7 |
| | | % of MU | 0.04 | 0.08 | 0.18 | 1.22 | 1.31 | 1.28 | 0.16 | 0.24 | 0.19 | 0.13 | 0.13 | 0.04 | 0.04 |

### White-beaked Dolphin

11.8.90 A key source of precaution in this assessment is that the harbour porpoise EDRs and dose-response curves have been used for white-beaked dolphins, as there is no equivalent for this species. Harbour porpoise have a higher hearing sensitivity than white-beaked dolphins (Southall *et al.*, 2019) and are considered to be particularly responsive to anthropogenic disturbance, with multiple studies showing that porpoises respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g. Brandt *et al.*, 2013; Thompson *et al.*, 2013; Tougaard *et al.*, 2013; Brandt *et al.*, 2018; Sarnocinska *et al.*, 2020; Thompson *et al.*, 2020; Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023).

11.8.91 Studies have shown that dolphin species show comparatively less of a disturbance response from underwater noise compared to harbour porpoise (e.g. Kastelein *et al.*, 2006; Stone *et al.*, 2017). Considering the above, it can be concluded that using EDRs and dose-response curves derived from studies on harbour porpoise as a proxy for white-beaked dolphins is likely to result in an over-estimate of the number of white-beaked dolphins predicted to experience disturbance.

#### Tier 1

11.8.92 The highest number of white-beaked dolphins predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2029 and 2030 , which coincides with the expected pile driving campaign of the Proposed Development (Table 11.72). The maximum cumulative number of white-beaked dolphins predicted to be disturbed during the construction phase of this Proposed Development is 4,408 animals (10.03% of the MU population). The number of white-beaked dolphins predicted to be impacted by the Proposed Development represents 82.67% of this total.

11.8.93 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for white-beaked dolphins.

#### Tier 1 and 2

11.8.94 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.95 The highest number of white-beaked dolphins predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2029 and 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.72). The maximum cumulative number of bottlenose dolphins predicted to be disturbed during the expected pile driving campaign of the Proposed Development is estimated as 17,045 animals (38.78% of MU population). The number of white-beaked dolphins predicted to be impacted by the Proposed Development represents 21.38% of this total.

11.8.96 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could affect vital rates to the extent that there is a change to the population trajectory or viability. Therefore, the magnitude of impact is assessed as High for white-beaked dolphins.

### Tier 1, 2 and 3

11.8.97 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice.

11.8.98 The highest number of white-beaked dolphins predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2029, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.72). The maximum cumulative number of white-beaked dolphins predicted to be disturbed during the expected pile driving campaign of the Proposed Development is estimated as 18,305 animals (41.65% of MU population). The number of white-beaked dolphins predicted to be impacted by the Proposed Development represents 19.91% of this total.

11.8.99 The predicted extent of the cumulative disturbance is to a moderate proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could affect vital rates to the extent that there is a change to the population trajectory or viability. Therefore, magnitude of impact is assessed as High for white-beaked dolphins, which is considered highly precautionary given the caveats in the assessment approach discussed above, and that it is unlikely that all Tier 3 projects will progress to construction.

Table 11.72 Number of White-beaked Dolphin Predicted to be Disturbed per day per Project[11]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | Dose-response | | | | 3,644 | 3,644 | 3,644 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 75 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 7 | 7 | 7 | 7 | | | | | | | | | |
| Inch Cape | 1 | EIAR dose-response | 48 | | | | | | | | | | | | |
| Orkney Caithness | 1 | Calculated (5 km EDR) | 11 | 11 | 11 | | | | | | | | | | |
| Pentland Floating | 1 | EIAR dose-response | 337 | | | | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 764 | 764 | 764 | 764 | | | | | |
| Berwick Bank | 2 | EIAR dose-response | 830 | 830 | 830 | 830 | 830 | 830 | 830 | 830 | - | | | | |
| Caledonia | 2 | EIAR dose-response | | | | 3,114 | 3,114 | 3,114 | | | | | | | |
| Cenos | 2 | EIAR dose-response | | | | | - | - | 963 | 963 | 963 | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 7 | 7 | | | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 6,984 | 6,984 | 6,984 | - | - | | | | |
| Ossian | 2 | EIAR dose-response | | | | | | | 1,531 | 1,531 | 1,531 | 1,531 | 1,531 | 1,531 | 1,531 |
| Salamander | 2 | EIAR dose-response | | | | 5,697 | - | - | | | | | | | |
| West of Orkney | 2 | EIAR dose-response | | | | 1,709 | 1,709 | 1,709 | - | | | | | | |
| Arven | 3 | Calculated (15 km EDR) | | | | | | 126 | 126 | 126 | 126 | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 96 | 96 | 96 | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 75 | 75 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 57 | 57 | 57 | 57 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 170 | 170 | 170 | 170 | | | | | |
| Broadshore | 3 | Calculated (15 km EDR) | | | | 96 | 96 | 96 | 96 | | | | | | |

[11] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buchan | 3 | Calculated (15 km EDR) | | | | 126 | 126 | 126 | | | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 57 | 57 | 57 | 57 | 57 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 57 | 57 | | | | | | | | | | |
| Havbredey | 3 | Calculated (15 km EDR) | | | | | | | | 182 | 182 | 182 | 182 | | |
| Machair | 3 | Calculated (26 km EDR) | | | 0 | 0 | 0 | 0 | | | | | | | |
| Malin Sea Wind | 3 | Calculated (15 km EDR) | 0 | 0 | 0 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 170 | 170 | 170 | | | | | | | | |
| Scaraben | 3 | Calculated (15 km EDR) | | | | | 126 | 126 | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Seismic Survey 3 | 3 | Calculated (12 km EDR) | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Seismic Survey 4 | 3 | Calculated (12 km EDR) | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Seismic Survey 5 | 3 | Calculated (12 km EDR) | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| Spiorad na Mara | 3 | Calculated (26 km EDR) | | | | 0 | 0 | 0 | 0 | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 96 | 96 | 96 | 96 | 96 | | | | | | | |
| Talisk | 3 | Calculated (15 km EDR) | | | 182 | 182 | 182 | | | | | | | | |
| Total | 1 | # | 478 | 18 | 18 | 3,651 | 4,408 | 4,408 | 764 | 764 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 1.09 | 0.04 | 0.04 | 8.31 | 10.03 | 10.03 | 1.74 | 1.74 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 1,308 | 848 | 855 | 15,008 | 17,045 | 17,045 | 11,072 | 4,088 | 2,494 | 1,531 | 1,531 | 1,531 | 1,531 |
| | | % of MU | 2.98 | 1.93 | 1.95 | 34.15 | 38.78 | 38.78 | 25.19 | 9.30 | 5.67 | 3.48 | 3.48 | 3.48 | 3.48 |
| Total | 1,2,3 | # | 1,392 | 1,217 | 1,576 | 15,876 | 18,305 | 18,079 | 11,701 | 4,650 | 2,886 | 1,797 | 1,797 | 1,615 | 1,615 |
| | | % of MU | 3.17 | 2.77 | 3.59 | 36.12 | 41.65 | 41.13 | 26.62 | 10.58 | 6.57 | 4.09 | 4.09 | 3.67 | 3.67 |

### Minke Whale

11.8.100 A key source of precaution in this assessment is that the harbour porpoise EDRs and dose-response curves have been used for minke whales, as there is no equivalent for this species. Harbour porpoise have a higher hearing sensitivity than minke whales (Southall *et al.*, 2019) and are considered to be particularly responsive to anthropogenic disturbance, with multiple studies showing that porpoises respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g. Brandt *et al.*, 2013; Thompson *et al.*, 2013; Tougaard *et al.*, 2013; Brandt *et al.*, 2018; Sarnocinska *et al.*, 2020; Thompson *et al.*, 2020; Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023). Considering the above, it can be concluded that using EDRs and dose-response curves derived from studies on harbour porpoise as a proxy for minke whales is likely to result in an over-estimate of the number of minke whales predicted to experience disturbance.

#### Tier 1

11.8.101 The highest number of minke whales predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2029 and 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.73). The maximum cumulative number of minke whales predicted to be disturbed during the construction phase of this Proposed Development is 1,491 animals (7.41% of the MU population). The number of minke whales predicted to be impacted by the Proposed Development represents 91.75% of this total.

11.8.102 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for minke whales.

#### Tier 1 and 2

11.8.103 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.104 The highest number of minke whales predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.73). The maximum cumulative number of minke whales predicted to be disturbed during the expected pile driving campaign of the Proposed Development is estimated as 3,689 animals (18.34% of MU population). The number of minke whales predicted to be impacted by the Proposed Development represents 37.08% of this total.

11.8.105 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for minke whales.

#### Tier 1, 2 and 3

11.8.106 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice..

11.8.107 The highest number of minke whales predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.73). The maximum cumulative number of minke whales predicted to be disturbed in 2028 is estimated as 4,008 animals (19.92% of MU population). The number of minke whales predicted to be impacted by the Proposed Development represents 34.13% of this total.

11.8.108 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for minke whales, which is considered highly precautionary given the caveats in the assessment approach discussed above, and that it is unlikely that all Tier 3 projects will progress to construction.

#### iPCoD Modelling

11.8.109 iPCoD modelling was used to assess if the cumulative disturbance is expected to result in population level impacts (**Volume 3, Appendix 11.2: iPCoD Modelling Report**).

11.8.110 The cumulative iPCoD results for minke whales show that the mean unimpacted population size of minke whales in the CGNS MU remains at ~99.9% of the size of the un-impacted population, and is predicted to continue on the same trajectory as the un-impacted population.

#### Conclusion

11.8.111 The predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the distribution of the population. However, the iPCoD modelling shows that the minke whale population size or trajectory will not be affected by the impact. Therefore, the magnitude of impact is assessed as Low for minke whales.

Table 11.73 Number of Minke Whale Predicted to be Disturbed per day per Project[12]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspen | - | Dose-response | | | | 1,368 | 1,368 | 1,368 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 8 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 4 | 4 | 4 | 4 | | | | | | | | | |
| Inch Cape | 1 | EIAR dose-response | 158 | | | | | | | | | | | | |
| Orkney Caithness | 1 | Calculated (5 km EDR) | 4 | 4 | 4 | | | | | | | | | | |
| Pentland Floating | 1 | EIAR dose-response | 40 | | | | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 123 | 123 | 123 | 123 | | | | | |
| Berwick Bank | 2 | EIAR dose-response | 132 | 132 | 132 | 132 | 132 | 132 | 132 | 132 | - | | | | |
| Caledonia | 2 | EIAR dose-response | | | | 556 | 556 | 556 | | | | | | | |
| Cenos | 2 | EIAR dose-response | | | | | - | - | 384 | 384 | 384 | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 4 | 4 | | | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 777 | 777 | 777 | - | - | | | | |
| Ossian | 2 | EIAR dose-response | | | | | | | 362 | 362 | 362 | 362 | 362 | 362 | 362 |
| Salamander | 2 | EIAR dose-response | | | | 1,535 | - | - | | | | | | | |
| West of Orkney | 2 | EIAR dose-response | | | | 90 | 90 | 90 | - | | | | | | |
| Arven | 3 | Calculated (15 km EDR) | | | | | | 9 | 9 | 9 | 9 | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 9 | 9 | 9 | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 8 | 8 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 30 | 30 | 30 | 30 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 89 | 89 | 89 | 89 | | | | | |
| Broadshore | 3 | Calculated (15 km EDR) | | | | 9 | 9 | 9 | 9 | | | | | | |

[12] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buchan | 3 | Calculated (15 km EDR) | | | | 9 | 9 | 9 | | | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 30 | 30 | 30 | 30 | 30 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 30 | 30 | | | | | | | | | | |
| Havbredey | 3 | Calculated (15 km EDR) | | | | | | | | 16 | 16 | 16 | 16 | | |
| Machair | 3 | Calculated (26 km EDR) | | | 30 | 30 | 30 | 30 | | | | | | | |
| Malin Sea Wind | 3 | Calculated (15 km EDR) | 10 | 10 | 10 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 89 | 89 | 89 | | | | | | | | |
| Scaraben | 3 | Calculated (15 km EDR) | | | | | 9 | 9 | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Seismic Survey 3 | 3 | Calculated (12 km EDR) | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Seismic Survey 4 | 3 | Calculated (12 km EDR) | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Seismic Survey 5 | 3 | Calculated (12 km EDR) | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Spiorad na Mara | 3 | Calculated (26 km EDR) | | | | 63 | 63 | 63 | 63 | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 9 | 9 | 9 | 9 | 9 | | | | | | | |
| Talisk | 3 | Calculated (15 km EDR) | | | 16 | 16 | 16 | | | | | | | | |
| Total | 1 | # | 214 | 8 | 8 | 1,372 | 1,491 | 1,491 | 123 | 123 | 0 | 0 | 0 | 0 | 0 |
| | | % of MU | 1.06 | 0.04 | 0.04 | 6.82 | 7.41 | 7.41 | 0.61 | 0.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 346 | 140 | 144 | 3,689 | 3,046 | 3,046 | 1,778 | 1,001 | 746 | 362 | 362 | 362 | 362 |
| | | % of MU | 1.72 | 0.70 | 0.72 | 18.34 | 15.14 | 15.14 | 8.84 | 4.98 | 3.71 | 1.80 | 1.80 | 1.80 | 1.80 |
| Total | 1,2,3 | # | 390 | 261 | 400 | 4,008 | 3,472 | 3,376 | 2,021 | 1,149 | 805 | 412 | 412 | 396 | 396 |
| | | % of MU | 1.94 | 1.30 | 1.99 | 19.92 | 17.26 | 16.78 | 10.05 | 5.71 | 4.00 | 2.05 | 2.05 | 1.97 | 1.97 |

Harbour Seal

Tier 1

11.8.112 The highest number of harbour seals predicted to be disturbed across Tier 1 projects between 2025 and 2037 is in 2029 and 2030, which coincides with the expected construction phase of the Proposed Development (Table 11.74). The maximum cumulative number of harbour seals predicted to be disturbed during the construction phase of the Proposed Development is 52 animals (2.23% of the combined ES and NC&O SMU population). The number of harbour seals predicted to be impacted by the Proposed Development represents 1.92% of this total.

11.8.113 The predicted extent of the cumulative disturbance is to a small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in at-sea distribution that are predicted to be fully recoverable over the short term and will not affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for harbour seals.

Tier 1 and 2

11.8.114 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.115 The highest number of harbour seals predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2029 and 2030, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.74). The maximum cumulative number of harbour seals predicted to be disturbed during the expected pile driving campaign of the Proposed Development is estimated as 56 animals (2.40 % of combined SMU population). The number of harbour seals predicted to be impacted by the Proposed Development represents 1.79% of this total.

11.8.116 The predicted extent of the cumulative disturbance is to a small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in at-sea distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for harbour seals.

Tier 1, 2 and 3

11.8.117 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice..

11.8.118 The highest number of harbour seals predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2029, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.74). The maximum cumulative number of harbour seals predicted to be disturbed during the expected pile driving campaign of the Proposed Development is estimated as 208 animals (8.91% of combined SMU population). The number of harbour seals predicted to be impacted by the Proposed Development represents 0.48% of this total.

11.8.119 The predicted extent of the cumulative disturbance is to a small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in at-sea distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for harbour seals, which is considered precautionary given that it is unlikely that all Tier 3 projects will progress to construction.

#### iPCoD Modelling

11.8.120 iPCoD modelling was used to assess if the cumulative disturbance is expected to result in population level impacts (**Volume 3, Appendix 11.2: iPCoD Modelling Report**).

11.8.121 The cumulative iPCoD results for harbour seals show that the mean unimpacted population size of harbour seals in the ES SMU remains at 100% of the size of the un-impacted population and is predicted to continue on a stable trajectory, the same as the un-impacted population.

11.8.122 The results for the ES SMU are considered the worst-case given the very small overlap between the disturbance contours from the Proposed Development and the NC&O SMU, and the comparatively fewer plans and projects located within the NC&O SMU (Table 11.74).

#### Conclusion

11.8.123 The predicted extent of the cumulative disturbance is to a small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in at-sea distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population size or trajectory, as shown by iPCoD modelling. Therefore, the magnitude of impact is assessed as Low for harbour seals.

Table 11.74 Number of Harbour Seal Predicted to be Disturbed per day per Project[13]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ES SMU | | | | | | | | | | | | | | | |
| Aspen | - | Dose-response | | | | <1[14] | <1 | <1 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 5 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 1 | 1 | 1 | 1 | | | | | | | | | |
| Green Volt | 1 | EIAR dose-response | <1[14] | <1 | <1 | | | | | | | | | | |
| Inch Cape | 1 | EIAR dose-response | 20 | | | | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 51 | 51 | 51 | 51 | | | | | |
| Berwick Bank | 2 | EIAR dose-response | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 1 | 1 | | | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 1 | 1 | 1 | - | - | | | | |
| Salamander | 2 | Calculated (15 km EDR) | | | | 4 | - | - | | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 5 | 5 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 5 | 5 | 5 | 5 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 15 | 15 | 15 | 15 | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 5 | 5 | 5 | 5 | 5 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 5 | 5 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 15 | 15 | 15 | | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| NC&O SMU | | | | | | | | | | | | | | | |
| Broadshore | 3 | Calculated (15 km EDR) | | | | 26 | 26 | 26 | 26 | | | | | | |
| Buchan | 3 | Calculated (15 km EDR) | | | | 26 | 26 | 26 | | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 26 | 26 | 26 | 26 | 26 | | | | | | | |

[13] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.
[14] The number of harbour seals impacted is less than one, but has been treated as one for the purpose of this assessment, in line with the precautionary principle.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ayre | 3 | Calculated (15 km EDR) | | | | | 26 | 26 | 26 | | | | | | |
| Total | 1 | # | 27 | 2 | 2 | 2 | 52 | 52 | 51 | 51 | 0 | 0 | 0 | 0 | 0 |
| | | % of SMU | 1.16 | 0.09 | 0.09 | 0.09 | 2.23 | 2.23 | 2.19 | 2.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2 | # | 30 | 5 | 6 | 10 | 56 | 56 | 55 | 54 | 0 | 0 | 0 | 0 | 0 |
| | | % of SMU | 1.29 | 0.21 | 0.26 | 0.43 | 2.40 | 2.40 | 2.36 | 2.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1,2,3 | # | 38 | 54 | 70 | 121 | 208 | 193 | 135 | 77 | 8 | 8 | 8 | 8 | 8 |
| | | % of SMU | 1.63 | 2.31 | 3.00 | 5.18 | 8.91 | 8.27 | 5.78 | 3.30 | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 |

Grey Seal

Tier 1

11.8.124 The highest number of grey seals predicted to be disturbed across Tier 1 projects between 2025 and 2032 is in 2025 (1,327 grey seals, 3.27% of the combined ES and NC&O SMU population), which does not coincide with the expected pile driving campaign of the Proposed Development (Table 11.75). The maximum cumulative number of grey seals predicted to be disturbed during the construction phase of the Proposed Development is 512 animals, (1.26% of the combined SMU population) in 2029 and 2030. The number of grey seals predicted to be impacted by the Proposed Development represents 22.27% of this total.

11.8.125 The predicted extent of the cumulative disturbance is to a small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in at-sea distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for grey seals.

Tier 1 and 2

11.8.126 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are in the planning system. This means that full EIAs or scoping reports are available and there is reasonable confidence in the timelines of project construction.

