Cenos Offshore Windfarm Limited

Cenos EIA

EIAR Chapter 11 – Marine Mammal Ecology

ASSIGNMENT	A100907-S01
DOCUMENT	A100907-S01-A-ESIA-012
CLIENT	CEN001-FLO-CON-ENV-RPT-0014

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REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	18/12/24	Issued for Use	PR	EE	DB	Cenos
R02	26/11/24	Issued for Review	PR	EE/DB	NB	Cenos
R01	16/10/24	Issued for Review	SB/MK	EE/DB	NB	Cenos

CONTENTS

ACRONYMS

ACRONYM	DEFINITION
2D	Two-dimentional
3D	Three-dimentional
ADD	Acoustic Deterrent Device
ALDFG	Abandoned, Lost or Discarded Fishing Gear
BEIS	Department for Business, Energy & Industrial Strategy
CaP	Cable Plan
CBRA	Cable Burial Risk Assessment
CES	Crown Estate Scotland
CGNS	Celtic and Greater North Seas
CPT	Cone Penetration Test
CRRU	Cetacean Research and Rescue Unit
CTV	Crew Transfer Vessel
DAS	Digital Aerial Survey
dB	Decibel
DoL	Depth of Lowering
DSLP	Development Specification and Layout Plan
ECOMMAS	East Coast Scotland Marine Mammal Acoustic Study
EDRs	Effective Deterrent Ranges
EEA	European Economic Area
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EICC	Export/Import Cable Corridor
EMF	Electromagnetic Field
EMP	Environmental Management Plan
EPS	European Protected Species
ES SMU	East Scotland Seal Management Unit
EU	European Union
FAD	Fish Aggregation Device
FPSO	Floating Production Storage and Offloading
FSO	Floating Storage and Offloading
FTU	Floating Turbine Unit
GMF	Geomagnetic Field

ACRONYM	DEFINITION
GNS	Greater North Seas
GPS	Global Positioning System
GSD	Ground Sample Distance
HDD	Horizontal Direct Drilling
HF	High Frequency
HOD	High-Order Detonation
HRA	Habitats Regulation Assessment
IAC	Inter-Array Cable
IAMMWG	Inter-Agency Marine Mammal Working Group
INNS	Invasive Non-Native Species
INNSMP	Invasive Non-Native Species Management Plan
IUCN	International Union for Conservation of Nature
IPCoD	Interim Population Consequences of Disturbance
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
LOD	Low-Order Deflagration
M	Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	Multibeam Echo Sounder
MPCP	Marine Pollution Contingency Plan
MHWS	Mean High Water Spring
MMO	Marine Mammal Observer
MMMP	Marine Mammal Mitigation Protocol
MMMU	Marine Mammal Mitigation Units
MPCP	Marine Pollution Contingency Plan
MU	Management Unit
NMP	National Marine Plan
NCMPA	Nature Conservation Marine Protected Area
NM	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NS	North Sea
NNS	Northern North Sea
OMP	Operations and Maintenance Programme

ACRONYM	DEFINITION
OSCP	Offshore Substation and Converter Platform
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PAMO	Passive Acoustic Monitoring Operator
PCW	Phocid Carnivores in Water
PMF	Priority Marine Feature
PS	Piling Strategy
PTS	Permanent Threshold Shift
rms	Root-Mean-Square
ROV	Remotely Operated Vehicle
SAC	Special Areas of Conservation
SBP	Sub-Bottom Profiler
SCANS	Small Cetaceans in European Atlantic Waters and the North Sea
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure
SMU	Seal Management Unit
SMWWC	Scottish Marine Wildlife Watching Code
SNH	Scottish Natural Heritage
SNS	Southern North Sea
SOPEP	Ship Oil Pollution Emergency Plan
SOV	Service Operation Vessel
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
SSC	Suspended Sediment Concentrations
SSS	Side Scan Sonar
TLP	Tension Leg Platform
TTS	Temporary Threshold Shift
TWT	The Wildlife Trust
UHF	Ultra-High Frequency
USBL	Ultra-Short Baseline
UK	United Kingdom

ACRONYM	DEFINITION
UKBAP	Suspended Sediment Concentrations
UXO	Unexploded Ordnance
VHF	Very High Frequency
VMP	Vessel Management Plan
WDC	Whale and Dolphin Conservation
WiSe	Wildlife Safe
ZoI	Zone of Influence
2D	Two-Dimensional
3D	Three-Dimensional
µPa	Micro-Pascal