11.8.127 The highest number of grey seals predicted to be disturbed across Tier 1 and 2 projects between 2025 and 2032 is in 2031 (3,554 grey seals, 8.76% of the combined SMU population), which does not coincide with the expected pile driving campaign of the Proposed Development (Table 11.75). The maximum cumulative number of grey seals predicted to be disturbed during the construction phase of the Proposed Development is estimated as 3,095 animals (7.63% of the combined SMU population), in 2029 and 2030. The number of grey seals predicted to be impacted by the Proposed Development represents 3.68% of this total.

11.8.128 The predicted extent of the cumulative disturbance is to a small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to small-scale changes in at-sea distribution that are predicted to be fully recoverable over the short term and unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low for grey seals.

Tier 1, 2 and 3

11.8.129 The assessment of Tier 3 projects is uncertain because these projects are not yet consented, therefore the assessment should be considered as indicative only and highly unlikely to occur in practice.

11.8.130 The highest number of grey seals predicted to be disturbed across Tier 1, 2 and 3 projects between 2025 and 2032 is in 2029, which coincides with the expected pile driving campaign of the Proposed Development (Table 11.75). The maximum cumulative number of grey seals predicted to be disturbed during the expected pile driving campaign of the Proposed Development is estimated as 5,657 animals (13.95% of combined SMU population). The number of grey seals predicted to be impacted by the Proposed Development represents 2.02% of this total.

11.8.131 The predicted extent of the cumulative disturbance is to a relatively small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the at-sea distribution of the population. The changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory or viability. Therefore, the magnitude of impact is assessed as Medium for grey seals, which is considered precautionary given that it is unlikely that all Tier 3 projects will progress to construction.

### iPCoD Modelling

11.8.132 iPCoD modelling was used to assess if the cumulative disturbance is expected to result in population level impacts (**Volume 3, Appendix 11.2: iPCoD Modelling Report**).

11.8.133 The iPCoD results for grey seals show that the mean unimpacted population size of grey seals in the ES SMU reaches ~99.8% of the size of the un-impacted population at the end of the cumulative piling scenario, where it remains until the end of the modelling scenario (up to 2050). The population is predicted to continue on an increasing trajectory, the same as the un-impacted population.

11.8.134 The results for the ES SMU are considered the worst-case given the very small overlap between the disturbance contours from the Proposed Development and the NC&O SMU, and the comparatively fewer plans and projects located within the NC&O SMU (Table 11.75).

### Conclusion

11.8.135 The predicted extent of the cumulative disturbance is to a relatively small proportion of the SMU population, though it will occur across multiple projects over several years. Behavioural changes are expected from each disturbance event that an individual is exposed to, which may lead to longer-term but temporary and recoverable changes in the at-sea distribution of the population. However, the iPCoD modelling shows that the grey seal population size or trajectory will not be affected by the impact. Therefore, the magnitude of impact is assessed as Low for grey seals.

Table 11.75 Number of Grey Seal Predicted to be Disturbed per day per Project[15]

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ES SMU | | | | | | | | | | | | | | | |
| Aspen | - | Dose-response | | | | 114 | 114 | 114 | - | | | | | | |
| Culzean | 1 | Calculated (15 km EDR) | 79 | | | | | | | | | | | | |
| Eastern Green Link 2 (EGL 2) | 1 | Calculated (5 km EDR) | 9 | 9 | 9 | 9 | | | | | | | | | |
| Green Volt | 1 | EIAR dose-response | 3 | 3 | 3 | | | | | | | | | | |
| Inch Cape | 1 | EIAR dose-response | 1,236 | | | | | | | | | | | | |
| Seagreen Phase 1A | 1 | EIAR dose-response | | | | | 398 | 398 | 398 | 398 | | | | | |
| Berwick Bank | 2 | EIAR dose-response) | 1,358 | 1,358 | 1,358 | 1,358 | 1,358 | 1,358 | 1,358 | 1,358 | - | | | | |
| Cenos | 2 | Calculated (15 km EDR) | | | | | - | - | 137 | 137 | 137 | | | | |
| Central North Sea Electrification Project | 2 | Calculated (5 km EDR) | | | 9 | 9 | | | | | | | | | |
| Muir Mhòr | 2 | EIAR dose-response | | | | | 1,225 | 1,225 | 1,225 | - | - | | | | |
| Ossian | 2 | EIAR dose-response | | | | | | | 436 | 436 | 436 | 436 | 436 | 436 | 436 |
| Salamander | 2 | EIAR dose-response | | | | 1,429 | - | - | | | | | | | |
| Beech | 3 | Calculated (15 km EDR) | | 79 | 79 | | | | | | | | | | |
| Bellrock | 3 | Calculated (15 km EDR) | | | | 79 | 79 | 79 | 79 | | | | | | |
| Bowdun | 3 | Calculated (26 km EDR) | | | | | 237 | 237 | 237 | 237 | | | | | |
| Campion | 3 | Calculated (15 km EDR) | | 79 | 79 | 79 | 79 | 79 | | | | | | | |
| Cedar | 3 | Calculated (15 km EDR) | | 79 | 79 | | | | | | | | | | |
| Morven | 3 | Calculated (26 km EDR) | | | 237 | 237 | 237 | | | | | | | | |
| Seismic Survey 1 | 3 | Calculated (12 km EDR) | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |
| Seismic Survey 2 | 3 | Calculated (12 km EDR) | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |
| NC&O SMU | | | | | | | | | | | | | | | |

[15] Colour co-ordination for tables: Blue = Concept/in planning/consenting, Orange = Construction, Green = Operational. The black box outlining the years 2028-2030 represent the years in which piling will be undertaken at Aspen; 2031 will comprise a non-piling construction year.

| Project | Tier | Source | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broadshore | 3 | Calculated (15 km EDR) | | | | 457 | 457 | 457 | 457 | | | | | | |
| Buchan | 3 | Calculated (15 km EDR) | | | | 457 | 457 | 457 | | | | | | | |
| Stromar | 3 | Calculated (15 km EDR) | | 457 | 457 | 457 | 457 | 457 | | | | | | | |
| Ayre | 3 | Calculated (15 km EDR) | | | | | 457 | 457 | 457 | | | | | | |
| Total | 1 | # | 1,327 | 12 | 12 | 123 | 512 | 512 | 398 | 398 | 0 | 0 | 0 | 0 | 0 |
| | | % of SMU | 3.27 | 0.03 | 0.03 | 0.30 | 1.26 | 1.26 | 0.98 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1, 2 | # | 2,685 | 1,370 | 1,379 | 2,919 | 3,095 | 3,095 | 3,554 | 2,329 | 573 | 436 | 436 | 436 | 436 |
| | | % of SMU | 6.62 | 3.38 | 3.40 | 7.20 | 7.63 | 7.63 | 8.76 | 5.74 | 1.41 | 1.07 | 1.07 | 1.07 | 1.07 |
| Total | 1,2,3 | # | 2,787 | 2,166 | 2,412 | 4,787 | 5,657 | 5,420 | 4,886 | 2,668 | 675 | 538 | 538 | 538 | 538 |
| | | % of combined SMUs | 6.87 | 5.34 | 5.95 | 11.80 | 13.95 | 13.36 | 12.04 | 6.58 | 1.66 | 1.33 | 1.33 | 1.33 | 1.33 |

### *Sensitivity of Receptor*

11.8.136 During the Proposed Development alone assessment, all marine mammal species were assessed as having a Low sensitivity to behavioural disturbance from underwater noise during pile driving, and geophysical surveys. Therefore, for the purpose of the CEA, all marine mammal species are assessed as having a Low sensitivity overall to underwater noise from pile driving and geophysical surveys.

### *Significance of Cumulative Effect*

11.8.137 A summary of the cumulative impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in Table 11.76Table 11.76.

11.8.138 The magnitude of the cumulative impact is deemed to be Medium for bottlenose dolphin and Risso's dolphin, High for white-beaked dolphin and Low for all the other receptors (Table 11.76). The sensitivity of all the receptors is Low. The cumulative effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.76 Significance of Impact 1: Disturbance From Underwater Noise From Piling and Geophysical Surveys

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | Low | Minor |
| Bottlenose dolphin | Medium | Low | Minor |
| Risso's dolphin | Medium | Low | Minor |
| Atlantic white-sided dolphin | Low | Low | Minor |
| White-beaked dolphin | High | Low | Minor |
| Minke whale | Low | Low | Minor |
| Harbour seal | Low | Low | Minor |
| Grey seal | Low | Low | Minor |

### *Secondary Mitigation and Residual Cumulative Effects*

11.8.139 No additional marine mammal mitigation is considered necessary because the likely cumulative effect in the absence of further mitigation (in addition to the embedded commitments) is not significant in EIA terms.

## Operation and Maintenance Cumulative Effects Assessment

### Impact 2: Entanglement Risk With Mooring Lines and Cables

#### *Magnitude of Cumulative Impact*

11.8.140 There are numerous floating offshore wind projects currently being developed in Scottish waters, these include Cenos, Culzean, Green Volt, Hywind, Kincardine, Muir Mhòr, Ossian, Pentland Floating and Salamander Table 11.64(Table 11.77).

11.8.141 Among the projects referenced in paragraph 11.8.140, the Culzean project was the only one to exclude the risk of marine mammal entanglement from further assessment at the scoping stage (Total Energies, 2023). All projects acknowledged that marine debris accumulating on floating lines and cables could lead to negative interactions between mobile marine species and project infrastructure. For those projects with an EIA in the public domain, comprehensive details were provided regarding their entanglement risk monitoring strategies. These include plans for monitoring large strains on mooring lines, conducting surveys with remotely operated vehicles, removing debris from infrastructure, and implementing reporting procedures (Flotation Energy, 2023; Pentland Floating OWF, 2022; Royal HaskoningDHV, 2023; Salamander Offshore Wind Farm, 2023).

11.8.142 Therefore, there is a general recognition within the industry of the need to implement mitigation strategies to reduce the risk of entanglement which are implemented by each project. The potential for secondary entanglement is confined to specific array areas, making it spatially limited and temporary in nature, as the dynamic infrastructure will be removed from the water column following the completion of each project's O&M phase. Although the risk of entanglement persists throughout the lifespan of the projects, if it would occur any impacts would be limited to a small proportion of the population and is therefore unlikely to influence overall population trends. Based on this, the magnitude of the effect is considered to be Low.

#### *Sensitivity of Receptor*

11.8.143 During the project alone assessment, all marine mammal species were assessed as having a High sensitivity to entanglement risk with mooring lines and cables. Basking sharks were assessed as having a Medium sensitivity to entanglement risk with mooring lines and cables.

#### *Significance of Cumulative Effect*

11.8.144 A summary of the cumulative impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in Table 11.77.

11.8.145 The magnitude of the cumulative impact is deemed to be Low and the sensitivity of the receptor is High, except for basking sharks which have a Medium sensitivity (Table 11.77). The cumulative effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.77 Significance of Impact 2: Entanglement Risk With Mooring Lines and Cables

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Low | High | Minor |
| Bottlenose dolphin | Low | High | Minor |
| Risso's dolphin | Low | High | Minor |
| Atlantic white-sided dolphin | Low | High | Minor |
| White-beaked dolphin | Low | High | Minor |
| Minke whale | Low | High | Minor |
| Humpback whale | Low | High | Minor |
| Harbour seal | Low | High | Minor |
| Grey seal | Low | High | Minor |
| Basking shark | Low | Medium | Minor |

#### *Secondary Mitigation and Residual Cumulative Effects*

11.8.146 No additional marine mammal mitigation is considered necessary because the likely cumulative effect of entanglement risk with mooring lines and cables in the absence of further mitigation (in addition to the embedded commitments) is not significant in EIA terms.

### Impact 3: Noise Related Impacts Associated With Floating Foundations

#### *Magnitude of Cumulative Impact*

11.8.147 In accordance with the assessment of operational noise outlined in Section 11.7, Impact 12, behavioural disturbance resulting from the Proposed Development is expected to be localised. Based on baseline data and the CEA shortlist, it is projected that by 2034, 19 OWFs will be operational off the east coast of Scotland. These developments will be located at varying distances from the shore and include the Proposed Development, Green Volt, Inch Cape, Moray West, Neart Na Gaoithe, Bellrock, Berwick Bank, Broadshore, Buchan, Caledonia, Cenos, Culzean, Morven, Muir Mhòr, Salamander, Scaraben, Stromar, Beech, Cedar and Bowdun.

11.8.148 While operational noise is likely to be to be detectable within the Array Areas, evidence indicates that marine mammals will continue to occupy such environments, where renewable energy infrastructures are present. Marine mammals have been consistently recorded within OWF sites, including harbour porpoise, bottlenose dolphins, grey seal and harbour seal (Scheidat *et al.,* 2011; Todd *et al.,* 2016; Vallejo *et al.,* 2017; Russell *et al.,* 2016; Clausen *et al.,* 2021; Fernandez-Betelu *et al.,* 2024). While research has indicated that harbour porpoise presence locally may be reduced in the vicinity of the WTGs, harbour porpoise were still regularly recorded within 600 m of WTGs (Risch *et al.,* 2023).

11.8.149 Although the footprint of operational wind farms is expected to increase, any behaviour response to noise emissions are anticipated to remain confined to the respective array areas and are unlikely to lead to the complete exclusion of marine mammals. As such, the cumulative impact is expected to affect only a small proportion of the population and is not predicted to influence population trajectories. Given the nature, frequency, and duration of potential disturbance over the operational lifetime of the Proposed Development and other projects included in the CEA, the magnitude of effect has been assessed as Medium.

*Sensitivity of Receptor*

11.8.150 During the Proposed Development alone assessment, harbour porpoise, all dolphin species and both seal species were assessed as having a Negligible sensitivity to noise related impacts associated with floating foundations. Minke and humpback whales, and basking sharks were assessed as having a Low sensitivity to noise related impacts associated with floating foundations.

*Significance of Cumulative Effect*

11.8.151 A summary of the cumulative impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in Table 11.78.

11.8.152 The magnitude of the cumulative impact is deemed to be Medium and the sensitivity of the receptor is Negligible, expect for minke whale, humpback whale and basking sharks (Table 11.78). The cumulative effect will, therefore, be of Negligible to Minor significance, which is not significant in EIA terms.

Table 11.78 Significance of Impact 3: Noise Related Impacts Associated With Floating Foundations

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Harbour porpoise | Medium | Negligible | **Negligible** |
| Bottlenose dolphin | Medium | Negligible | **Negligible** |
| Risso's dolphin | Medium | Negligible | **Negligible** |
| Atlantic white-sided dolphin | Medium | Negligible | **Negligible** |
| White-beaked dolphin | Medium | Negligible | **Negligible** |
| Minke whale | Medium | Low | **Minor** |
| Humpback whale | Medium | Low | **Minor** |
| Harbour seal | Medium | Negligible | **Negligible** |
| Grey seal | Medium | Negligible | **Negligible** |
| Basking shark | Medium | Low | **Minor** |

#### *Secondary Mitigation and Residual Cumulative Effects*

11.8.153 No additional marine mammal mitigation is considered necessary because the likely cumulative effect of noise related impacts associated with floating foundations in the absence of further mitigation (in addition to the embedded commitments) is not significant in EIA terms.

### Impact 4: EMF Impacts on Other Megafauna

#### *Magnitude of Cumulative Impact*

11.8.154 In line with the findings of the Proposed Development alone assessment, it is anticipated that any impacts to basking sharks from EMFs will be highly localised, with magnetic field strength falling to negligible levels approximately 10 meters from the cable (Normandeau Associates Inc. *et al.,* 2011).

11.8.155 The implementation of a CaP (C-OFF-04, Table 11.16) as part of the Proposed Development embedded commitment measures will outline specific actions such as cable burial or protective measures to reduce the magnitude of EMF-related impacts on basking sharks.

11.8.156 It is anticipated that any EMF impacts on basking sharks will be highly localised and limited to the array area and export corridor of respective projects. Therefore, it is highly unlikely that cumulative impacts will occur. Any cumulative impacts will be limited, affecting only a small segment of the population. As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Low.

#### *Sensitivity of Receptor*

11.8.157 During the Proposed Development alone assessment, basking sharks were assessed as having a Medium sensitivity to EMF impacts.

#### *Significance of Cumulative Effect*

11.8.1 A summary of the cumulative impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in Table 11.79.

11.8.2 The magnitude of the cumulative impact is deemed to be Low and the sensitivity of the receptor is Medium (Table 11.79). The cumulative effect will, therefore, be of Minor significance, which is not significant in EIA terms.

Table 11.79 Significance of Impact 4: EMF Impacts on Other Megafauna

| Receptor | Magnitude | Sensitivity | Significance |
|---|---|---|---|
| Basking shark | Low | Medium | Minor |

*Secondary Mitigation and Residual Cumulative Effects*

11.8.3 No additional marine mammal mitigation is considered necessary because the likely cumulative effect of EMF impacts in the absence of further mitigation (in addition to the embedded commitments) is not significant in EIA terms.

## Proposed Monitoring for Cumulative Effects

11.8.4 Monitoring is not proposed for marine mammals and basking sharks as no likely significant cumulative effects were predicted during the construction, O&M and decommissioning phases of the Proposed Development.

## 11.9 Transboundary Effects

11.9.1 A Transboundary effect assessment assesses the effects from the Proposed Development upon the interests of the European Economic Areas (EEA) States for marine mammals and other megafauna.

11.9.2 Transboundary effects may occur from the Proposed Development alone, or cumulatively with other plans or projects. This assessment considered the potential for transboundary effects of the residual effects of the Project (i.e. after mitigation measures have been applied for the Proposed Development).

11.9.3 Disturbance or displacement effects on marine mammals and other megafauna as a result of underwater noise during the construction phase of the Proposed Development may occur over large ranges. In turn, there is a potential for transboundary effects to occur where underwater noise extends into other EEA States. Impacts identified due to changes in prey resources could arise from transboundary impacts on fish and shellfish receptors.

11.9.4 The distance of the Proposed Development from waters of other EEA States is approximately 113 km (to Norway at its closest point), making the Proposed Development a significant distance from any other EEA State. Therefore, the potential for significant transboundary impacts is considered to be small.

11.9.5 Any transboundary impacts that do occur as a result of the Proposed Development are predicted to be short-term and intermittent, with the recovery of marine mammal and other megafauna populations to baseline levels following the completion of the work. Therefore, the magnitude of transboundary effects are assessed as Negligible and the sensitivity of receptors as Negligible. Therefore, the effect will be of Negligible significance, which is not significant in EIA terms.

## 11.10 Inter-related Effects

11.10.1 Inter-related effects may occur due to multiple impacts on a receptor or a group of receptors from the Proposed Development. This includes the following:

- **Project Lifecycle Effects** - Interactions between impacts across different phases of the Proposed Development i.e., interaction of impacts across construction, O&M and decommissioning; and
- **Inter-related Receptor Effects** - Interactions between impacts on a receptor or group of receptors within an Proposed Development stage (Inter-related Receptor Effects).

11.10.2 Project Lifecycle and Receptor led inter-related effects from marine mammals are presented in Table 11.80.

Table 11.80 Inter-related Effects of Marine Mammals

| Impact | Significant Inter-related Effect |
|---|---|
| Project Lifecycle Effects | |
| Disturbance from underwater noise | Disturbance to marine mammals and basking sharks as a result of underwater noise will be present across construction, O&M and decommissioning phases of the Proposed Development. The inter-related effect will occur across the potential project lifetime. |

| Impact | Significant Inter-related Effect |
|---|---|
| | The main source of disturbance from underwater noise will be piling activities during the construction phase. In addition, there is also disturbance from geophysical surveys (construction, O&M, decommissioning), UXO clearance (construction), vessel activity (construction, O&M, decommissioning), other construction activities (construction), operational floating WTGs (O&M) and removal of structures (decommissioning).<br><br>The implementation of MMMP (UXO, piling and geophysical surveys) ensures that disturbance from underwater noise is Low to Negligible in magnitude, with Negligible significance, and therefore, not significant across all phases of the Proposed Development. As a result, the effects across the Proposed Development lifetime are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments for each individual phase. |
| Vessel Disturbance | Disturbance to marine mammals and basking sharks as a result of vessels will be present across construction, O&M and decommissioning phases of the Proposed Development. The inter-related effect will occur across the potential project lifetime.<br><br>The implementation of a VMP ensures that disturbance from vessel activity is assessed as Low in magnitude, with Negligible significance, and therefore, not significant across all phases of the Proposed Development. As a result, the effects across the Proposed Development lifetime are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments for each individual phase. |
| Vessel Collision Risk | The potential of vessel collision risk impacts on marine mammals and basking sharks will be present across construction, O&M and decommissioning phases of the Proposed Development. The inter-related effect will occur across the potential project lifetime.<br><br>The implementation of a VMP ensures that vessel collision risks are assessed as Negligible in magnitude and significance, and therefore, not significant across all phases of the Proposed Development. As a result, the effects across the Proposed Development lifetime are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments for each individual phase. |
| Changes to Prey | The potential impacts of changes to prey on marine mammals and basking sharks will be present across construction, O&M and decommissioning phases of the Proposed Development. The inter-related effect will occur across the potential project lifetime.<br><br>The magnitude of the impact has been assessed as Low and Negligible significance, and therefore, not significant across all |

| Impact | Significant Inter-related Effect |
|---|---|
| | phases of the Proposed Development. As a result, the effects across the Proposed Development lifetime are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments for each individual phase. |
| Inter-related Receptor Effects | |
| The combination of injury from anthropogenic noise impacts, disturbance from underwater noise, the presence of vessels and loss of prey resources on marine mammals and basking sharks. | The greatest potential for spatial and temporal interactions is likely to occur with underwater construction noise impacts (i.e. during the construction phase). It is noted that some of these interactions are mutually exclusive as disturbance/displacement resulting from underwater noise will mean reduced potential for vessel interactions. In addition, vessel presence prior to piling is likely to disturb and/or displace some receptor species (Benhemma-Le Gall *et al.,* 2023), and therefore limit the amount of disturbance receptors may experience as a result of piling activities. It is therefore not anticipated that any inter-related effects will be produced that are of greater significance than the assessments presented for each individual impact. |

## 11.11 Assessment Summary

11.11.1 A summary of the findings of the effects and CEAs undertaken in Section 11.7 and Section 11.8 is provided in Table 11.81 and Table 11.82 respectively. This includes residual effect significance after any required secondary mitigation and proposed monitoring.

Table 11.81 Summary of Assessment of Effects on Marine Mammals

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| Construction | | | | | | | |
| **Impact 1**: Injury From Underwater Noise From Piling | Bottlenose dolphin, Risso's dolphin, Atlantic white-sided dolphin, white-beaked dolphin, harbour seal and grey seal | Negligible | Low | Negligible | n/a | n/a | n/a |
| | Harbour porpoise, minke whale, humpback whale and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| **Impact 1**: Disturbance From Underwater Noise From Piling | Harbour porpoise, bottlenose dolphin, Atlantic white-sided dolphin, minke whale, humpback whale, grey seal and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| | Risso's dolphin and white-beaked dolphin | Medium | Low | Minor | n/a | n/a | n/a |
| | Harbour seal | Negligable | Low | Negligable | n/a | n/a | n/a |
| **Impact 2**: Injury From Underwater Noise From UXO Clearance | Bottlenose dolphin, Risso's dolphin, Atlantic white-sided dolphin, white-beaked dolphin, grey seal and harbour seal | Negligable | Low | Negligable | n/a | n/a | n/a |
| | Harbour porpoise, and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| | Minke whale and humpback whale | Low | Medium | Minor | n/a | n/a | n/a |
| **Impact 2**: Disturbance From | Harbour porpoise, bottlenose dolphin GNS MU, Risso's dolphin, Atlantic white- | Low | Low | Minor | n/a | n/a | n/a |

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| Underwater Noise From High Order UXO Clearance | sided dolphin, white-beaked dolphin, minke whale, humpback whale, grey seal and basking shark | | | | | | |
| | Bottlenose dolphin CES MU | Medium | Low | Minor | n/a | n/a | n/a |
| | Harbour Seal | Negligable | Low | Negligable | n/a | n/a | n/a |
| **Impact 2**: Disturbance From Underwater Noise From Low Order UXO Clearance | Harbour porpoise, bottlenose dolphin CES MU, Risso's dolphin, white-beaked dolphin, minke whale, humpback whale and grey seal | Low | Low | Minor | n/a | n/a | n/a |
| | Bottlenose dolphin GNS MU, Atlantic white-sided dolphin, harbour seal and basking shark | Negligable | Low | Negligable | n/a | n/a | n/a |
| **Impact 2**: Disturbance Using TTS as a Proxy Resulting From UXO Clearance | Bottlenose dolphin, Atlantic white-sided dolphin, Risso's dolphin, white-beaked dolphin and harbour seal | Negligable | Low | Negligable | n/a | n/a | n/a |
| | Harbour porpoise, humpback whale, grey seal and basking sharks | Low | Low | Minor | n/a | n/a | n/a |
| | Minke whale | Medium | Low | Minor | n/a | n/a | n/a |
| **Impact 3**: Injury From Underwater Noise From Geophysical Surveys | All marine mammals and basking sharks | Negligable | Low | Negligable | n/a | n/a | n/a |

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| **Impact 3**: Disturbance From Underwater Noise From Geophysical Surveys (SBP, USBL, UHRS) | All marine mammals<br><br>Basking shark | Low<br><br>Negligable | Low<br><br>Low | Minor<br><br>Negligable | n/a<br><br>n/a | n/a<br><br>n/a | n/a<br><br>n/a |
| **Impact 3**: Disturbance From Underwater Noise From Geophysical Surveys (MBES and SSS) | All marine mammals and basking shark | Negligible | Low | Negligible | n/a | n/a | n/a |
| **Impact 4**: Injury From Underwater Noise From Other Construction Activities | Harbour porpoise, bottlenose dolphin, Risso's dolphin, Atlantic white-sided dolphin, white-beaked dolphin, harbour seal, grey seal, basking shark<br><br>Minke whale and humpback whale | Negligible<br><br>Negligible | Low<br><br>Medium | Negligible<br><br>Negligible | n/a<br><br>n/a | n/a<br><br>n/a | n/a<br><br>n/a |
| **Impact 4**: Disturbance From Underwater Noise From Other Construction Activities | Harbour porpoise, bottlenose dolphin, Atlantic white-sided dolphin, white-beaked dolphin, minke whale, humpback whale, harbour seal, grey seal and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| **Impact 5**: Vessel Disturbance | All marine mammals and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| **Impact 6**: Vessel Collision Risk | All marine mammals and basking shark | Negligible | High | Minor | n/a | n/a | n/a |

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| **Impact 7**: Changes to Prey | All marine mammals and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| O&M | | | | | | | |
| **Impact 8**: Vessel Disturbance | All marine mammals and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| **Impact 9**: Vessel Collision Risk | All marine mammals and basking shark | Negligible | High | Minor | n/a | n/a | n/a |
| **Impact 10**: Changes to Prey | All marine mammals and basking shark | Negligible | Low | Negligible | n/a | n/a | n/a |
| **Impact 11**: Primary Entanglement Risk With Mooring Lines and Cables | All marine mammals<br><br>Basking shark | Negligible<br><br>Negligible | High<br><br>Medium | Minor<br><br>Negligible | n/a<br><br>n/a | n/a<br><br>n/a | n/a<br><br>n/a |
| **Impact 11**: Secondary Entanglement Risk With Mooring Lines and Cables | All marine mammals<br><br>Basking shark | Low<br><br>Low | High<br><br>Medium | Minor<br><br>Minor | n/a<br><br>n/a | n/a<br><br>n/a | n/a<br><br>n/a |
| **Impact 12**: Noise Related Impacts Associated With Floating Foundations | Harbour porpoise, bottlenose dolphin, Risso's dolphin Atlantic white-sided dolphin, white-beaked dolphin, harbour seal, grey seal<br><br>Minke whale, humpback whale, basking shark | Medium<br><br>Medium | Negligible<br><br>Low | Negligible<br><br>Minor | n/a<br><br>n/a | n/a<br><br>n/a | n/a<br><br>n/a |
| **Impact 13**: Collision Risk With | Harbour porpoise, bottlenose dolphin, Risso's dolphin, Atlantic white-sided | Negligible | Negligible | Negligible | n/a | n/a | n/a |

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| Floating Foundation | dolphin, white-beaked dolphin, harbour seal, grey seal, basking shark | | | | | | |
| | Minke whale | Low | Low | Minor | n/a | n/a | n/a |
| | Humpback whale | Negligible | Low | Negligible | n/a | n/a | n/a |
| **Impact 14**: Habitat Loss/Change | All marine mammals and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| **Impact 15**: Physical Barrier Effects | Harbour porpoise, bottlenose dolphin, Risso's dolphin, Atlantic white-sided dolphin, white-beaked dolphin, harbour seal, grey seal, basking shark | Low | Negligible | Negligible | n/a | n/a | n/a |
| | Minke whale and humpback whale | Medium | Low | Minor | n/a | n/a | n/a |
| **Impact 16**: EMF Impacts on Other Megafauna | Basking shark | Low | Medium | Minor | n/a | n/a | n/a |
| Decommissioning | | | | | | | |
| **Impact 17**: Vessel Disturbance | All marine mammals and basking shark | Low | Low | Minor | n/a | n/a | n/a |
| **Impact 18**: Vessel Collision Risk | All marine mammals and basking shark | Negligible | High | Minor | n/a | n/a | n/a |
| **Impact 19**: Changes to Prey | All marine mammals and basking shark | Negligible | Low | Negligible | n/a | n/a | n/a |

Table 11.82 Summary of Assessment of Cumulative Effects on Marine Mammals

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| Construction | | | | | | | |
| **Impact 20**: Disturbance From Underwater Noise From Piling and Geophysical Surveys | Bottlenose dolphin and Risso's dolphin | Medium | Low | Minor | n/a | n/a | n/a |
| | Harbour porpoise, Atlantic-white-sided dolphin, minke whale, humpback whale, harbour seal and grey seal | Low | Low | Minor | n/a | n/a | n/a |
| | White-beaked dolphin | High | Low | Minor | n/a | n/a | n/a |
| O&M | | | | | | | |
| **Impact 21:** Entanglement Risk With Mooring Lines and Cables | All marine mammal species | Low | High | Minor | n/a | n/ | n/a |
| | Basking sharks | Low | Medium | Minor | n/a | n/a | n/a |
| **Impact 22**: Noise Related Impacts Associated With | Harbour porpoise, bottlenose dolphin, Risso's | Medium | Negligable | Negligible | n/a | n/ | n/a |

| Impact | Receptor | Magnitude of Impact | Sensitivity of Receptor | Effect Significance | Secondary Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|
| Floating Foundations | dolphin, Atlantic white-sided dolphin, white-beaked dolphin, harbour seal and grey seal | | | | | | |
| | Minke whale, humpback whale and basking shark | Medium | Low | Minor | n/a | n/a | n/a |
| **Impact 23**: EMF Impacts on Other Megafauna | Basking shark | Low | Medium | Minor | n/a | n/a | n/a |

## 11.12 References


Aarts, G., Brasseur, S. and Kirkwood, R. (2018), 'Behavioural response of grey seals to pile-driving', Wageningen Marine Research report, C006/18.

Allen, R., Jarvis, D., Sayer, S., and Mills, C. (2012), 'Entanglement of grey seals *Halichoerus grypus* at a haul out site in Cornwall, UK', Marine Pollution Bulletin, 64:2815- 2819.

Andersen, S., Teilmann, J., Dietz, R., Schmidt, N., and Miller, L. (2012), 'Behavioural responses of harbour seals to human-induced disturbances', Aquatic Conservation: Marine and Freshwater Ecosystems, 22/1:113–121

Anderwald, P., Brandecker, A., Coleman, M., Collins, C., Denniston, H., Haberlin, M. D., O'Donovan, M., Pinfield, R., Visser, F. and Walshe, L. (2013), 'Displacement responses of a mysticete, an odontocete, and a phocid seal to construction-related vessel traffic', Endangered Species Research, 21.

Arso Civil, M., Quick, N., Mews, S., Hague, E. Cheney, B.J., Thompson, P.M. & Hammond, P.S. (2021), 'Improving understanding of bottlenose dolphin movements along the east coast of Scotland', Final report. Report number SMRUC-VAT-2020-10 provided to European Offshore Wind Deployment Centre (EOWDC), March 2021 (unpublished).

Au, W., Pack, A. A., Lammers, M. O., Herman, L. M., Deakos, M. H., & Andrews, K. (2006). Acoustic properties of humpback whale songs. The Journal of the Acoustical Society of America,120(2), 1103-1110. doi:10.1121/1.2211547

Authier, M., Peltier, H., Dorémus, G., Dabin, W., Canneyt, O. V. and Ridoux, V. (2014), 'How much are stranding records affected by variation in reporting rates? A case study of small delphinids in the Bay of Biscay', Biodiversity and Conservation, 23.

Back, J.J., Hoskins, A.J., Kirkwood, R. and Arnould, J.P.Y. (2018), 'Behavioral responses of Australian fur seals to boat approaches at a breeding colony', Nature Conservation, 31: 35–52.

Bailey, H. and Thompson, P. (2006), 'Quantitative analysis of bottlenose dolphin movement patterns and their relationship with foraging', Journal of Animal Ecology, 75: 456-465.

Basran, C. J., Bertulli, C. G., Cecchetti, A., Rasmussen, M. H., Whittaker, M. and Robbins, J. (2019), 'First estimates of entanglement rate of humpback whales *Megaptera novaeangliae* observed in coastal Icelandic waters', Endangered Species Research, 38:67-77.

Basran, C. J., Woelfing, B., Neumann, C. and Rasmussen, M. H. (2020), 'Behavioural Responses of Humpback Whales (*Megaptera novaeangliae*) to Two Acoustic Deterrent Devices in a Northern Feeding Ground off Iceland', Aquatic Mammals, 46/6:584-602.

BBC (2012), 'Basking shark caught in creels in Loch Broom', http://www.bbc.co.uk/news/uk-scotland-highlands-islands-13604986 [Accessed: April 2025].

BEIS. (2020), 'Review of Consented Offshore Wind Farms in the Southern North Sea Harbour Porpoise SAC.', The Department for Business Energy and Industrial Strategy.

Bejder, L., Samuels, A.M.Y., Whitehead, H.A.L., Gales, N., Mann, J., Connor, R., Heithaus, M., Watson-Capps, J.A.N.A., Flaherty, C. and Krützen, M. (2006), 'Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance', Conservation Biology, 20/6:1791-1798.

Bellomo, S., Cipriano, G., Santacesaria, F.C., Fanizza, C., Crugliano, R., Pollazzon, V., Ricci, P., Maglietta, R. and Carlucci, R. (2021),'Impact of cetacean watching vessels on Risso's dolphins behaviour in the Gulf of Taranto: Preliminary information to regulate dolphin watching', In 2021 International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea), IEEE, 111-115.

Benhemma-Le Gall, A., Graham, I., Merchant, N. and Thompson, P. (2021), 'Broad-scale responses of harbor porpoises to pile-driving and vessel activities during offshore windfarm construction', Frontiers in Marine Science 8/66724: 1-18.

Benhemma-Le Gall, A., Thompson, P., Merchant, N. and Graham, I. (2023), 'Vessel noise prior to pile driving at offshore windfarm sites deters harbour porpoises from potential injury zones', Environmental impact assessment review, 103: 107271.

Benjamins, S., V. Harnois, H. Smith, L. Johanning, L. Greenhill, C. Carter, Wilson, and B. Wilson. (2014), 'Understanding the potential for marine megafauna entanglement risk from marine renewable energy developments', Scottish Natural Heritage Commissioned Report No. 791.

Bergström, L., Sundqvist, F., & Bergström, U. (2013), 'Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community', Marine Ecology Progress Series, 485: 199-210.

Bergström, L., Kautsky, L., Malm, T., Rosenberg, R., Wahlberg, M., Capetillo, N. Å., & Wilhelmsson, D. (2014), 'Effects of offshore wind farms on marine wildlife—a generalized impact assessment', Environmental Research Letters, 9/3, 034012.

BERR and DEFRA. (2008), 'Review of cabling techniques and environmental effects applicable to the offshore wind farm industry', This report was prepared by consultants from Royal Haskoning and BOMEL Ltd.

Bishop, A., Pomeroy, P. and Twiss, S.D. (2015), 'Breeding male grey seals exhibit similar activity budgets across varying levels exposures to human activity', Marine Ecology Progress Series, 527: 247-259.

Bloomfield, A. and Solandt, J.L. (2008), 'The Marine Conservation Society Basking Shark Watch Project: 20-year report (1987-2006)', Marine Conservation Society, Ross on Wye, UK.

Boisseau, O., McGarry, T., Stephenson, S., Compton, R., Cucknell, A.C., Ryan, C., McLanaghan, R. and Moscrop, A. (2021), 'Minke whales *Balaenoptera acutorostrata* avoid a 15 kHz acoustic deterrent device (ADD). Marine Ecology Progress Series', 667:191-206.

Booth, C. and Heinis, F. (2018), 'Updating the Interim PCoD Model: Workshop Report - New transfer functions for the effects of permanent threshold shifts on vital rates in marine mammal species', Report Code SMRUC-UOA-2018-006, submitted to the University of Aberdeen and Department for Business, Energy and Industrial Strategy (BEIS), June 2018 (unpublished).

Booth, C. G., Heinis, F. and Harwood, J. (2019), 'Updating the Interim PCoD Model: Workshop Report - New transfer functions for the effects of disturbance on vital rates in marine mammal species', Report

Code SMRUC-BEI-2018-011, submitted to the Department for Business, Energy and Industrial Strategy (BEIS), February 2019 (unpublished).

Botterell, Z.L., Penrose, R., Witt, M.J. and Godley, B.J. (2020), 'Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (1910–2018)', Journal of the Marine Biological Association of the United Kingdom, 100/6: 869-877.

Boyd, I. and Hanson, N. (2021), 'Impacts of Climate Change on Marine Mammals', SMRU.

Braithwaite, J. E., Meeuwig, J. J. and Hipsey, M. R. (2015), 'Optimal migration energetics of humpback whales and the implications of disturbance', Conservation Physiology, 3: cov001.

Brandt, M. J., Diederichs, A., Betke, K. and Nehls, G. (2011), 'Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea', Marine Ecology Progress

Brandt, M. J., Hoeschle, C., Diederichs, A., Betke, K., Matuschek, R., Witte, S. and Nehls, G. (2013), 'Far-reaching effects of a seal scarer on harbour porpoises, *Phocoena phocoena'*, Aquatic Conservation-Marine and Freshwater Ecosystems, 23:222-232.

Brandt, M. J., Dragon, A. C., Diederichs, A., Schubert, A., Kosarev, V., Nehls, G., Wahl, V., Michalik, A., Braasch, A., Hinz, C. and Ketzer, C. (2016), 'Effects of offshore pile driving on harbour porpoise abundance in the German Bight: Assessment of Noise Effects, Final Report'.

Brandt, M. J., Dragon, A. C., Diederichs, A., Bellmann, M. A., Wahl, V., Piper, W., Nabe-Nielsen, J. and Nehls, G. (2018), 'Disturbance of harbour porpoises during construction of the first seven offshore windfarms in Germany', Marine Ecology Progress Series, 596: 213-232.