GLOSSARY

TERM	DEFINITION
2023 Scoping Opinion	Scoping Opinion received in June 2023, superseded by the 2024 Scoping Opinion.
2023 Scoping Report	Environmental Impact Assessment (EIA) Scoping Report submitted in 2023, superseded by the 2024 Scoping Report.
2024 Scoping Opinion	Scoping Opinion received in September 2024, superseding the 2023 Scoping Opinion.
2024 Scoping Report	EIA Scoping Report submitted in April 2024, superseding the 2023 Scoping Report.
Area of Opportunity	The area in which the limits of electricity transmission via High Voltage Alternating Current (HVAC) cables can reach oil and gas assets for decarbonisation. This area is based on assets within a 100 kilometre (km) radius of the Array Area.
Array Area	The area within which the Wind Turbine Generators (WTGs), floating substructures, moorings and anchors, Offshore Substation Converter Platforms (OSCPs) and Inter-Array Cables (IAC) will be present.
Cenos Offshore Windfarm ('the Project')	'The Project' is the term used to describe Cenos Offshore Windfarm. The Project is a floating offshore windfarm located in the North Sea, with a generating capacity of up to 1,350 Megawatts (MW). The Project which defines the Red Line Boundary (RLB) for the Section 36 Consent and Marine Licence Applications (MLA), includes all offshore components seaward of Mean High Water Springs (MHWS) (WTGs, OSCPs, cables, floating substructures moorings and anchors and all other associated infrastructure). The Project is the focus of this Environmental Impact Assessment Report (EIAR).
Cenos Offshore Windfarm Ltd. (The Applicant)	The Applicant for the Section 36 Consent and associated Marine Licences.
Cumulative Assessment	The consideration of potential impacts that could occur cumulatively with other relevant projects, plans, and activities that could result in a cumulative effect on receptors.
Developer	Cenos Offshore Windfarm Ltd., a Joint Venture between Flotation Energy and Vårgrønn As (Vårgrønn).

TERM	DEFINITION
Environmental Impact Assessment (EIA)	The statutory process of evaluating the likely significant environmental effects of a proposed project or development. Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and maintenance and decommissioning.
Environmental Impact Assessment Regulations	This term is used to refer to the Environmental Impact Assessment Regulations which are of relevance to the Project. This includes the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended); and the Marine Works (Environmental Impact Assessment) Regulations 2007.
Environmental Impact Assessment Report	A report documenting the findings of the EIA for the Project in accordance with relevant EIA Regulations.
Export/Import Cable	High voltage cable used to export/import power between the OSCPs and Landfall.
Export/Import Cable Bundle (EICB)	Comprising two Export/Import Cables and one fibre-optic cable bundled in a single trench.
Export/Import Cable Corridor (EICC)	The area within which the Export/Import Cable Route will be planned and the Export/Import Cable will be laid, from the perimeter of the Array Area to MHWS.
Export/Import Cable Route	The area within the Export/Import Export Corridor (EICC) within which the Export/Import Cable Bundle (EICB) is laid, from the perimeter of the Array Area to MHWS.
Floating Turbine Unit (FTU)	The equipment associated with electricity generation comprising the WTG, the floating substructure which supports the WTG, mooring system and the dynamic section of the IAC.
Flotation Energy	Joint venture partner in Cenos Offshore Windfarm Ltd.
Habitats Regulations	The Habitats Directive (Directive 92/43/ECC) and the Wild Birds Directive (Directive 2009/147/EC) were transposed into Scottish Law by the Conservation (Natural Habitats &c) Regulations 1994 ('Habitats Regulations') (up to 12 NM); by the Conservation of Offshore Marine Habitats and Species Regulations 2017 ('Offshore Marine Regulations') (beyond 12 NM); the Conservation of Habitats and Species Regulations 2017 (of relevance to consents under Section 36 of the Electricity Act 1989);