Brasseur, S., G. Aarts, E. Meesters, T. van Polanen Petel, E. Dijkman, J. Cremer, and P. Reijnders. (2012). Habitat preference of harbour seals in the Dutch coastal area: analysis and estimate of effects of offshore wind farms.

Braulik, G. (2019), '*Lagenorhynchus acutus*. The IUCN Red List of Threatened Species 2019: e.T11141A50361160', https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T11141A50361160.en. [Accessed: April 2025].

Braulik, G.T., Minton , G., Amano, M. & Bjørge, A. (2023), '*Phocoena phocoena* (amended version of 2020 assessment). The IUCN Red List of Threatened Species 2023: e.T17027A247632759', https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T17027A247632759.en. [Accessed: April 2025].

Britton, J. (2012), 'The Impact of Boat Disturbance on the Grey Seal, (*Halichoerus grypus*) around the Isle of Man', M.Sc. Thesis submitted to Bangor University.

Brownlow, A., ten Doeschate, M. and Davison, N.J. (2024), 'Scottish Marine Animal Stranding Scheme Annual Report 2023 report to Marine Directorate, Scottish Government'.

Bryant, P.J., Lafferty, C.M. and Lafferty, S.K. (1984), 'Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales', In: Jones, M.L., Swartz, S.L., Leatherwood, S. (eds) The gray whale Eschrichtius robustus, Academic Press, New York, NY, 375−387.

Burns, R.D.J., Martin, S.B., Wood, M.A., Wilson, C.C., Lumsden, C.E. and Pace, F. (2022), 'Hywind Scotland Floating Offshore Wind Farm: Sound Source Characterisation of Operational Floating

Turbines. Document 02521, Version 3.0 FINAL. Technical report by JASCO Applied Sciences for Equinor Energy AS.

Calderan, S., Boisseau, O., Lacey, C., Leaper, R., van Geel, N., & Risch, D. (2024). A preliminary description of Atlantic white-sided dolphin (*Lagenorhynchus acutus*) vocalizations. Marine Mammal Science, 40(4), e13135. https://doi.org/10.1111/mms.13135.

Caledonia Offshore Wind Farm Ltd. (2024). Volume 2 Proposed Development (Offshore) Chapter 5 Fish and Shellfish Ecology. Volume-2-Chapter-5-Fish-and-Shellfish-Ecology.pdf [Accessed: June 2025]

Canning, S. J., Santos, M. B., Reid, R. J., Evans, P. G., Sabin, R. C., Bailey, N. and Pierce, G. J. (2008), 'Seasonal distribution of white-beaked dolphins (*Lagenorhynchus albirostris*) in UK waters with new information on diet and habitat use', Journal of the Marine Biological Association of the UK, 88: 1159-1166.

Carlucci, R., G. Cipriano, M. Bonato, G. Buscaino, R. Crugliano, C. Fanizza, S. Gatto, R. Maglietta, C. Papetti, M. Pelagatti, P. Ricci, F.C. Santacesaria, and E. Papale. (2024), 'Anthropogenic Noise Effects on Risso's Dolphin Vocalizations in the Gulf of Taranto (Northern Ionian Sea, Central Mediterranean Sea)', Ocean & Coastal Management, 254: 107-177.

Carroll, A., Przeslawski, R., Duncan, A.J., Gunning, M., & Bruce, B.D. (2016). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Marine pollution bulletin, 114 1, 9-24.

Carter, M.I.D., Boehme, L., Cronin, M.A., Duck, C.D., Grecian, W.J., Hastie, G.D., Jessopp, M., Matthiopoulos, J., McConnell, B.J., Miller, D.L., Morris, C.D., Moss, S.E.W., Thompson, D., Thompson, P.M., and Russell, D.J.F. (2022), 'Sympatric seals, satellite tracking and protected areas: habitat-based distribution estimates for conservation and management', Frontiers in Marine Science, 9: 875-869.

Carter, M. I. D, Bivins, M., Duck, C. D., HasKe, G. D., Morris, C. D., Moss, S. E. W., Thompson, D., Thompson, P. M., Vincent, C. and Russell, D. J. F. (2025), 'Updated habitat-based at-sea distribution maps for harbour and grey seals in Scotland. Sea Mammal Research Unit, University of St Andrews, Commissioned Report to Scottish Government.

Casper, B.M. and Mann, D.A. (2010), 'Field hearing measurements of the Atlantic sharpnose shark', Journal of Fish Biology.

Casper, B. M. Halvorsen, M. B. and Popper, A. N. (2012), 'Are Sharks Even Bothered by a Noisy Environment?', The Effects of Noise on Aquatic Life, 93–97. doi:10.1007/978-1-4419-7311-5.

Cassoff, R. M., Moore, K. M., McLellan, W. A., Barco, S. G., Rotstein, D. S. and Moore, M. J. (2011), 'Lethal entanglement in baleen whales. Diseases of Aquatic Organisms', 96:175-185.

Cates, K., Demaster, D., Brownell, R., Gende, S., Ritter, F. and Panigada, S. (2017), 'Strategic Plan to Mitigate the Impacts of Ship Strikes on Cetacean Populations: 2017-2020', IWC/66/CC20, CC Agenda Item 5.2.

Cetacean Strandings Investigation Programme (CSIP), (2016), 'Annual Report for the period 1st January – 31st December 2015 (Contract number MB0111)', Compiled by R. Deaville (ZSL). Contributing Authors: P.D. Jepson and M. Perkins (ZSL) A. Brownlow, N. Davison and M. ten Doeschate (SRUC) B. Smith, R. Lyal, L. Allan and R.C. Sabin (NHM) R. Penrose (MEM).

Cetacean Strandings Investigation Programme (CSIP), (2017), 'Annual Report for the period 1st January – 31st December 2016 (Contract number MB0111)', Compiled by R. Deaville (ZSL). Contributing authors: P.D. Jepson and M. Perkins (ZSL), A. Brownlow, N. Davison and M. ten Doeschate (SRUC), B. Smith, L. Allan and R.C. Sabin (NHM), R. Penrose (MEM), J.E.F. Barnett, N. Clear, A. Crosby and R. Williams (CWTMSN/UoE).

Cetacean Strandings Investigation Programme (CSIP), (2018), 'Annual Report for the period 1st January – 31st December 2017 (Contract numbers MB0111 and ME6008)', Compiled by R. Deaville (ZSL). Contributing Authors: P.D. Jepson and M. Perkins (ZSL), A. Brownlow, N. Davison and M. ten Doeschate (SRUC), B. Smith, L. Allan, S. Wilson, K. Swindells and R.C. Sabin (NHM), R. Penrose (MEM), J.E.F. Barnett, K. Astley, N. Clear, A. Crosby and R. Williams (UoE/CWTMSN).

Cetacean Strandings Investigation Programme (CSIP), (2019), 'Annual Report for the period 1st January – 31st December 2018 (Contract number ME6008)', Compiled by R. Deaville (ZSL). Contributing Authors: P.D. Jepson, M. Perkins and R. Williams (ZSL), A. Brownlow, N. Davison, M. ten Doeschate and E. MacLennan (SRUC), B. Smith, K. Swindells and R.C. Sabin (NHM), R. Penrose (MEM), J.E.F. Barnett, K. Astley, N. Clear, A. Crosby and R. Williams (UoE/CWTMSN).

Cetacean Strandings Investigation Programme (CSIP), (2020), 'Annual Report for the period 1st January – 31st December 2019 (Contract number ME6008)', Compiled by R. Deaville (ZSL). Contributing Authors: P.D. Jepson, M. Perkins and R. Williams (ZSL), A. Brownlow, N. Davison, M. ten Doeschate and E. MacLennan (SRUC), B. Smith, A. Baillie and R.C. Sabin (NHM), R. Penrose (MEM), J.E.F. Barnett, K. Astley, N. Clear, A. Hawtrey-Collier, A. Crosby and R. Williams (UoE/CWTMSN).

Cetacean Strandings Investigation Programme (CSIP), (2021), 'Annual Report for the period 1st January – 31st December 2020 (Contract number ME6008)', Compiled by R. Deaville (ZSL). P. Jepson, M. Perkins and R. Williams (ZSL) A. Brownlow, N. Davison, M. ten Doeschate and E. MacLennan (SRUC) B. Smith, A. Baillie and R.C. Sabin (NHM) R. Penrose and M. Westfield (MEM) J.E.F. Barnett, A. Hawtrey-Collier, K. Astley, N. Clear, A. Crosby and R. Williams (UoE/CWTMSN).

Cetacean Strandings Investigation Programme (CSIP), (2022), 'Annual Report for the period 1st January – 31st December 2021 (Contract number ME6008)', Compiled by R. Deaville (ZSL). M. Perkins, R. Williams and S. Spiro (ZSL) B. Smith, A. Baillie and R.C. Sabin (NHM) M. Westfield (MEM) A. Hawtrey-Collier, N. Clear, A. Crosby and R. Williams (CWTMSN) J.E.F. Barnet (CMPT).

Cetacean Strandings Investigation Programme (CSIP), (2023), 'Annual Report for the period 1st January – 31st December 2022 (Contract number ME6008)', Compiled by R. Deaville (ZSL). M. Perkins, R. Williams and S. Spiro (ZSL) B. Smith, A. Baillie and R.C. Sabin (NHM) M. Westfield (MEM) A. Hawtrey-Collier, N. Clear, A. Crosby and R. Williams (CWTMSN) J.E.F. Barnet (CMPT).

Chapuis, L., Collin, S.P., Yopak, K.E., McCauley, R.D., Kempster, R.M., Ryan, L.A., Schmidt, C., Kerr, C.C., Gennari, E., Egeberg, C.A., & Hart, N.S. (2019). The effect of underwater sounds on shark behaviour. Scientific Reports, 9.

Chen, F., Shapiro, G. I., Bennett, K. A., Ingram, S. N., Thompson, D., Vincent, C., Russell D. J. F. and Embling, C. B. (2017), 'Shipping noise in a dynamic sea: a case study of grey seals in the Celtic Sea'. Mar Pollut Bull, 15;114/1: 372-383.

Cheney, B., Thompson, P., Durban, J., Culloch, R., Elwen, S., Robinson, K., Eisfeld-Pierantonio, S., Reid, R. and Reid, J. (2013), 'Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins *Tursiops truncatus* in Scottish waters', Mammal Review, 43: 71–88.

Cheong, S-H., Wang, L., Lepper, P. and Robinson, S. (2020), 'Final Report: Characterisation Of Acoustic Fields Generated By UXO Removal - Phase 2', NPL Report AC 19.

Chin, A., Mourier, J. and Rummer, J.L. (2015), 'Blacktip reef sharks (*Carcharhinus melanopterus*) show high capacity for wound healing and recovery following injury', Conservation Physiology, 3/1: 1-9.

Christiansen, F., Rasmussen, M., and Lusseau, D. (2013), 'Whale watching disrupts feeding activities of minke whales on a feeding ground', Marine Ecology Progress Series, 478: 239.

Christiansen, F., and Lusseau, D. (2015a), 'Linking Behavior to Vital Rates to Measure the Effects of Non-Lethal Disturbance on Wildlife', Conservation Letters, 8: 424-431.

Christiansen, F. and Lusseau, D. (2015b). 'Understanding the ecological effects of whale-watching on cetaceans. Whale-watching, sustainable tourism and ecological management', Cambridge University Press, Cambridge, UK, 177-192.

Christiansen, F., Bertulli, C. G., Rasmussen, M. H. and Lusseau, D. (2015), 'Estimating cumulative exposure of wildlife to non-lethal disturbance using spatially explicit capture–recapture models', The Journal of Wildlife Management, 79: 311-324.

Clausen, K. T., Teilmann, J., Wisniewska, D. M., Balle, J. D., Delefosse, M., and Beest, F. M. (2021), 'Echolocation activity of harbour porpoises, *Phocoena phocoena*, shows seasonal artificial reef attraction despite elevated noise levels close to oil and gas platforms', Ecological Solutions and Evidence 2:e12055.

CMACS (2012), 'East Anglia Three Offshore Wind Farm: Electromagnetic Field Environmental Appraisal. Assessment of EMF on sub tidal marine ecology', https://www.scottishpowerrenewables.com/userfiles/file/6.3.9-2-Volume-3-Chapter-9-Underwater-Noise-and-Electromagnetic-Fields-Appendix-9.2.pdf [Accessed: May 2025].

Compagno, L.J.V. (1984), 'FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1: Hexanchiformes to Lamniformes', FAO Fish. Synop., 125: 1-249.

Cooke, J.G. (2018a), '*Balaenoptera acutorostrata*. The IUCN Red List of Threatened Species 2018: e.T2474A50348265', https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T2474A50348265.en. Accessed: April 2025].

Cooke, J.G. (2018b), '*Megaptera novaeangliae*. The IUCN Red List of Threatened Species 2018: e.T13006A50362794', https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T13006A50362794.en. [Accessed: April 2025].

Copping, A. E., Hemery, L. G., Overhus, D. M., Garavelli, L., Freeman, M. C., Whiting, J. M., Gorton, A. M., Farr, H. K., Rose, D. J., & Tugade, L. G. (2020). Potential Environmental Effects of Marine Renewable Energy Development—The State of the Science. Journal of Marine Science and Engineering, 8(11), 879. https://doi.org/10.3390/jmse8110879

Copping, A., and Hemery, L. (2020), 'OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World', Report for Ocean Energy Systems (OES).

Cornish Seal Sanctuary. (2023), 'Confused Cornish seals give up on wash-out summer and start prepping for winter' Confused Cornish seals give up on wash-out summer and start prepping for winter [Accessed: March 2025].

Cornwall Wildlife Trust (2020), 'Cornwall Wildlife Trust Seaquest Project – Review of land-based effort data 2010-2020', https://www.cornwallwildlifetrust.org.uk/sites/default/files/2022-07/Seaquest%20Southwest%20Land%20Based%20Effort%20Survey%20Review%202010%20-%202022%20Public%20Report%20%20final_0.pdf [Accessed: March 2025].

Cotton, P. A., Sims, D. W., Fanshawe, S., and Chadwick, M. (2005), 'The effects of climate variability on zooplankton and basking shark (*Cetorhinus maximus*) relative abundance off southwest Britain', Fish. Oceanogr, 14: 151–155.

Cowling, M., Kirkwood, R., Boren, L.J., Sutherland, D.R., and Scarpaci, C. (2015), 'The effects of vessel approaches on the New Zealand fur seal (*Arctocephalus forsteri*) in the Bay of Plenty, New Zealand', Marine Mammal Science, 31: 501-519.

Cranford,T. W. and Krysl, P. (2015), 'Fin Whale Sound Reception Mechanisms: Skull Vibration Enables Low-Frequency Hearing', PLoS ONE 10/1: e0116222.

Crocker, S.E., & Fratantonio, F.D. (2016). Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys.

Crocker, S.E., Fratantonio, F.D., Hart, P., Foster, D.S., O'Brien, T.F., & Labak, S.J. (2019). Measurement of Sounds Emitted by Certain High-Resolution Geophysical Survey Systems. IEEE Journal of Oceanic Engineering, 44, 796-813.

Culloch, R. M., Anderwald, P., Brandecker, A., Haberlin, D., McGovern, B., Pinfield, R., Visser, F., Jessopp, M. and Cronin, M. (2016), 'Effect of construction-related activities and vessel traffic on marine mammals', Marine Ecology Progress Series, 549:231-242.

Curtin, S., Richards, S. and Westcott, S. (2009), 'Tourism and grey seals in South Devon: management strategies, voluntary controls and tourists' perceptions of disturbance', Current Issues in Tourism, 12/1: 59-81.

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., Sundermeyer, J. and Siebert, U. (2013), 'Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore windfarm in Germany', Environmental Research Letters, 8/2: p025002.

David, J.A. (2006), 'Likely sensitivity of bottlenose dolphins to pile-driving noise', Water and Environment Journal, 20(1): 48-54.

Davison, N.J., ten Doeschate, M. and Brownlow, A. (2020), 'Scottish Marine Animal Stranding Scheme Annual Report 2019 report to Marine Directorate, Scottish Government'.

Davison, N.J. and ten Doeschate, M. (2021), 'Scottish Marine Animal Stranding Scheme Annual Report 2020 report to Marine Directorate, Scottish Government'.

Deecke, V. B., Slater, P. J. and Ford, J. K. (2002), 'Selective habituation shapes acoustic predator recognition in harbour seals', Nature, 420/6912: 171-173.

Degraer, S., Carey, D., Coolen, J., Hutchison, Z., Kerckhof, F., Rumes, B. and Vanaverbeke. J. (2020), 'Offshore wind farm artificial reefs affect ecosystem structure and functioning: a synthesis,' Oceanography, 33:48-57.

Dehnhardt, G., Mauck, B., Hanke, W., and Bleckmann, H. (2001), 'Hydrodynamic trail-following in harbor seals (Phoca vitulina)', Science, 293: 102–104.

Delefosse, M., M. L. Rahbek, L. Roesen, and K. T. Clausen. (2018). Marine mammal sightings around oil and gas installations in the central North Sea. Journal of the Marine Biological Association of the United Kingdom 98:993-1001

Diederichs, A., Nehls, G., Dähne, M., Adler, S., Koschinski, S. and Verfuß, U. (2008), 'Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore windfarms', BioConsult SH report to COWRIE Ltd.

Diederichs, A., G. Nehls, and M. J. Brandt. (2010), 'Does sand extraction near Sylt affect harbour porpoises?' Wadden Sea Ecosystem No. 26 edition, Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Douglas A. B., Calambokidis J., Raverty S., Jeffries S. J., Lambourn D. M. and Norman S. A. (2008), 'Incidence of ship strikes of large whales in Washington State', Journal of the Marine Biological Association of the United Kingdom, 88/6: 1121–1132.

Drewery, H.M. (2012), 'Basking Shark (*Cetorhinus maximus*) Literature Review, Current Research and New Research Ideas', Marine Scotland Science Report, 24/12.

Duarte, C.M., Chapuis, L., Collin, S.P., Costa, D.P., Devassy, R.P., Eguiluz, V.M., Erbe, C., Gordon, T.A., Halpern, B.S., Harding, H.R. and Havlik, M.N. (2021), 'The soundscape of the Anthropocene ocean', Science, 371/6529, p.eaba4658.

Dukas, R. (2002), 'Behavioural and ecological consequences of limited attention', Philosophical Transactions of the Royal Society of London B, 357: 1539–1547.

Dunlop, R. A. (2016), 'The effect of vessel noise on humpback whale, *Megaptera novaeangliae*, communication behaviour', Animal Behaviour, 111: 13-21.

Dunlop, R. A., Noad, M. J., McCauley, R. D., Scott-Hayward, L., Kniest, E., Slade, R., Paton, D. and Cato, D. H. (2017), 'Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity', Journal of Experimental Biology, 220: 2878-2886.

Dyndo, M., Wiśniewska, D.M., Rojano-Doñate, L. and Madsen, P.T. (2015), 'Harbour porpoises react to low levels of high frequency vessel noise', Scientific reports, 5/1, 11083.

Edds-Walton, P. L. (2000). 'Vocalizations Of Minke Whales *Balaenoptera Acutorostrata* In The St. Lawrence Estuary', Bioacoustics, 11:31-50.

Ellison, W. T., Southall, B. L., Clark, C. W., & Frankel, A. S. (2012), 'A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds', Conservation biology : the journal of the Society for Conservation Biology, 26/1: 21–28.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R. (2016), 'Communication masking in marine mammals: A review and research strategy', Marine pollution bulletin, 103/1-2: 15-38.

Erbe, C., Dunlop, R. and Dolman, S. (2018), 'Effects of Noise on Marine Mammals', in H. Slabberkoorn, R. J. Dooling, Ar. N. Popper and R. R. Fay (eds.), Effects of Anthropogenic Noise on Animals, Springer Handbook of Auditory Research (New York, NY: Springer and ASA Press).

European Commission (2020), 'The European Biodiversity Strategy to 2030', https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en [Accessed: May 2025].

European Commission (2021), 'European Union Guidance on wind energy developments and Natura 2000 legislation'.

Evans, P. G. H. (1990). 'Marine Mammals in the English Channel in relation to proposed dredging scheme', Sea Watch Foundation, Oxford.

Evans, P.G.H., Anderwald, P. and Baines, M.E. (2003), 'UK cetacean status review', Report to English Nature and the Countryside Council for Wales, Sea Watch Foundation, Oxford. 160.

Evans, P. G. H. and Bjørge, A. (2013), 'Impacts of climate change on marine mammals', MCCIP Science Review, 2013: 134-148.

Fandel, A.D., Garrod, A., Hoover, A.L., Wingfield, J.E., Lyubchich, V., Secor, D.H., Hodge, K.B., Rice, A.N. and Bailey, H. (2020). Effects of intense storm events on dolphin occurrence and foraging behavior. Scientific Reports, 10(1). doi:https://doi.org/10.1038/s41598-020-76077-3.

Federal Energy Regulatory Commission (FERC) (2010), 'Environmental assessment for hydropower licence : 10 Reedsport OPT Wave Park Project - Project No. 12713-002 Oregon'.

Fernandez-Betelu, O., Graham, I. M., Brookes, K. L., Cheney, B. J., Barton, T. R. and Thompson, P. M. (2021), 'Far-Field Effects of Impulsive Noise on Coastal Bottlenose Dolphins', Frontiers in Marine Science, 8:664230.

Fernandez-Betelu, O., V. Iorio-Merlo, I. M. Graham, A. Benhemma-Le Gall, B. Cheney, A. Payo-Payo, and P. M. Thompson. (2024), 'PrePARED Task 4.1 – Using modelled sandeel distribution maps to characterise spatio-temporal variation in the occurrence and foraging behaviour of harbour porpoises around offshore windfarms'.

Findlay, C.R., Rojano-Doñate, L., Tougaard, J., Johnson, M.P. and Madsen, P.T. (2023), 'Small reductions in cargo vessel speed substantially reduce noise impacts to marine mammals', Science Advances, 9/25, p.eadf2987.

Finneran, J. J. (2015), 'Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015', The Journal of the Acoustical Society of America, 138/3: 1702-1726.

Flotation Energy. (2023). Cenos Offshore Wind Farm Scoping Report.

Francis, M.P., & Duffy, C. (2002), 'Distribution, seasonal abundance and bycatch of basking sharks (*Cetorhinus maximus*) in New Zealand, with observations on their winter habitat', Marine Biology, 140: 831-842.

Fugro (2021), 'EPS and Basking Shark Risk Assessment for Survey Operation- Orkney Section, Orkney Islands', Global Marine Group.


Garavelli, L. (2020). '2020 State of the Science Report-Chapter 8: Encounters of Marine Animals with Marine Renewable Energy Device Mooring Systems and Subsea Cables', 10.2172/1633184.

Gazo, M., Aparicio, F., Cedenilla, M. A., Layna, J. F. and González, L. M. (2000), 'Pup survival in the Mediterranean monk seal (*Monachus monachus*) colony at Cabo Blanco Peninsula (Western Sahara-Mauritania)', Marine Mammal Science, 16: 158-168.

Gedamke, J., Costa, D. P. and Dunstan, A. (2001). 'Localization and visual verification of a complex minke whale vocalization', The Journal of the Acoustical Society of America, 109:3038-3047.

Geelhoed, S. C. V., Fiedrich, E., Joost, M., Machiels, M. A. M. and Ströber, N. (2018), 'Gemini T-c: aerial surveys and passive acoustic monitoring of harbour porpoises 2015', Wageningen Marine Research Report C020/17.

Genesis. (2011). 'Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive', Report for the Department of Energy and Climate Change.

Gill, A.B. and Taylor H. (2001), 'The potential effects of electromagnetic fields generated by cabling between offshore wind turbines upon Elasmobranch Fishes', Countryside Council for Wales.

Gill, A.B. & Kimber, J.A. (2005), 'The potential for cooperative management of elasmobranchs and offshore renewable energy development in UK waters', Journal of the Marine Biological Association of the United Kingdom, 85/5: 1075-1081.

Gill, A.B., Huang, Y., Gloyne-Philips, I., Metcalfe, J., Quayle, V., Spencer, J., and Wearmouth, V. (2009), 'COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2: EMF-sensitive fish response to EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry', Commissioned by COWRIE Ltd (Project reference COWRIE-EMF-1-06), 68.

Gill, A. B., Bartlett, M., and Thomsen, F. (2012), 'Potential interactions between diadromous fishes of U.K. conservation importance and electromagnetic fields and subsea noise from marine renewable energy developments,' J. Fish Biol. 81/2: 664–695.

Gill, A.B. and Desender, M., (2020). 2020 State of the Science Report, chapter 5: risk to animals from electromagnetic fields emitted by electric cables and marine renewable energy devices.

Gilles, A., Authier, M., Ramirez-Martinez, N. C., Araújo, H., Blanchard, A., Carlström, J., Eira, C., Dorémus, G., Fernández-Maldonado, C., Geelhoed, S. C. V., Kyhn, L., Laran, S., Nachtsheim, D., Panigada, S., Pigeault, R., Sequeira, M., Sveegaard, S., Taylor, N. L., Owen, K., Saavedra, C., Vázquez-Bonales, J.A., Unger, B., and Hammond, P. S. (2023), 'Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys', Final report published 29 September 2023, 64.

Gillespie, D., Palmer, L., Macaulay, J.D., Sparling, C.E., & Hastie, G.D. (2021). Harbour porpoises exhibit localized evasion of a tidal turbine. *Aquatic Conservation: Marine and Freshwater Ecosystems.*

Gillespie, D., G. Hastie, J. Montabaranom, E. Longden, K. Rapson, A. Holoborodko, and C. Sparling. (2023). Automated Detection and Tracking of Marine Mammals in the Vicinity of Tidal Turbines Using Multibeam Sonar. Journal of Marine Science and Engineering 11:2095

Goldstein, T., Johnson, S. P., Phillips, A. V., Hanni, K. D., Fauguier, D. A. and Gulland, F. M. D. (1999), 'Human-related injuries observed in live stranded pinnipeds along the central California coast 1986-1998', Aquatic Mammals, 25: 43–51.

Graham, I. M., Farcas, A., Merchant, N. D. and Thompson, P. (2017a), 'Beatrice Offshore Windfarm: An interim estimate of the probability of porpoise displacement at different unweighted single-pulse sound exposure levels', Prepared by the University of Aberdeen for Beatrice Offshore Windfarm Ltd.

Graham, I. M., Pirotta, E., Merchant, N. D., Farcas, A., Barton, T. R., Cheney, B., Hastie, G. D. and Thompson, P. M. (2017b), 'Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during harbor construction', Ecosphere 8.

Graham, I. M., Merchant, N. D., Farcas, A., Barton, T. R. C., Cheney, B., Bono, S. and Thompson, P. M. (2019), 'Harbour porpoise responses to pile-driving diminish over time', Royal Society Open Science, 6:190335: 1-13.

Green Volt (2023), 'Green Volt Offshore Windfarm Offshore EIA Report: Volume 1, Chapter 11, Marine Mammal Ecology'.

Greene, C. (1987), 'Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea', The Journal of the Acoustical Society of America.

Greenlink (2019), 'Greenlink Marine Environmental Impact Assessment Report – Ireland'.

Gregory, P.R. and Rowden, A.A. (2001), 'Behaviour patterns of bottlenose dolphins (*Tursiops truncatus*) relative to tidal state, time-of-day, and boat traffic in Cardigan Bay, West Wales', Aquatic Mammals, 27/2: 105-113.

Guan, S., and T. Brookens. (2021), 'The Use of Psychoacoustics in Marine Mammal Conservation in the United States: From Science to Management and Policy', Journal of Marine Science and Engineering, 9:507.

Hague, E. L., Sinclair, R. R. and Sparling, C. E. (2020), 'Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters', Scottish Marine and Freshwater Science 11/12.

Haine, O.S., Ridd, P.V. and Rowe, R. (2001), 'Range of electrosensory detection of prey by *Carcharhinus melanopterus* and *Himantura granulata*', Marine and Freshwater Research, 52: 291-296.

Hammond, P., and Wilson, L. (2016), 'Grey seal diet composition and prey consumption', Scottish Marine and Freshwater Science 7: 20-47.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J. (2021), 'Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys', Wageningen Marine Research.

Harnois, V., Smith, H. C., Benjamins, S. and Johanning, L. (2015).' Assessment of entanglement risk to marine megafauna due to offshore renewable energy mooring systems', International Journal of Marine Energy, 11:27-49.

Hart N.S. and Collin, S.P. (2015), 'Sharks senses and shark repellents', Integrative Zoology, 10: 38-64.

Hartley Anderson Ltd. (2020). Underwater acoustic surveys: review of source characteristics, impacts on marine species, current regulatory framework and recommendations for potential management options., NRW Evidence Report No: 448, 119pp, NRW, Bangor, UK.

Hastie, G.D., Russel, D.J.F., McConnell, B., Moss, S., Thompson, D. and Janik, V.M. (2015). 'Sound exposure in harbour seals during the installation of an offshore wind farm: predictions of auditory damage', Journal of Applied Ecology, 52: 631-640.

Hastie, G. D., Russell, D. J., Benjamins, S., Moss, S., Wilson, B., and Thompson, D. (2016). Dynamic habitat corridors for marine predators; intensive use of a coastal channel by harbour seals is modulated by tidal currents. Behavioral Ecology and Sociobiology:1-14.

Heiler, J., Elwen, S. H., Kriesell, H. J. and Gridley, T. (2016), 'Changes in bottlenose dolphin whistle parameters related to vessel presence, surface behaviour and group composition', Animal behaviour, 117: 167-177.

Heinänen, S. and Skov, H. (2015), 'The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area', JNCC Report No. 544, JNCC Peterborough.

Hermannsen, L., Tougaard, J., Beedholm, K., Nabe-Nielsen, J. and Madsen, P. T. (2015), Characteristics and Propagation of Airgun Pulses in Shallow Water with Implications for Effects on Small Marine Mammals. PLoS ONE 10(7): e0133436. https://doi.org/10.1371/journal.pone.0133436

Hernandez-Milian, G., S. Berrow, M. B. Santos, D. Reid, and E. Rogan. (2015), 'Insights into the Trophic Ecology of Bottlenose Dolphins (*Tursiops truncatus*) in Irish Waters', Aquatic Mammals, 41.

Hernandez-Milian, G., Santos, B. M., Reid, D., & Rogan, E. (2016), 'Insights into the diet of Atlantic white-sided dolphins (*Lagenorhynchus acutus*) in the Northeast Atlantic', Marine Mammal Science, 32/2: 735-742.

HiDef Aerial Surveying Limited (HiDef). (2025), Digital video aerial surveys of seabirds and marine megafauna at Cerulean Winds Aspen: Two-Year Report. April 2023 to February 2025.

Hildebrand, J.A. (2009), 'Anthropogenic and natural sources of ambient noise in the ocean', Marine Ecology Progress Series, 395: 5–20.

HM Government, Northern Ireland Executive, Scottish Government and Welsh Assembly Government (2011), 'UK Marine Policy Statement', https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf [Accessed: May 2025].

Hodgins, N.K., Steel, E.M., Dyke, K., Walters, A.E.M., Dolman, S.J., Hall, K., Neave-Webb, E., Evans, P.G.H., Bird, C., Robinson, K.P., Marwood, E.M., Foubister, R., Harrop, H., Knight, A., and Munro, K. (2024), 'Using citizen science to better understand Risso's dolphin (*Grampus griseus*) presence in northeast Scotland and the Northern Isles', Front. Conserv. Sci. 5:1366064.

Hoekendijk, J. P., Spitz, J., Read, A. J., Leopold, M. F. and Fontaine, M. C. (2018), 'Resilience of harbor porpoises to anthropogenic disturbance: Must they really feed continuously?', Marine Mammal Science, 34/1: 258-264.

Horwath, S., Hassrick, J., Grismala, R., Diller, E., Krebs, J., and Manhard, R. (2020), 'Comparison of environmental effects from different offshore wind turbine foundations', Bureau of Ocean Energy Management, Fairfax, VA, USA, OCS Study BOEM, 41.

Hutchison, Z.L., Gill, A.B., Sigray, P., He, H. and King, J.W. (2020a), 'Anthropogenic EMF influence the behaviour of bottom dwelling marine species'. Scientific Reports 10:4219

Hutchison, Z.L., Secor, D.H., Gill, A.B. (2020b), 'The interaction between resource species and electromagnetic fields associated with electricity production by offshore wind farms', Oceanography, 33: 96–107.

Institute of Ecology and Environmental Management (IEEM) (2010), 'Guidelines For Ecological Impact Assessment In Britain And Ireland Marine And Coastal Guidelines For Ecological Impact Assessment In The United Kingdom', Winchester: Chartered Institute of Ecology and Environmental Management.

Inter-Agency Marine Mammal Working Group (IAMMWG) (2023), 'Review of Management Unit boundaries for cetaceans in UK waters (2023)', JNCC Report 734, JNCC, Peterborough, ISSN 0963-8091.

Iorio-Merlo, V., Fernandez-Betelu, O., Benhemma-Le Gall, A., Graham, I. M., and. Thompson, P. M (2023). Task 4.2. Work Package 4 – Changes in the occurrence of harbour porpoises following the construction of Moray Firth offshore windfarms. PrePARED Report, No. 002. March 2024.

Jensen, A. S., and Silber, G. K. (2003), 'Large whale ship strike database', U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/OPR-25.

Jansen, O. E., Leopold, M. F., Meesters, E. H. W. G. and Smeenk, C. (2010), 'Are white-beaked dolphins *Lagenorhynchus albirostris* food specialists? Their diet in the southern North Sea', Journal of the Marine Biological Association of the United Kingdom, 90: 1501-1508.

Jansen, J. K., Brady, G. M., Ver Hoef, J. M., Boveng, P. L., Suydam, R., and Clark, C. (2015),'Spatially Estimating Disturbance of Harbor Seals (*Phoca vitulina*)', PLoS One, 10/7, e0129798.

Johnson, A., Salvador, G., Kenney, J., Robbins, J., Kraus, S., Landry, S. and Clapham, P. (2005), 'Fishing gear involved in entanglements of right and humpback whales', Marine Mammal Science, 21:635-645.

Joint Nature Conservation Committee (JNCC) (2010), 'Statutory nature conservation agency protocol for minimizing the risk of injury to marine mammals from piling noise'.

Joint Nature Conservation Committee (JNCC) (2017), 'JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys'.

Joint Nature Conservation Committee (JNCC) (2019a), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species S1351 - Harbour porpoise (*Phocoena*

*phocoena*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S1351-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019b), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2032 - White-beaked dolphin (*Lagenorhynchus albirostris*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S2032-UK-Habitats-Directive-Art17-2019.pdf Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019c), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1349 - Bottlenose dolphin (*Tursiops truncatus)*United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S1349-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019d), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2030 - Risso's dolphin (*Grampus griseus*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S2030-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019e), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2031 - Atlantic white-sided dolphin (*Lagenorhynchus acutus*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S2031-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019f), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2618 - Minke whale (*Balaenoptera acutorostrata*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S2618-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019g), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1345 - Humpback whale (*Megaptera novaeangliae*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S1345-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019h), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1365 - Common seal (*Phoca vitulina*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S1365-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2019i), 'European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1364 - Grey seal (*Halichoerus grypus*) United Kingdom', https://jncc.gov.uk/jncc-assets/Art17/S1364-UK-Habitats-Directive-Art17-2019.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2020), 'Guidance for assessing the significance of noise disturbance against the Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland).', JNCC Report No. 654, JNCC, Peterborough, ISSN 0963-8091.

Joint Nature Conservation Committee (JNCC) (2023a), 'JNCC guidance for the use of Passive Acoustic Monitoring in UK waters for minimising the risk of injury to marine mammals from offshore activities'.

Joint Nature Conservation Committee (JNCC) (2023b). MNR Disturbance Tool: Description and Output Generation. https://mnr.jncc.gov.uk/assets/mnr/documents/marine_noise_registry_helpguide_2023_v1.1.pdf [Accessed: April 2025].

Joint Nature Conservation Committee (JNCC) (2023c). Southern North Sea MPA. https:// https://jncc.gov.uk/our-work/southern-north-sea-mpa/ [Accessed: June 2025].

Joint Nature Conservation Committee (JNCC) (2025), 'JNCC guidelines for minimising the risk of injury to marine mammals from unexploded ordnance (UXO) clearance in the marine environment', JNCC, Aberdeen.

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

Joint Nature Conservation Committee (JNCC) on behalf of the Four Countries' Biodiversity Group (4CBG) (2024), 'UK Biodiversity Framework', JNCC, Peterborough, UK Biodiversity Framework | JNCC Resource Hub. [Accessed: April 2025].

Jones, E., Hastie, G., Smout, S., Onoufriou, J., Merchant, N. D., Brookes, K. and Thompson, D. (2017), 'Seals and shipping: quantifying population risk and individual exposure to vessel noise', Journal of Applied Ecology, 54: 1930-1940.

Kalmijn, A.J. (1982), 'Electric and magnetic field detection in elasmobranch fishes', Science, 218/4575: 916-918.

Karlsson, R., Tivefälth, M., Duranović, I., Martinsson, S., Kjølhamar, A., & Murvoll, M. K. (2022), 'Artificial hard-substrate colonisation in the offshore Hywind Scotland Pilot Park', Wind Energy Science, 7/2: 801-814.

Kastelein, R., Jennings, N., Verboom, W., De Haan, D. and Schooneman, N. (2006), 'Differences in the response of a striped dolphin (*Stenella coeruleoalba*) and a harbour porpoise (*Phocoena phocoena*) to an acoustic alarm', Marine Environmental Research, 61: 363-378.

Kastelein, R. A., Gransier, R., Hoek, L. and de Jong, C. A. (2012a), 'The hearing threshold of a harbor porpoise (*Phocoena phocoena*) for impulsive sounds (L)', The Journal of the Acoustical Society of America, 132/2: 607-610.

Kastelein, R. A., Gransier, R., Hoek, L., Macleod, A. and Terhune, J. M. (2012b), 'Hearing threshold shifts and recovery in harbor seals (*Phoca vitulina*) after octave-band noise exposure at 4 kHz', The Journal of the Acoustical Society of America, 132/4: 2745-2761.

Kastelein, R. A., van Heerden, D., Gransier, R. and Hoek, L. (2013a), 'Behavioral responses of a harbor porpoise (*Phocoena phocoena*) to playbacks of broadband pile driving sounds', Marine environmental research, 92: 206-214.

Kastelein, R. A., Gransier, R., Hoek, L. and Rambags, M. (2013b), 'Hearing frequency thresholds of a harbor porpoise (*Phocoena phocoena*) temporarily affected by a continuous 1.5 kHz tone', The Journal of the Acoustical Society of America, 134/3: .2286-2292.

Kastelein, R. A., Gransier, R., Marijt, M. A. and Hoek, L. (2015), 'Hearing frequency thresholds of harbor porpoises (*Phocoena phocoena*) temporarily affected by played back offshore pile driving sounds', The Journal of the Acoustical Society of America, 137/2: 556-564.