TERM	DEFINITION
	the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001; and the Wildlife and Countryside Act 1981. The Habitats Regulations set out the stages of the Habitats Regulations Appraisal (HRA) process required to assess the potential impacts of a proposed project on European Sites (Special Areas of Conservation, Special Protection Areas, candidate SACs and SPAs and Ramsar Sites).
Habitats Regulations Appraisal	The assessment of the impacts of implementing a plan or policy on a European Site, the purpose being to consider the impacts of a project against conservation objectives of the site and to ascertain whether it would adversely affect the integrity of the site.
High Voltage Alternating Current (HVAC)	Refers to high voltage electricity in Alternating Current (AC) form which is produced by the WTGs and flows through the IAC system to the OSCPs. HVAC may also be used for onward power transmission from the OSCPs to assets or to shore over shorter distances.
High Voltage Direct Current (HVDC)	Refers to high voltage electricity in Direct Current (DC) form which is converted from HVAC to HVDC at the OSCPs and transmitted to shore over longer distances.
Horizontal Directional Drilling (HDD)	An engineering technique for laying cables that avoids open trenches by drilling between two locations beneath the ground's surface.
Innovation and Targeted Oil & Gas (INTOG)	In November 2022, the Crown Estate Scotland (CES) announced the Innovation and Targeted Oil & Gas (INTOG) Leasing Round, to help enable this sector-wide commitment to decarbonisation. INTOG allowed developers to apply for seabed rights to develop offshore windfarms for the purpose of providing low carbon electricity to power oil and gas installations and help to decarbonise the sector. Cenos is an INTOG project and in November 2023 secured an Exclusivity Agreement as part of the INTOG leasing round.
Inter-Array Cable (IAC)	The cables which connect the WTGs to the OSCPs. WTGs may be connected with IACs into a hub or in series as a 'string' or a 'loop' such that power from the connected WTGs is gathered to the OSCPs via a single cable.
Joint Venture	The commercial partnership between Flotation Energy and Vårgrønn, the shareholders which hold the Exclusivity Agreement with CES to develop the Cenos site as an INTOG project.
Landfall	The area where the Export/Import Cable from the Array Area will be brought ashore. The interface between the offshore and onshore environments.

TERM	DEFINITION
Marine Licence	Licence required for certain activities in the marine environment and granted under the Marine and Coastal Access Act 2009 and/or the Marine (Scotland) Act 2010.
Marine Protected Area (MPA)	Marine sites protected at the national level under the Marine (Scotland) Act 2010 out to 12 NM, and the Marine and Coastal Access Act 2009 between 12-200 NM. In Scotland MPAs are areas of sea and seabed defined so as to protect habitats, wildlife, geology, underseas landforms, historic shipwrecks and to demonstrate sustainable management of the sea.
Marine Protected Area (MPA) Assessment	A three-step process for determining whether there is a significant risk that a proposed development could hinder the achievement of the conservation objectives of an MPA.
Mean High Water Springs (MHWS)	The height of Mean High Water Springs is the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest.
Mean Low Water Springs (MLWS)	The height of Mean Low Water Springs is the average throughout a year of the heights of two successive low waters during periods of 24 hours (approximately once a fortnight).
Mitigation Measures	Measures considered within the topic-specific chapters in order to avoid impacts or reduce them to acceptable levels. • Primary mitigation - measures that are an inherent part of the design of the Project which reduce or avoid the likelihood or magnitude of an adverse environmental effect, including location or design; • 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 Project; and • Tertiary mitigation – measures that are implemented in accordance with industry standard practice or to meet legislative requirements and are independent of the EIA (i.e. they would be implemented regardless of the findings of the EIA). Primary and tertiary mitigation are referred to as embedded mitigation. Secondary mitigation is referred to as additional mitigation.
Mooring System	Comprising the mooring lines and anchors, the mooring system connects the floating substructure to the seabed, provides station-keeping capability for the floating substructure and contributes to the stability of the floating substructure and WTG.

TERM	DEFINITION
Nature Conservation Marine Protected Area (NCMPA)	NCMPA designated by Scottish Ministers in the interests of nature conservation under the Marine (Scotland) Act 2010.
Offshore Substation Converter Platforms (OSCPs)	An offshore platform on a fixed jacket substructure, containing electrical equipment to aggregate the power from the WTGs and convert power between HVAC and HVDC for export/import via the export/import cable to/from the shore. The OSCPs will also act as power distribution stations for the Oil & Gas platforms.
Onward Development	Transmission projects which are anticipated to be brought forward for development by 3rd party oil and gas operators to enable electrification of assets via electricity generated by the Project. All Onward Development will subject to separate marine licensing and permitting requirements.
Onward Development Area	The area within which oil and gas assets would have the potential to be electrified by the Project.
Onward Development Connections	Oil and gas assets located in the waters surrounding the Array Area will be electrified via transmission infrastructure which will connect to the Project's OSCPs. These transmission cables are referred to as Onward Development Connections.
Project Area	The area that encompasses both the Array Area and EICC.
Project Design Envelope	A description of the range of possible elements that make up the Project design options under consideration and that are assessed as part of the EIA for the Project.
Study Area	Receptor specific area where potential impacts from the Project could occur.
Transboundary Assessment	The consideration of impacts from the Project which have the potential to have a significant effect on another European Economic Area (EEA) state's environment. Where there is a potential for a transboundary effect, as a result of the Project, these are assessed within the relevant EIA chapter.
Transmission Infrastructure	The infrastructure responsible for moving electricity from generating stations to substations, load areas, assets and the electrical grid, comprising the OSCPs, and associated substructure, and the Export/Import Cable.
Vårgrønn As (Vårgrønn)	Joint venture partner in Cenos Offshore Windfarm Ltd.