Kastelein, R. A., Helder-Hoek, L., Covi, J. and Gransier, R. (2016), 'Pile driving playback sounds and temporary threshold shift in harbor porpoises (*Phocoena phocoena*): Effect of exposure duration', The Journal of the Acoustical Society of America, 139/5: 2842-2851.

Kastelein, R. A., Helder-Hoek, L., Van de Voorde, S., von Benda-Beckmann, A. M., Lam, F. P. A., Jansen, E., de Jong, C. A. and Ainslie, M. A. (2017), 'Temporary hearing threshold shift in a harbor porpoise (*Phocoena phocoena*) after exposure to multiple airgun sounds', The Journal of the Acoustical Society of America, 142/4: 2430-2442.

Kempster, R.M. & Collin, S.P. (2011), 'Electrosensory pore distribution and feeding in the basking shark *Cetorhinus maximus* (Lamniformes: Cetorhinidae)', Aquatic Biology, 12/1: 33-36.

Ketten, D. R. (2004), 'Experimental measures of blast and acoustic trauma in marine mammals', Annual Report to the Office of Naval Research Program, FY99-00.

Ketten D. and Mountain D. (2011) 'Modelling minke whale hearing', Final report submitted to the Joint Industry Program by WHOI & Boston University.

Ketten, D. R., van Bemmelen, R., Lam, F. P. A., Kirkwood, R. J. and Ainslie, M. A. (2015), 'Assessing

Kiszka, J. & Braulik, G. (2018a), '*Lagenorhynchus albirostris*. The IUCN Red List of Threatened Species 2018: e.T11142A50361346', https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T11142A50361346.en. [Accessed: April 2025].

Kiszka, J. & Braulik, G. (2018b), '*Grampus griseus*. The IUCN Red List of Threatened Species 2018: e.T9461A50356660', https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T9461A50356660.en. [Accessed: April 2025].

Kimber, J.A., Sims, D.W., Bellamy, P.H. and Gill, A.B. (2011), 'The ability of a benthic elasmobranch to discriminate between biological and artificial electric fields'. Marine Biology 158: 1–8

Knowlton, A.R. and Kraus, S.D. (2001), 'Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean', Journal of Cetacean Research and anagement, 2:193-208.

Koroza, A., and Evans, P. G. H. (2022), 'Bottlenose Dolphin Responses to Boat Traffic Affected by Boat Characteristics and Degree of Compliance to Code of Conduct', Sustainability, 14/9: 5185.

Kvadsheim, P. H., DeRuiter, S., Sivle, L.D., Goldbogen, J., Roland-Hansen, R., Miller, P. J., Lam, F. P. A., Calambokidis, J., Friedlaender, A., Visser, F. and Tyack, P. L. (2017), 'Avoidance responses of minke whales to 1–4 kHz naval sonar', Marine Pollution Bulletin, 121/1-2: 60-68.

Lacey, C., Gilles, A., Herr, H., MacLeod, K., Ridoux, V., Santos, M. B., Sheidat, M., Teilmann, J., Sveegaard, S., Vingada, J. and Viquerat, S. (2022), 'Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys'. University of St Andrews, St Andrews.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., and Podesta, M. (2001), 'Collisions between ships and whales', Marine Mammal Science, 17: 3-75.

Lambert, E., MacLeod, C.D., Hall, K., Brereton, T., Dunn, T.E., Wall, D., Jepson, P.D., Deaville, R. and Pierce, G.J. (2011), 'Quantifying likely cetacean range shifts in response to global climatic change: implications for conservation strategies in a changing world', Endangered Species Research, 15/3: 205-222.

Langton, T.E.S., Beckett, C.L., King, G.L., Gaywood, M.J., (1996), 'Distribution and status of marine turtles in Scottish waters', Scottish National Heritage Research, Survey, and Monitoring Report, No.8.

Lea, M.A., Johnson, D., Ream, R., Sterling, J., Melin, S, and Gelatt, T. (2009), 'Extreme weather events influence dispersal of naive northern fur seals', Biology Letters, 5: 252-257.

Lepper, P.A., Cheong, SH., Robinson, S.P., Wang, L., Tougaard, J., Griffiths, E. and Hartley, J.P. (2024). 'In-situ comparison of high-order detonations and low-order deflagration methodologies for underwater exploded ordnance (UXO) disposal', Marine Pollution Bulletin, 199: 115965.

Lien, J. & Fawcett, L. (1986), 'Distribution of basking sharks, *Cetorhinus maximus*, incidentally caught in inshore fishing gear in Newfoundland', Canadian Field-Naturalist, 100: 246-252.

Liu, F. (1973). Snap loads in lifting and mooring cable systems induced by surface wave conditions.

Løviknes, S., Jensen, K. H., Krafft, B. A., Anthonypillai, V. and Nøttestad, L. (2021), 'Feeding Hotspots and Distribution of Fin and Humpback Whales in the Norwegian Sea From 2013 to 2018', Frontiers in Marine Science, 8.

Lucke, K., Lepper, P.A., Hoeve, B., Everaarts, E., van Elk, N. and Siebert, U. (2007), 'Perception of Low-Frequency Acoustic Signals by a Harbour Porpoise (*Phocoena phocoena*) in the Presence of Simulated Offshore Wind Turbine Noise', Aquatic Mammals, 33/1: 55-68.

Lucke, K., Siebert, U., Lepper, P.A., Blanchet, M.A. (2009), 'Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli', The Journal of the Acoustical Society of America, 125/6: 4060-4070.

Luksenburg, J. A. (2014), 'Prevalence of External Injuries in Small Cetaceans in Aruban Waters, Southern Caribbean', PLOS ONE, 9/2: e88988.

Lusseau, D. (2003), 'Male and female bottlenose dolphins Tursiops spp. have different strategies to avoid interactions with tour boats in Doubtful Sound, New Zealand', Marine Ecology Progress Series, 257: 267-274.

Lusseau, D. and Higham, J.E.S. (2004), 'Managing the impacts of dolphin-based tourism through the definition of critical habitats: the case of bottlenose dolphins (*Tursiops spp.*) in Doubtful Sound, New Zealand', Tourism Management, 25/6:657-667.

Lusseau, D. (2006), 'The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand', Marine Mammal Science, 22: 802-818.

Lusseau, D. and Bejder, L. (2007),'The long-term consequences of short-term responses to disturbance experiences from whale watching impact assessment', International Journal of Comparative Psychology, 20/2.

Lusseau, D., New, L., Donovan, C., Cheney, B., Thompson, P., Hastie, G. and Harwood, J. (2011), 'The development of a framework to understand and predict the population consequences of disturbances for the Moray Firth bottlenose dolphin population', Scottish Natural Heritage Commissioned Report, 98.

MacLennan, E., L. Hartny-Mills, F. L. Read, S. J. Dolman, A. Philp, K. E. Dearing, D. Jarvis, and A. C. Brownlow. (2021), 'Scottish Entanglement Alliance (SEA) - understanding the scale and impacts of marine animal entanglement in the Scottish creel fishery', Scottish Entanglement Alliance (SEA).

MacLeod, C. D. (2009), 'Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis', Endangered Species Research, 7/2: 125-136.

MacLeod, C. D. (2013), 'White-beaked Dolphins in the Northeast Atlantic: A brief review of their ecology and potential threats to conservation status', Proceedings of the ECS / ASCOBANS/ WDC Workshop Towards a Conservation Strategy for White-beaked Dolphins in the Northeast Atlantic, ECS SPECIAL PUBLICATION SERIES.

MacLeod, C. D., Santos, M. B., Burns, F., Brownlow, A., and Pierce, G. J. (2014), 'Can habitat modelling for the octopus *Eledone cirrhosa* help identify key areas for Risso's dolphin in Scottish waters?', 725/1: 125–136.

Madsen, P., Wahlberg, M., Tougaard, J., Lucke, K. and Tyack, P. (2006), 'Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs', Marine Ecology Progress Series, 309: 279–295

Malme, C., P. Miles, C. Clark, P. Tyack, and J. Bird. (1984), 'Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior—Phase II', U-S. Department of the Interior Minerals Management Service.

Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Marine Directorate (2025). Marine licensing – unexploded ordnance clearance: application guidance. https://www.gov.scot/publications/marine-licensing-unexploded-ordnance-clearance-guidance/[Accessed: June 2025]

Marine Management Organisation (MMO) (2015). Modelled Mapping of Continuous Underwater Noise Generated by Activities. A report produced for the Marine Management Organisation, pp 50. MMO Project No: 1097. ISBN: 978-1-909452-87-9.

Marine Scotland (2014), 'Guidance on the Offence of Harassment at Seal Haul-out Sites'. guidance-on-the-offence-of-harassment-at-seal-haul-out-sites.pdf-1 [Accessed: April 2025].

Marine Scotland (2020), 'The protection of Marine European Protected Species from injury and disturbance Guidance for Scottish Inshore Waters (July 2020 Version)' . https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/07/marine-european-protected-species-protection-from-injury-and-disturbance/documents/marine-european-protected-species-guidance-july-2020/marine-european-protected-species-guidance-july-2020/govscot%3Adocument/EPS%2Bguidance%2BJuly%2B2020.pdf [Accessed: April 2025].

Marine Scotland (2022), 'Marine Scotland – License Operations Team: Scoping Opinion for Green Volt Offshore Windfarm', https://marine.gov.scot/sites/default/files/scoping_opinion_9.pdf [Accessed: May 2025].

Marley, S., Kent, C. S. and Erbe, C. (2017a), 'Occupancy of bottlenose dolphins (Tursiops aduncus) in relation to vessel traffic, dredging, and environmental variables within a highly urbanised estuary', Hydrobiologia, 792: 243-263.

Marley, S. A., Salgado Kent, C. P., Erbe, C. and Parnum, I. M. (2017b), 'Effects of vessel traffic and underwater noise on the movement, behaviour and vocalisations of bottlenose dolphins in an urbanised estuary', Scientific Reports, 7/1.

MarLIN. (2025). The Marine Life Information Network. Basking shark *(Cetorhinus maximus)*. Www.marlin.ac.uk. https://www.marlin.ac.uk/species/detail/1438 [Accessed: April 2025].

Martay, B., Macphie, K.H., Bowgen, K.M., Pearce-Higgins, J.W., Robinson, R.A., Scott, S.E., Williams, J.M. (2023), 'Climate change and migratory species: a review of impacts, conservation actions, indicators and ecosystem services. Part 1 – Impacts of climate change on migratory species', JNCC, Peterborough, ISBN 978-0-86139-001-4. Climate change and migratory species: a review of impacts, conservation actions, indicators and ecosystem services | JNCC Resource Hub [Accessed: April 2025].

Martin, B., MacDonnell, J., Vallarta, J., Lumsden, E. and Burns, R. (2011). 'HYWIND acoustic measurement report: Ambient levels and HYWIND signature. Technical report for Statoil by Jasco Applied Sciences'. Available online at https://static1.squarespace.com/static/52aa2773e4b0f29916f46675/t/5fda3a9324291a0a8b1d0a25/1608137377245/Equinor-Hywind-Acoustic-Measurement-Report-JASCO-00229- December-2011.pdf (Accessed: May 2025)

Martin, R.A., da Silva, C.R., Moore, M.P. and Diamond, S.E. (2023), 'When will a changing climate outpace adaptive evolution?', Wiley Interdisciplinary Reviews: Climate Change, 14/6: p.e852.

Maxwell, S.M., Kershaw, F., Locke, C.C., Conners, M.G., Dawson, C., Aylesworth, S., Loomis, R. and Johnson, A.F. (2022). 'Potential impacts of floating wind turbine technology for marine species and habitats', Journal of Environmental Management, 307:114577.

McComb, M., Tricas, T. and Kajiura, S. (2009), 'Enhanced visual fields in hammerhead sharks. The Journal of experimental biology', 212: 4010-8.

McConnell, B., M. Fedak, P. Lovell, and P. Hammond. (1999), 'Movements and foraging areas of grey seals in the North Sea', Journal of Applied Ecology 36: 573-590.

McGarry, T., Boisseau, O., Stephenson, S. and Compton, R. (2017), 'Understanding the Effectiveness of Acoustic Deterrent Devices (ADDs) on Minke Whale (*Balaenoptera acutorostrata*), a Low Frequency Cetacean', Report for the Offshore Renewables Joint Industry Programme (ORJIP) Project 4, Phase 2. Prepared on behalf of the Carbon Trust.

McGarry, T., De Silva, R., Canning, S., Mendes, S., Prior, A., Stephenson, S. & Wilson, J. (2022), 'Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation' (Version 4: October 2022), JNCC Report No. 615, JNCC, Peterborough, ISSN 0963- 8091. Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation (Version 4) [Accessed: April 2025].

McQueen, A. D., Suedek, B. C., de Jong, C., Thomsen, F. (2020), 'Ecological Risk Assessment of underwater sound from dredging operations', Integrated Environmental Assessment and Management, 16:481-493.

Mellinger, D. K., Carson, C. D. and Clark, C. W. (2000). 'Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico', Marine Mammal Science, 16:739-756.

Merchant, N. D.,Brookes, K.L., Faulkner, R.C., Bicknell, A.W.J., Godley, B.J. and Witt, M.J. (2016). Underwater Noise Levels in UK waters. Nature Scientific Reports 6, 36942.

Meyer, C.G., Holland, K.N., and Papastamatiou, Y.P. (2005), 'Sharks can detect changes in the geomagnetic field', Journal of The Royal Society Interface, 2/2:129–130.

Mikkelsen, L., Johnson, M., Wisniewska, D. M., Neer, A. van, Siebert, U., Madsen, P. T., and Teilmann, J. (2019), 'Long term sound and movement recording tags to study natural behavior and reaction to ship noise of seals', Ecology and Evolution, 9/5:2588–2601.

Mooney, T. A., Yang, W. C., Yu, H. Y., Ketten, D. R. and Jen, I. F. (2015), 'Hearing abilities and sound reception of broadband sounds in an adult Risso's dolphin (*Grampus griseus*)', Journal of Comparative Physiology A, 201: 751-761.

Morell, M., IJsseldijk, L.L., Berends, A.J., Gröne, A., Siebert, U., Raverty, S.A., Shadwick, R.E. and Kik, M.J. (2021), 'Evidence of hearing loss and unrelated toxoplasmosis in a free-ranging harbour porpoise (*Phocoena phocoena*)', Animals, 11/11:3058.

Muir Mhòr (2023), 'Muir Mhòr Offshore Wind Farm, Offshore EIA Scoping Report'.

Musick, J. A. (1997), 'Ecology and conservation of long-lived marine animals', Symposium on Conservation of Long-Lived Marine Animals, Monterey, Ca, 1-10.

Myrberg, A.A. Jr (2001), 'The Acoustical Biology of Elasmobranchs', Environmental Biology of Fishes. 60: 31-46.

Nabe-Nielsen, J., Van Beest, F., Grimm, V., Sibly, R., Teilmann, J. & Thompson, P. M. (2018), 'Predicting the impacts of anthropogenic disturbances on marine populations', Conservation Letters, e12563.

Nachtigall, P. E., Mooney, T. A., Taylor, K. A., Miller, L. A., Rasmussen, M. H., Akamatsu, T., Teilmann, J., Linnenschmidt, M. and Vikingsson, G. A.  (2008), 'Shipboard measurements of the hearing of the white-beaked dolphin *Lagenorhynchus albirostris'*, Journal of Experimental Biology, 211: 642-647.

Nachtigall, P. E., Supin, A. Y., Smith, A. B. and Pacini, A. F. (2016), 'Expectancy and conditioned hearing levels in the bottlenose dolphin (*Tursiops truncatus*)', Journal of Experimental Biology, 219(6): 844-850.

National Marine Fisheries Service (NMFS) (2018), '2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0)', NOAA Technical Memorandum NMFS-OPR-59, National Oceanic and Atmospheric Administration.

National Marine Fisheries Service (NMFS). (2020). Takes of Marine Mammals Incident to Specified Activities; Taking Marine Mammals Incidental to Offshore Wind Construction Activities off of Virginia.

National Marine Fisheries Service (NMFS) (2024).' National Marine Fisheries Service: Summary of Marine Mammal Protection Act Acoustic Thresholds'.

NatureScot (2019), 'Basking sharks - Identifying zones where basking sharks occur more frequently within a possible MPA to aid management discussions', Basking sharks - Identifying zones where basking sharks occur more frequently within a possible MPA to aid management discussions | NatureScot [Accessed: April 2025].

NatureScot (2024), 'NatureScot Open Data', https://opendata.nature.scot/ [Accessed: April 2025].

NBN Trust (2023), 'Marine Turtles', https://registry.nbnatlas.org/public/show/dr1313 [Accessed: April 2025].

NBN Trust (2024), 'Rhyacophila dorsalis map on the NBN Atlas', https://species.nbnatlas.org/species/NBNSYS0000008339 [Accessed: April 2025].

Nedwell, J., Langworthy, J. and Howell, D. (2003). 'Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise', Subacoustech Report ref: 544R0423, published by COWRIE.

New, L. F., Harwood, J., Thomas, L., Donovan, C., Clark, J. S., Hastie, G., Thompson, P. M., Cheney, B., Scott-Hayward, L. and Lusseau, D. (2013), 'Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance', Functional Ecology, 27/2: 314-322.

NOAA. (2019). Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Site Characterization Surveys of Lease Areas OCS–A 0486, OCS–A 0487, and OCS–A 0500.

Normandeau, Exponent, Tricas, T., and Gill, A. (2011), 'Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species', U.S. Dept. of the Interior, Bureau of Ocean OW Fish and Shellfish Ecology 319 Code: UKCAL-CWF-CON-EIA-RPT-00002-2005 Rev: Issued Date: 18 October 2024 Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study

Northridge, S., Cargill, A., Coram, A., Mandleberg, L., Calderan, S. and Reid, R. (2010), 'Entanglement of minke whales in Scottish waters: an investigation into occurrence, causes and mitigation', Contract Report, Final Report to Scottish Government CR/2007/49.

Nowacek, S. M., Wells, R. S. and Solow, A. R. (2001), 'Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida', Marine Mammal Science, 17: 673-688.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L. (2007), 'Responses of cetaceans to anthropogenic noise', Mammal Review, 37/2: 81-115.

Ocean Winds. (2024). Low order deflagration of unexploded ordnance reduces underwater noise impacts from offshore wind farm construction. Ocean Winds, Seiche Ltd, University of Aberdeen, EODEX.

O'Neil, K.E., Cunningham, E.G. and Moore, D.M. (2019), 'Sudden seasonal occurrence of humpback whales *Megaptera novaeangliae* in the Firth of Forth, Scotland and first confirmed movement between high-latitude feeding grounds and United Kingdom waters', Marine Biodiversity Records, 12/1.

Onoufriou, J., Jones, E., Hastie, G. and Thompson, D. (2016), 'Investigations into the interactions between harbour seals (*Phoca vitulina*) and vessels in the inner Moray Firth', Scottish Marine and Freshwater Science, 7/15.

Onoufriou, J., Russell, D. J. F., Thompson, D., Moss, S. E., & Hastie, G. D. (2021). Quantifying the effects of tidal turbine array operations on the distribution of marine mammals: Implications for collision risk. Renewable Energy, 180, 157–165. https://doi.org/10.1016/j.renene.2021.08.052

ORCA (2024), 'Whale & Dolphin Sightings', https://orca.org.uk/whale-dolphin-sightings [Accessed: April 2025].

Osinga, N., Nussbaum, B. S., Brakefield, M. P., & Haes De Udo, A. H. (2012), 'Response of common seals (*Phoca vitulina*) to human disturbances in the Dollard estuary of the Wadden Sea', Mammalian Biology, 77/4: 281-287.

OSPAR (2008), 'OSPAR Guidance on Environmental Considerations for Offshore Wind-Farm Development', Reference Number 2008-3, Offshore Renewables | OSPAR Commission [Accessed: April 2025].

OSPAR (2009), 'Overview of the impacts of anthropogenic underwater sound in the marine environment', OSPAR Biodiversity Series. Noise background document.doc [Accessed: April 2025].

OSPAR (2021), 'Status Assessment 2021 – Basking Shark', https://oap.ospar.org/en/ospar-assessments/committee-assessments/biodiversity-committee/status-assesments/basking-shark/ [Accessed: April 2025].

Pace, F., C. Robinson, C. E. Lumsden, and S. B. Martin. (2021). Underwater Sound Sources Characterisation Study: Energy Island, Denmark. Document 02539, Version 2.1. Technical report by JASCO Applied Sciences for Fugro Netherlands Marine B.V.:152.

Palanca, M. (2021). Humpback whale (Megaptera novaeangliae) social calls in the Southeast Pacific population: context, diversity, and call bouts analysis [Master's thesis]. University of Bonn. https://https://doi.org/10.13140/RG.2.2.31737.39526

Palmer, L., D. Gillespie, J. D. MacAulay, C. E. Sparling, D. J. Russell, and G. D. Hastie. (2021), 'Harbour porpoise (*Phocoena phocoena*) presence is reduced during tidal turbine operation', Aquatic Conservation: Marine and Freshwater Ecosystems, 31: 3543-3553.

Paxton, C.G.M., Scott-Hayward, L.A.S. and Rexstad, E. (2014), 'Statistical approaches to aid the identification of Marine Protected Areas for minke whale, Risso's dolphin, white-beaked dolphin and basking shark', Scottish Natural Heritage Commissioned Report, 594.

Paxton, C.G.M., Scott-Hayward, L., Mackenzie, M., Rexstad, E., & Thomas, L. (2016), 'Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resource', JNCC Report, 517.

Pellegrini, A., Romeu, B., Ingram, S. N., and Daura-Jorge. (2021), 'Boat disturbance affects the acoustic behaviour of dolphins engaged in a rare foraging cooperation with fishers', Anim. Conserv, 24: 613-625.

Peltier, H., Dabin, W., Cécile, D., Fabien, D., Dorémus, G., Canneyt, O. V., Laran, S., Fernandez, P. M., Spitz, J., Matthieu, A., Daniel, P. and Ridoux, V. (2019), 'Can modelling the drift of bycaught dolphin stranded carcasses help identify involved fisheries? An exploratory study', Global Ecology and Conservation. 21: e00843.

Penrose, R. S. and Westfield, M. J. B. (2023). 'British & Irish Marine Turtle Strandings & Sightings Annual Report 2020', Ceredigion.

Pentland Floating Offshore Wind Farm. (2022). Volume 2: Offshore EIAR. Chapter 11: Marine Mammals and Other Megafauna

Pierce, G., Santos, M., Reid, R., Patterson, I., and Ross, H. (2004),'Diet of minke whales *Balaenoptera acutorostrata* in Scottish (UK) waters with notes on strandings of this species in Scotland 1992–2002', Journal of the Marine Biological Association of the UK, 84: 1241-1244.

Pikesley, S.K., Carruthers, M., Hawkes, L.A. and Witt, M.J. (2024), 'Analysis of Basking Shark Watch Database 1987 to 2020', NatureScot Research Report 1279.

Pine, M. K., Schmitt, P., Culloch, R. M., Lieber, L. and Kregting, L. T. (2019), 'Providing ecological context to anthropogenic subsea noise: Assessing listening space reductions of marine mammals from tidal energy devices', Renewable and Sustainable Energy Reviews, 103: 49-57.

Pirotta, E., Milor, R., Quick, N., Moretti, D., Di Marzio, N., Tyack, P., Boyd, I. and Hastie, G. (2012), 'Vessel noise affects beaked whale behavior: results of a dedicated acoustic response study', PloS ONE, 7/8: e42535.

Pirotta, E., Laesser, B.E., Hardaker, A., Riddoch, N., Marcoux, M. and Lusseau, D. (2013), 'Dredging displaces bottlenose dolphins from an urbanised foraging patch', Marine Pollution Bulletin, 74: 396-402.

Pirotta, E., Brookes, K. L., Graham, I. M. and Thompson, P. M. (2014), 'Variation in harbour porpoise activity in response to seismic survey noise', Biology letters, 10/5: 20131090.

Pirotta, E., Merchant, N. D., Thompson, P. M., Barton, T. R. and Lusseau, D. (2015), 'Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity', Biological Conservation, 181: 82-89.

Pirotta, V. (2017), 'Migrating humpback whales (*Megaptera novaeangliae*) do not respond to underwater construction or whale alarms off Sydney, Australia', Macquarie University, Thesis.

Piwetz, S. (2019), 'Common bottlenose dolphin (*Tursiops truncatus*) behavior in an active narrow seaport', PLoS ONE, 14/2: e0211971.

Poloczanska, E.S., Burrows, M.T., Brown, C.J., García Molinos, J., Halpern, B.S., Hoegh-Guldberg, O., Kappel, C.V., Moore, P.J., Richardson, A.J., Schoeman, D.S. and Sydeman, W.J. (2016). Responses of marine organisms to climate change across oceans. Frontiers in Marine Science, 3: 62.

Pomeroy, P. P., Fedak, M. A., Rothery, P. and Anderson, S. (1999), 'Consequences of maternal size for reproductive expenditure and pupping success of grey seals at North Rona, Scotland', Journal of Animal Ecology, 68/2: 235-253.

Popper, A.N. Hawkins, A.D. Fay, R.R. Mann, D.A. Bartol, S. Carlon, T.J. Coombs, S. Ellison, W.T. Gentry, R.L. Halvorsen, M.B. Løkkeborg, S. Rogers, P.H. Southall, B.L. Zeddies, D.G. and Tavolga, W.N. (2014), 'ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards'.

Rako Gospic, N. and Picciulin, M. (2016), 'Changes in whistle structure of resident bottlenose dolphins in relation to underwater noise and boat traffic', Mar. Pollute Bull. 105/1: 193–198.

Rasmussen, M.H., Atem, A.C.G. and Miller, L.A. (2016),' Behavioral Responses by Icelandic White-Beaked Dolphins (*Lagenorhynchus albirostris*) to Playback Sounds', Aquatic Mammals, 42/3: 317-329.

Recalde-Salas, A., Erbe, C., Salgado Kent, C., & Parsons, M. (2020). Non-song vocalizations of humpback whales in Western Australia. Frontiers in Marine Science, 7, Article 141. https://doi.org/10.3389/fmars.2020.00141

Reichmuth, C., Sills, J. M., Mulsow, J. and Ghoul, A. (2019), 'Long-term evidence of noise-induced permanent threshold shift in a harbor seal (*Phoca vitulina*)', The Journal of the Acoustical Society of America, 146/4: 2552-2561.

Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). 'Atlas of Cetacean distribution in north-west European waters', Joint Nature Conservation Committee, Peterborough, ISBN 1 86107 550 2.

Richardson, W.J., Greene, C.R., Malme, C.I. and Thomson D.H. (1995), 'Marine Mammals and Noise', (Academic Press, San Diego).

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Marshall, A., Romanov, E. & Kyne, P.M. (2021), '*Cetorhinus maximus* (amended version of 2019 assessment). The IUCN Red List of Threatened Species 2021: e.T4292A194720078', https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T4292A194720078.en. [Accessed: April 2025].

Riley, M.J., Harman, A. and Rees, R.G. (2009), 'Evidence of continued hunting of whale sharks Rhincodon typus in the Maldives', Environmental Biology of Fishes, 86/3: 371.

Risch, D., Clark, C. W., Dugan, P. J. Popescu, M., Siebert, U. and Van Parijs, S. M. (2013). 'Minke whale acoustic behavior and multi-year seasonal and diel vocalization patterns in Massachusetts Bay, USA', Marine Ecology Progress Series, 489:279-295.

Risch, D., Siebert, U. and Van Parijs, S. M. (2014). 'Individual calling behaviour and movements of North Atlantic minke whales (*Balaenoptera acutorostrata*)', Behaviour, 151:1335-1360.

Risch, D., Favill, G., Marmo, B., van Geel, N., Benjamins, S., Thompson, P., Wittich, A. and Wilson, B. (2023), 'Characterisation of underwater operational noise of two types of floating offshore wind turbines', Supergen Offshore Renewable Energy Hub.

Robards, M. D., Silber, G. K., Adams, J. D., Arroyo, J., Lorenzini, D., Schwehr, K. and Amos, J. (2016), 'Conservation science and policy applications of the marine vessel Automatic Identification System (AIS)—A review', Bulletin of Marine Science, 92/1: 75-113.

Roberts, L., Collier, S., Law, S., Gaion, A., (2019), 'The impact of marine vessels on the presence and behaviour of harbour porpoise (*Phocoena phocoena*) in the waters off Berry Head, Brixham (South West England)', Ocean Coast. Manag, 179: 104860.

Robinson, K.P., Tetley, M.J. and Mitchelson-Jacob, E.G. (2009), 'The distribution and habitat preference of coastally occurring minke whales (*Balaenoptera acutorostrata*) in the outer southern Moray Firth, northeast Scotland', Journal of Coastal Conservation, 13: 39-48.

Robinson, K.P., O'Brien, J.M., Berrow, S.D., Cheney, B., Costa, M., Eisfeld, S.M., Haberlin, D., Mandleberg, L., O'donovan, M., Oudejans, M.G. and Ryan, C. (2012), 'Discrete or not so discrete: Long distance movements by coastal bottlenose dolphins in UK and Irish waters', J. Cetacean Res. Manage., 12/3: 365-371.

Robinson, S. P., Wang, L., Cheong, S. H., Lepper, P. A., Marubini, F. and Hartley, J. P. (2020), 'Underwater acoustic characterisation of unexploded ordnance disposal using deflagration', Marine Pollution Bulletin, 160.

Robinson, S. P., Wang, L., Cheong, S. H., Lepper, P. A., Hartley, J. P., Thompson, P. M., Edwards, E. and Bellmann, M. (2022), 'Acoustic characterisation of unexploded ordnance disposal in the North Sea using high order detonations', Marine Pollution Bulletin, 184: 114-178.

Robinson, K. P., D. A. I. MacDougall, C. C. G. Bamford, W. J. Brown, C. J. Dolan, R. Hall, G. N. Haskins, G. Russell, T. Sidiropoulos, T. M. C. Sim, E. Spinou, E. Stroud, G. Williams, and R. M. Culloch. (2023), 'Ecological habitat partitioning and feeding specialisations of coastal minke whales (*Balaenoptera acutorostrata*) using a recently designated MPA in northeast Scotland', PLoS ONE, 18:e0246617.

Rojano-Doñate, L., McDonald, B.I., Wisniewska, D.M., Johnson, M., Teilmann, J., Wahlberg, M., Højer-Kristensen, J. and Madsen, P.T. (2018), 'High field metabolic rates of wild harbour porpoises. Journal of Experimental Biology', 221/23.

Rolland, R. M., Parks, S. E., Hunt, K. E., Castellote, M., Corkeron, P. J., Nowacek, D. P., Wasser, S. K. and Kraus, S. D. (2012), 'Evidence that ship noise increases stress in right whales', Proceedings. Biological sciences, 279/1737: 2363–2368.

Royal HaskoningDHV. (2023). Green Volt, Offshore Windfarm EIA Report. Volume 1, Chapter 11 Marine Mammal Ecology.

Ruiz-Mar, G. M., Heckel, G., Solana-Arellano, E., Schramm, Y., García-Aguilar, C. M., & Arteaga, C. M. (2022), 'Human activities disturb haul out and nursing behavior of Pacific harbor seals at Punta Banda Estuary, Mexico', PLOS ONE, 17/7: e0270129.

Russell, D. J., Brasseur, S. M., Thompson, D., Hastie, G. D., Janik, V. M., Aarts, G., McClintock, B. T., Matthiopoulos, J., Moss, S. E., and McConnell, B.J. (2014). Marine mammals trace anthropogenic structures at sea. Current Biology 24:R638-R639.

Russell, D. J., Hastie, G. D. Thompson, D., Janik, V. M., Hammond, P. S., Scott-Hayward, L. A., Matthiopoulos, J., Jones, E. L. and McConnell, B. J. (2016), 'Avoidance of windfarms by harbour seals is limited to pile driving activities', Journal of Applied Ecology, 53: 1642-1652.

Russell, D., and Hastie, G. (2017), 'Associating predictions of change in distribution with predicted received levels during piling', Report produced for SMRU Consulting.

Ryan, C., R. Leaper, P. G. Evans, K. Dyke, K. P. Robinson, G. N. Haskins, S. Calderan, N. van Geel, O. Harries, and K. Froud. (2016), 'Entanglement: an emerging threat to humpback whales in Scottish waters', Paper SC/66b/HIM/01 submitted to the International Whaling Commission Scientific Committee.

Salamander Offshore Wind Farm. (2023). Salamander Offshore EIA Report. Volume ER.A.3, Chapter 11: Marine Mammals.

Salomons, E. M., Binnerts, B., Betke, K. and von Benda-Beckmann, A. M. (2021), 'Noise of underwater explosions in the North Sea. A comparison of experimental data and model predictions', The Journal of the Acoustical Society of America, 149/3:1878-1888.

Santos, M. B., Pierce, G. J., Reid, R. J., Patterson, I. A. P., Ross, H. M., & Mente, E. (2001), 'Stomach contents of bottlenose dolphins (*Tursiops truncatus*) in Scottish waters', Journal of the Marine Biological Association of the United Kingdom, 81/5: 873–878.

Santos, M., Pierce, G. J., Learmonth, J. A., Reid, R., Ross, H., Patterson, I., Reid, D. and Beare. D. (2004), 'Variability in the diet of harbor porpoises (*Phocoena phocoena*) in Scottish waters 1992–2003', Marine Mammal Science, 20: 1-27.

Sarnocinska, J., Tougaard, J., Johnson, M., Madsen, P. T., & Wahlberg, M. (2016), 'Comparing the performance of C-PODs and SoundTrap/PAMGUARD in detecting the acoustic activity of harbor porpoises (*Phocoena phocoena*)', Proceedings of Meetings on Acoustics, 27/1, Article 070013

Schaffeld, T., Ruser, A., Woelfing, B., Baltzer, J., Kristensen, J. H., Larsson, J., Schnitzler, J. G. and Siebert, U. (2019), 'The use of seal scarers as a protective mitigation measure can induce hearing impairment in harbour porpoises', The Journal of the Acoustical Society of America, 146/6: 4288-4298.

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., Petel, P. V. T., Teilmann, J. and Reijnders, P. (2011), 'Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea', Environmental Research Letters, 6/2: 025102.

Schoeman, R.P., Patterson-Abrolat, C. and Plön, S. (2020), 'A global review of vessel collisions with marine animals', Frontiers in Marine Science, 7: 292.

Schulte-Pelkum, N., Wieskotten, S., Hanke, W., Dehnhardt, G. and Mauck, B. (2007), 'Tracking of biogenic hydrodynamic trails in harbour seals (*Phoca vitulina*)', Journal of Experimental Biology, 210/5: 781-787.

SCOS (2022), 'Scientific Advice on Matters Related to the Management of Seal Populations: 2021', Scientific Advice on Matters Related to the Management of Seal Populations: 2022 [Accessed: April 2025].

SCOS (2023), 'Scientific advice on matters related to the management of seal populations: 2023, Interim advice. NERC: Special Committee on Seals (SCOS) Main Advice Report', scos-2023-interim-advice-final.pdf [Accessed: April 2025].

SCOS (2024), 'Scientific advice on matters related to the management of seal populations: 2024. Natural Environment Research Council Special Committee on Seals.' Scientific Advice on Matters Related to the Management of Seal Populations: 2022 [Accessed: April 2025]

Scottish Government (2011), 'Scotland's Marine Atlas: Information for The National Marine Plan', https://www.gov.scot/publications/scotlands-marine-atlas-information-national-marine-plan/pages/36/ [Accessed: April 2025].

Scottish Government (2014), 'Scotland's Planning Policy', https://www.gov.scot/publications/scottish-planning-policy/ [Accessed: April 2025].

Scottish Government (2015), 'Scotland's National Marine Plan', https://www.gov.scot/publications/scotlands-national-marine-plan/ [Accessed: April 2025].

Scottish Government (2020), 'Sectoral Marine Plan for Offshore Wind Energy (2020)', Sectoral Marine Plan for Offshore Wind Energy Sectoral marine plan for offshore wind energy - gov.scot [Accessed: April 2025].

Scottish Government (2022), 'Guidance for applicants on using the design envelope for applications under section 36 of the Electricity Act 1989', Guidance for applicants on using the design envelope for applications under section 36 of the Electricity Act 1989 [Accessed: May 2025].

Scottish Marine Animal Stranding Scheme (SMASS) (2023), 'Scottish Marine Animal Stranding Scheme Annual Report 2021 report to Marine Directorate, Scottish Government', Marine Mammal Strandings Co-ordination and Investigation (Scotland) [Accessed: April 2025].

Scottish Natural Heritage (SNH) (2016), 'Assessing collision risk between underwater turbines and marine wildlife', SNH guidance note.

Scottish Natural Heritage (SNH) (2017), 'The Scottish Marine Wildlife Watching Code SMWWC – Part 1', Scottish Natural Heritage, Scottish Marine Wildlife Watching Code | NatureScot [Accessed: April 2025].

Sea Watch Foundation (2012), 'THE HUMPBACK WHALE IN UK WATERS', https://seawatchfoundation.org.uk/wp-content/uploads/2012/07/Humpback_Whale.pdf [Accessed: April 2025].

Sea Watch Foundation (2024). 'Recent Sightings', https://www.seawatchfoundation.org.uk/recentsightings/ [Accessed: April 2025].

Seiche Ltd. (2022), 'Arklow Geophysical and Geotechnical Surveys Subsea Noise Assessment', P1523-REPT-02-R1.

Shark Trust (2024), 'Basking Shark Project', https://www.sharktrust.org/basking-shark-project [Accessed: April 2025].

Simmonds, M. P. and Eliott, W. J. (2008), 'Climate change and cetaceans: concerns and recent developments', Journal of the Marine biological Association of the United Kingdom, 89/1: 203-210.

Sims, D. W. and Reid, P. C. (2002), 'Congruent trends in long-term zooplankton decline in the north-east Atlantic and basking shark *Cetorhinus maximus* fishery catches off west Ireland. 1986–1990', Fisheries Oceanography, 11: 59-63.

Sims, D.W. Southall, E.J. Richardson, A.J. Reid, P.C. and Metcalfe, J.D. (2003), 'Seasonal movements and behaviour of basking sharks from archival tagging: no evidence of winter hibernation', Marine Ecology Progress Series, 248: 187-196.

Sinclair, R. Kazer, S. Ryder, M. New, P. and Verfuss, U. (2021), 'Review and recommendations on assessment of noise disturbance for marine mammal', NRW Evidence Report No. 529, 143.

Sivle, L. D., Kvadsheim, P. H., Curé, C., Isojunno, S., Wensveen, P. J., Lam, F. P. A., Visser, F., Kleivanec, L., Tyack, P. L., Harris, C. M. and Miller, P. J. (2015), 'Severity of expert-identified behavioural responses of Humpback Whale, Minke Whale, and Northern Bottlenose Whale to naval sonar', Aquatic Mammals, 41/4: 469-502.

Smout, S., Rindorf, A., Hammond, P. S., Harwood, J. and Matthiopoulos, J. (2014), 'Modelling prey consumption and switching by UK grey seals', ICES Journal of Marine Science, 71/1: 81-89.