TERM	DEFINITION
Wind Turbine Generator (WTG)	The equipment associated with electricity generation from available wind resource, comprising the surface components located above the supporting substructure (e.g., tower, nacelle, hub, blades, and any necessary power transformation equipment, generators, and switchgears).
Worst-Case Scenario	The worst-case scenario based on the Project Design Envelope which varies by receptor and/or impact pathway identified.

11 MARINE MAMMAL ECOLOGY

11.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) presents the Marine Mammal Ecology receptors of relevance to the Project and assesses the potential impacts from the construction, operation and maintenance and decommissioning of the Project on these receptors. Where required, mitigation is proposed, and the residual impacts and their significance are assessed. Potential cumulative, transboundary and whole project impacts are also considered.

Table 11-1 below provides a list of all the supporting studies which relate to and should be read in conjunction with the marine mammal impact assessment. All supporting studies are appended to this EIAR.

Table 11-1 Supporting studies

DETAILS OF STUDY	SUPPORTING STUDIES AND LOCATION (WHERE RELEVANT)
Unexploded Ordnance (UXO) Survey Specifications	EIAR Vol. 4, Appendix 4
UXO Threat and Risk Assessment	EIAR Vol. 4, Appendix 5
UXO Risk Mitigation Strategy	EIAR Vol. 4, Appendix 6
Underwater Noise Modelling Report	EIAR Vol. 4, Appendix 15
Marine Mammal Baseline Report	EIAR Vol. 4, Appendix 16
Marine Mammal Cumulative Effects Assessment Screening	EIAR Vol. 4, Appendix 17
Interim Population Consequences of Disturbance (iPCoD) Modelling Report	EIAR Vol. 4, Appendix 18
Outline Marine Mammal Mitigation Protocol	EIAR Vol. 4, Appendix 33

The impact assessment presented herein draws upon information presented within other impact assessments within this EIAR, including:

- EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography, and Coastal Processes – which assesses the impact of the Project on aspects such as geology, bathymetry, seabed sediment and sediment transport (including sediment plumes), hydrodynamics, waves and coastal characteristics) which could indirectly affect the distribution of marine mammal and megafauna receptors;
- EIAR Vol. 3, Chapter 9: Marine Water and Sediment Quality – which assesses the potential impacts of increased Suspended Sediment Concentrations (SSC) and disturbance and release of contaminated sediments or radioactive particles, which have the potential to affect marine mammal and megafauna prey species;
- EIAR Vol. 3, Chapter 10: Benthic Ecology – which assesses the potential impacts on benthic habitats and species, which may impact marine mammal and megafauna prey species, and outlines mitigation measures to reduce biofouling;

- EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology – which assesses the potential impacts on key marine mammal and megafauna prey species, such as herring, cod, whiting, sandeel and flatfish;
- EIAR Vol. 3, Chapter 14: Commercial Fisheries – which assesses the potential impacts on commercial fishing effort, which may affect marine mammal and megafauna prey species; and
- EIAR Vol. 3, Chapter 15: Shipping and Navigation- which characterises the baseline vessel traffic conditions and assesses the impact of additional vessels associated with the Project, which has been used to inform the assessment of vessel collision for marine mammals and megafauna.

Where information is used to inform the impact assessment, reference to the relevant EIAR chapter is given.

The following specialists have contributed to the assessment:

- Stephanie Blyth, Xodus Group;
- Pia Ricca, Xodus Group;
- Monika Kosecka, Xodus Group; and
- Ewan Edwards, Xodus Group.