Solandt, J.L. and Chassin, E. (2013), 'Marine Conservation Society Basking Shark Watch Overview of data from 2009 to 2013', Ross on Wye, UK: Marine Conservation Society, 6.

Soloway, A. G. and Dahl, P. H. (2014), 'Peak sound pressure and sound exposure level from underwater explosions in shallow water. The Journal of the Acoustical Society of America, 136/3, EL218-EL223.

Southall, B. L., Schusterman, R. J., Kastak, D. (2000), 'Masking in three pinnipeds: Underwater, low-frequency critical ratios', J. Acoust. Soc. Am, 108 (3): 1322–1326.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. J. Greene, D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. (2007), 'Marine mammal noise exposure criteria: initial scientific recommendations', Aquatic Mammals, 33: 411- 414.

Southall, B., Calambokidis, J., Tyack, P., Moretti, D., Hildebrand, J., Kyburg, C., Carlson, R., Friedlaender, A., Falcone, E., Schorr, G. and Douglas, A. (2011), 'Biological and Behavioral Response Studies of Marine Mammals in Southern California, 2010 (" SOCAL-10")', Project Report. https://apps.dtic.mil/sti/pdfs/ADA538910.pdf [Accessed: April 2025]

Southall, B., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., Ellison, W. T., Nowacek, D. and Tyack, P. (2019). 'Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects', Aquatic Mammals, 45: 125-232.

Southall, B.L., Nowacek, D.P., Bowles, A.E., Senjgaglia, V., Bejder, L. and. Tyack, P.L. (2021), 'Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise', Aquatic Mammals, 47/5: 421–464.

Sparkes, M. (2024), 'Collision between boat and basking shark captured by camera tag', New Scientist, Collision between boat and basking shark captured by camera tag | New Scientist [Accessed: April 2025].

Sparling, C. E., M. Lonergan, and B. McConnell. (2017), 'Harbour seals (*Phoca vitulina*) around an operational tidal turbine in Strangford Narrows: No barrier effect but small changes in transit behaviour', Aquatic Conservation: Marine and Freshwater Ecosystems, 28/1: 194-204.

Speedie, C. D,and Johnson, L. A. (2008), 'The Basking Shark (*Cetorhinus Maximus*) in West Cornwall', Natural England Research Report NERR018. Sheffield: Natural England.

Speedie, C.D. Johnson, L. A. and Witt, M.J. (2009), 'Basking Shark Hotspots on the West Coast of Scotland: Key sites, threats and implications for conservation of the species', Commissioned Report No.339.

Sprogis, K. R., Videsen, S. and Madsen, P. T. (2020), 'Vessel noise levels drive behavioural responses of humpback whales with implications for whale-watching', eLife, 9.

Stamation, K. A., Croft, D. B., Shaughnessy, P. D., Waples, K. A. and Briggs, S. V. (2010), 'Behavioral responses of humpback whales (*Megaptera novaeangliae*) to whale-watching vessels on the southeastern coast of Australia', Marine Mammal Science, 26: 98-122.

Stansbury, A.L., Götz, T., Deecke, V.B. and Janik, V.M. (2015). 'Grey seals use anthropogenic signals from acoustic tags to locate fish: evidence from a simulated foraging task'. Proceedings of the Royal Society B: Biological Sciences, 282(1798), p.20141595.

Stimpert, A. K., Au, W. W. L., Parks, S. E., Hurst, T., & Wiley, D. N. (2011). Common humpback whale (Megaptera novaeangliae) sound types for passive acoustic monitoring. Journal of the Acoustical Society of America, 129(1), 476–482. https://doi.org/10.1121/1.3504708

Stöber, U., & Thomsen, F. (2021), 'How could operational underwater sound from future offshore wind turbines impact marine life?', The Journal of the Acoustical Society of America, 149/3: 1791-1795.

Stone, C. J. (2003), 'The effects of seismic activity on marine mammals in UK waters, 1998-2000', JNCC Report No. 323 (Joint Nature Conservation Committee).

Stone, C., Hall, K., Mendes, S. and Tasker, M. (2017), 'The effects of seismic operations in UK waters: analysis of Marine Mammal Observer data', Journal of Cetacean Research and Management, 16/1.

Sun, R., Liu, K., Huang, W., Wang, X., Zhuang, H., Wang, Z., Zhang, Z. and Zhao, L. (2024), 'Global distribution prediction and ecological conservation of basking shark (*Cetorhinus maximus*) under integrated impacts', Global Ecology and Conservation, 56: e03310.

Swails, K. S. (2005), 'Patterns of seal strandings and human interactions in Cape Cod, Massachuettes (Ph.D. thesis)', Master's project, Duke University, https://hdl.handle.net/10161/234 [Accessed: April 2025].

Taninoki, R., Abe, K., Sukegawa, T., Azuma, D., and Nishikawa, M. (2017). 'Dynamic Cable System for Floating Offshore Wind Power Generation', SEI Tech, Rev. 84/53-58: 146.

Taormina, B., Bald, J., Want, A., Thouzeau, G., Lejart, M., Desroy, N. and Carlier, A. (2018), 'A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions', Renewable and Sustainable Energy Reviews, 96: 380-391.

Teilmann, J., J. Carstensen, R. Dietz, S. M. C. Edrén, and S. M. Andersen. (2006a). Final report on aerial monitoring of seals near Nysted Offshore Wind Farm. 251

Teilmann, J., J. Tougaard, and J. Carstensen. (2006b). Summary on harbour porpoise monitoring 1999-2006 around Nysted and Horns Rev Offshore Wind Farms.

Teilmann, J., Christiansen, C.T., Kjellerup, S., Dietz, R., and Nachmann, G. (2013), 'Geographic, seasonal, and diurnal surface behavior of harbor porpoises', Marine Mammal Science, 29: 60–76.

The Environment and Forestry Directorate. (2023), 'Scottish Biodiversity Strategy to 2045: Tackling the Nature Emergency in Scotland', Biodiversity strategy to 2045: tackling the nature emergency - draft - gov.scot [Accessed: April 2025].

Thompson, F., McCully, S. R., Wood, D., Pace, F. and White, P. (2009). 'A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters with particular emphasis on aggregate dredging: PHASE 1 Scoping and review of key issues., MALSF'.

Thompson, P. M., Brookes, K. L., Graham, I. M., Barton, T. R., Needham, K., Bradbury, G. and Merchant, N. D. (2013), 'Short-term disturbance by a commercial two-dimmensional seismic survey does not lead to long-term displacement of harbour porpoises', Proceedings of the Royal Society B-Biological Sciences, 280: 1-8.

Thompson, P. M., Graham, I. M., Cheney, B., Barton, T. R., Farcas, A. and Merchant, N. D. (2020), 'Balancing risks of injury and disturbance to marine mammals when pile driving at offshore windfarms', Ecological Solutions and Evidence, 1: e12034.

Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006), 'Effects of offshore wind farm noise on marine mammals and fish', Biola, Hamburg, Germany on behalf of COWRIE Ltd, 62.

Thomsen, F., Gill, A., Kosecka, M., Andersson, M., Andre, M., Degraer, S., Folegot, T., Gabriel, J., Judd, A., Neumann, T., Norro, A., Risch, D., Sigray, P., Wood, D., and Wilson, B. (2015), 'MaRVEN—Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy', Final Study Report No. RTD-KI-NA-27-738-EN-N.

Thomsen, F., Stöber, U. and Sarnocińska-Kot, J. (2023), 'Hearing Impact on Marine Mammals Due to Underwater Sound from Future Wind Farms', In The Effects of Noise on Aquatic Life: Principles and Practical Considerations (Cham: Springer International Publishing).

Todd, V. L., Todd, I. B., Gardiner, J. C., Morrin, E. C., MacPherson, N. A., DiMarzio, N. A. and Thomsen, F. (2015). 'A review of impacts of marine dredging activities on marine mammals', ICES Journal of Marine Science: Journal du Conseil, 72:328-340.

Todd, V. L., J. C. Warley, and I. B. Todd. (2016), 'Meals on Wheels? A Decade of Megafaunal Visual and Acoustic Observations from Offshore Oil & Gas Rigs and Platforms in the North and Irish Seas', PLoS ONE, 11:e0153320.

Total Energies. (2023). Culzean Floating Wind Pilot EIA Scoping Report.

Tougaard, J. (2021), 'Thresholds for noise induced hearing loss in marine mammals', J. Acoust. Soc. Am, 118: 3154-3163.

Tougaard, J., Buckland, S., Robinson, S. and Southall, B. (2013), 'An analysis of potential broad-scale impacts on harbour porpoise from proposed pile driving activities in the North Sea', Report of an expert group convened under the Habitats and Wild Birds Directive - Marine Evidence Group MB0138, 38.

Tougaard, J., Wright, A.J. and Madsen, P.T. (2015), 'Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises', Marine pollution bulletin, 90/1-2: 196-208.

Tougaard, J., Hermannsen, L., & Madsen, P. T. (2020), 'How loud is the underwater noise from operating offshore wind turbines?', The Journal of the Acoustical Society of America, 148/5, 2885-2893.

Townhill, B. Couce, E. Lynam, C. and Pinnegar, J. (2024) Investigating Climate Change Resilience of Vulnerable Marine Species around the UK [InCResiVul] - ME5241. Report to Centre for Environment, Fisheries and Aquaculture Science (Cefas). September 2024.

Trigg, L. (2019), 'Assessing the exposure and behavioural response of grey seals (*Halichoerus grypus*) to shipping noise', A Ph.D. thesis submitted to the University of Plymouth.

Tripovich, J. S., Hall-Aspland, S., Charrier, I., and Arnould, J. P. Y. (2012), 'The behavioural response of australian fur seals to motor boat noise', PLoS One, 7/5:3–9.

Tubelli, A. A., Zosuls, A., Ketten, D. R., Yamato, M. and Mountain, D. C. (2012), 'A prediction of the minke whale (*Balaenoptera acutorostrata*) middle-ear transfer function', Journal of the Acoustical Society of America, 132:3263-3272.

Tubelli, A. A., Zosuls, A., Ketten, D. R. and Mountain, D. C. (2018), 'A model and experimental approach to the middle ear transfer function related to hearing in the humpback whale (*Megaptera novaeangliae)*', Journal of the Acoustical Society of America, 144: 525-535.

Twiss, S.D., Shuert, C.R., Brannan, N., Bishop, A.M. and Pomeroy, P.P. (2020). 'Reactive stress-coping styles show more variable reproductive expenditure and fitness outcomes', Scientific Reports, 10(1), 1-12.

Tyack, P. (2009), 'Acoustic playback experiments to study behavioral responses of free-ranging marine animals to anthropogenic sound', Marine Ecology Progress Series, 395: 187-200.

Tyack, P. L. and Thomas, L. (2019), 'Using dose–response functions to improve calculations of the impact of anthropogenic noise', Aquatic Conservation: Marine and Freshwater Ecosystems, 29: 242-253.

Tyler-Walters, H., James, B., Carruthers, M. (eds.), Wilding, C., Durkin, O., Lacey, C., Philpott, E., Adams, L., Chaniotis, P.D., Wilkes, P.T.V., Seeley, R., Neilly, M., Dargie, J. and Crawford-Avis, O.T. (2016), 'Descriptions of Scottish Priority Marine Features (PMFs)', Scottish Natural Heritage Commissioned Report No. 406, Descriptions of Scottish Priority Marine Features (PMFs) | Scotland's Marine Assessment 2020 [Accessed: April 2025].

UK Government (2025), 'UK Government Policy paper: Marine environment: unexploded ordnance clearance joint position statement', https://www.gov.uk/government/publications/marine-environment-unexploded-ordnance-clearance-joint-position-statement/marine-environment-unexploded-ordnance-clearance-joint-position-statement [Accessed: May 2025]

Vallejo, C. G., Grellier, K., Nelson, J. E., Mcgregor, M. R., Canning, J. S., Caryl, M. F., & Mclean, N. (2017), 'Responses of two marine top predators to an offshore wind farm', Ecology and Evolution, 7/21: 8698-8708.

van Beest, F. M., Teilmann, J., Dietz, R., Galatius, A., Mikkelsen, L., Stalder, D., Sveegarrd, S. and Nabe-Nielsen, J. (2018), 'Environmental drivers of harbour porpoise fine-scale movements', Marine Biology 165/5.

van der Hoop, J., Corkeron, P. and Moore. M. (2017), 'Entanglement is a costly life-history stage in large whales', Ecology and Evolution, 7: 92-106.

Vanderlaan, A. S. M., Serdynska, A. R. and Brown, M. W. (2008), 'Reducing the risk of lethal encounters: Vessels and right whales in the Bay of Fundy and on the Scotian Shelf', Endangered Species Research, 4/3: 283-297.

Vella, G., Rushforth, I., Mason, E., Hough, A., England, R., Styles, P., Holt, T. & Thorne, P. (2001), 'Assessment of the effects of noise and vibration from offshore wind farms on marine wildlife', Report to ETSU (Department of Trade and Industry), W/13/00566/00/REP.

Verboom, W. (2014). 'Preliminary information on dredging and harbour porpoises', Juno Bioacoustics.

Villagra, D., García-Cegarra, A., Gallardo, D. I. and Pacheco, A. S. (2021), 'Energetic Effects of Whale-Watching Boats on Humpback Whales on a Breeding Ground', Frontiers in Marine Science, 7: 600508.

Visser, F., Hartman, K.L., Rood, E.J., Hendriks, A.J., Zult, D.B., Wolff, W.J., Huisman, J. and Pierce, G.J. (2011), 'Risso's dolphins alter daily resting pattern in response to whale watching at the Azores', Marine Mammal Science, 27/2: 366-381.

von Benda-Beckmann, A. M., Aarts, G., Sertlek, H. Ö., Lucke, K., Verboom, W. C., Kastelein, R. A., Ketten, D. R., van Bemmelen, R., Lam, F. P. A., Kirkwood, R. J. and Ainslie, M. A. (2015), 'Assessing the impact of underwater clearance of unexploded ordnance on harbour porpoises (*Phocoena phocoena*) in the Southern North Sea', Aquatic Mammals, 41/4: 503.

Waggitt, J.J., Evans, P.G., Andrade, J.B., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J., Felce, T., Fijn, R.C., García-Barón, I., Garthe, S., Geelhoed, S., Gilles, A., Goodall, M., Haelters, J., Hamilton, S., Hartny-Mills, L., Hodgins, N.K., James, K., Jessopp, M.J., Kavanagh, A.S., Leopold, M.F., Lohrengel, K., Louzao, M., Markones, N., Martínez-Cedeira, J.A., Cadhla, O.Ó., Perry, S.L., Pierce, G.J., Ridoux, V., Robinson, K.P., Santos, M.B., Saavedra, C., Skov, H., Stienen, E., Sveegaard, S., Thompson, P.M., Vanermen, N., Wall, D., Webb, A., Wilson, J., Wanless, S., Hiddink, J.G., & Punt, A.E. (2020). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Journal of Applied Ecology, 57, 253-269.

Wallace, B.P., Tiwari, M. & Girondot, M. (2013), 'Dermochelys coriacea. The IUCN Red List of Threatened Species 2013: e.T6494A43526147', https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T6494A43526147.en. [Accessed: April 2025].

Wawrzynkowski, P., Molins, C., & Lloret, J. (2025), 'Assessing the potential impacts of floating Offshore Wind Farms on policy-relevant species: A case study in the Gulf of Roses, NW Mediterranean', Marine Policy, 172: 106518.

Weir, C.R. (2001), 'Sightings of marine mammals and other animals recorded from offshore installations in the North Sea', North Sea Bird Club 21st Anniversary report, 93-103.

Wells, R. S., Early, G. A., Gannon, J. G., Lingenfelser, R. G. and Sweeney, P. (2008), 'Tagging and tracking of rough-toothed dolphins (*Steno bredanensis*) from the March 2005 mass stranding in the Florida Keys', NOAA Technical Memorandum NMFS-SEFSC-574.

Wells, R.S., Natoli, A. and Braulik, G. (2019), '*Tursiops truncatus* (errata version published in 2019). The IUCN Red List of Threatened Species. 2019: e.T22563A156932432', https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T22563A156932432.en. [Accessed: April 2025].

White, P. R., and Todd, V. L. (2024). Baleen Whale Vocalizations. Noisy Oceans: Monitoring Seismic and Acoustic Signals in the Marine Environment, 183-207.

Whyte, K. F., Russell, D. J. F., Sparling, C. E., Binnerts, B. and Hastie, G. D. (2020), 'Estimating the effects of pile driving sounds on seals: Pitfalls and possibilities', J Acoust Soc Am, 147: 3948.

Wilhelmsson, D., Malm, T., Thompson, R., Tchou, J., Sarantakos, G., McCormick, N., Luitjens, S., Gullström, M., Patterson Edwards, J.K., Amir, O. and Dubi, A. (eds.). (2010), 'Greening Blue Energy: Identifying and managing the biodiversity risks and opportunities of offshore renewable energy', Gland, Switzerland: IUCN, 102.

Wilson, B., R. Batty, F. Daunt, and C. Carter. (2007). 'Collision risks between marine renewable energy devices and mammals, fish and diving birds', Scottish Association for Marine Science, Oban.

Wilson, E. (2000), 'Determination of boat disturbance on the surface feeding behaviour of basking sharks *Cetorhinus maximus'*, Unpublished MSc thesis, University of Plymouth, U.K.

Wilson, L. and Hammond, P. (2016), 'Harbour seal diet composition and prey consumption', Scottish Marine and Freshwater Science 7/21.

Wilson, S. C. (2014), 'The impact of human disturbance at seal haul-outs. A literature review for the Seal Conservation Society', sealconservationsociety2014.pdf [Accessed: April 2025].

Wisniewska, D. M., Johnson, M., Teilmann, J., Rojano-Donate, L., Shearer, J., Sveegaard, S., Miller, L. A., Siebert, U. and Madsen, P. T. (2016), 'Ultra-high foraging rates of harbor porpoises make them vulnerable to anthropogenic disturbance', Current Biology, 26/11: 1441-1446.

Wisniewska, D. M., Johnson, M., Teilmann, J., Siebert, U., Galatius, A., Dietz, R. and Madsen, P. T. (2018), 'High rates of vessel noise disrupt foraging in wild harbour porpoises (*Phocoena phocoena*)', Proceedings of the Royal Society B: Biological Sciences, 285/1872: 20172314.

Witt, M. J., Doherty, P.D., Godley, B.J., Graham, R.T., Hawkes L.A. and Henderson, S.M. (2016), 'Basking shark satellite tagging project: insights into basking shark (*Cetorhinus maximus*) movement, distribution and behaviour using satellite telemetry', Final Report, Scottish Natural Heritage Commissioned Report No. 908.

Witt M. J., Hawkes, L.A., Henderson, S.M. (2019), 'Identifying zones where basking sharks occur more frequently within a possible MPA to aid management discussions', Basking sharks - Identifying zones where basking sharks occur more frequently within a possible MPA to aid management discussions.pdf [Accessed: April 2025].

Zoidis, A. M., Smultea, M. A., Frankel, A. S., Hopkins, J. L., Day, A., McFarland, A. S., Whitt, A. D., & Fertl, D. (2008). Vocalizations produced by humpback whale (*Megaptera novaeangliae*) calves recorded in Hawaii. Journal of the Acoustical Society of America, 123(3), 1737–1746. https://doi.org/10.1121/1.2836750

Xodus (2015). 'Marine noise inputs: technical note on underwater noise. A-100142-S20- TECH-001'. Available online at https://marine.gov.scot/sites/default/files/underwater_noise_technical_assessment_a100142-s20-tech-001-a01_0.pdf [Accessed: April 2025].

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