11.2 Legislation, policy, and guidance

The wider marine planning, legislation, policy and guidance is discussed in EIAR Vol. 2, Chapter 3: Policy and Legislative Context. The following legislation, policy, and guidance are relevant to the assessment of impacts from the Project on marine mammals:

- Legislation:
  - International:
    - Convention for the Protection of the Marine Environment of the North-East Atlantic (The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Convention); and
    - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).
  - National:
    - Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in offshore (>12 Nautical Mile (NM)) waters;
    - Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) for Scottish territorial (<12 NM) waters ('the Habitats Regulations 1994');
    - European Protected Species (EPS) listed under Schedule 2 of the Habitats Regulations 1994 (as amended in Scotland);
    - Wildlife and Countryside Act 1981 (as amended);
    - Nature Conservation (Scotland) Act 2004;
    - Marine (Scotland) Act 2010;
    - Marine and Coastal Access Act 2009.
- Policy:
  - The Scottish Biodiversity Strategy, including the following documents: Scotland's Biodiversity: It's in Your Hands and the 2020 Challenge for Scotland's Biodiversity (Scottish Government, 2022);

- Scotland's National Marine Plan (NMP) (Marine Scotland, 2015)[1], including the following principles which are applicable to the conservation of marine mammals:
  - GEN 1 General Planning Principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan;
  - GEN 9 Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area;
  - GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects;
  - GEN 19 Sound Evidence: Decision making in the marine environment will be based on sound scientific and socio–economic evidence; and
  - Paragraph 4.51 and 4.53 of the National Marine Plan which makes reference to protected species, stating "*The presence (or potential presence) of a legally protected species is an important consideration. If there is evidence to suggest that a protected species is present or may be affected by a proposed development, steps must be taken to establish their presence. The level of protection afforded by legislation must be factored into the planning and design of the development and any impacts must be fully considered prior to the determination of the application. (…) for certain species deliberate or reckless disturbance or harassment is prohibited and can only be carried out in accordance with the terms of a licence*".
- A Blue Economy Vision for Scotland (Scottish Government, 2022);
- PMFs:
  - Which states that, within Scottish waters, cetaceans and pinnipeds are considered PMFs under marine conservation priorities within Scottish Waters (Tyler-Walters *et al.*, 2016; NatureScot, 2020).
- United Kingdom Biodiversity Action Plan (UK BAP):
  - Under the UK BAP, cetaceans and pinnipeds are considered priority species, which are either the most threatened or which require additional conservation within United Kingdom (UK) waters.

- Guidance:
  - Joint Nature Conservation Committee (JNCC) guidance on minimising the risk of injury to marine mammals from geophysical survey operations (seismic survey guidelines) (JNCC, 2017);
  - JNCC Consultation Report: Harbour porpoise Special Area of Conservations (SACs) noise guidance. JNCC Report No. 652 (JNCC, 2020a);
  - Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010);
  - Draft JNCC guidelines for minimising the risk of injury to marine mammals from explosive use in the marine environment (JNCC, 2023);
  - The protection of marine EPS from injury and disturbance: guidance for inshore waters (July 2020 version) (Marine Scotland, 2020);
  - Guidance on the Offence of Harassment at Seal Haul-out Sites (Marine Scotland, 2014);
  - A review of noise abatement systems for Offshore Wind Farm (OWF) construction noise, and the potential for their application in Scottish Waters (Verfuss *et al.*, 2019);
  - Scottish Marine Wildlife Watching Code (NatureScot, 2017); and
  - Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report (SMRU Ltd; on behalf of The Crown Estate, 2010)

[1] *Following the most recent review of the NMP in 2021, the Scottish Ministers announced, in 2022, their intention to update the National Marine Plan. This update is underway but has not yet reached a draft consultation stage. A stakeholder engagement strategy and statement of public participation was published in August 2024.*

11.3 Scoping and consultation

Stakeholder consultation has been ongoing throughout the Environmental Impact Assessment (EIA) and has played an important part in ensuring the scope of the baseline characterisation and impact assessment are appropriate with respect to the Project and the requirements of the regulators and their advisors.

The 2024 Scoping Report was submitted to Marine Directorate – Licensing Operations Team (MD-LOT) in April 2024, relevant stakeholders were consulted. The Scoping Opinion was received in September 2024. The 2024 Scoping Report and Scoping Opinion supersedes the 2023 Scoping Report and Scoping Opinion for the Project. Relevant comments from the Scoping Opinion and other consultation specific to Marine Mammal Ecology are provided in Table 11-2 below, which provides a high-level response on how these comments have been addressed within the EIAR. A Scoping Workshop was held on the 29th February 2024 (as detailed in EIAR Vol. 2, Chapter 1: Introduction). Relevant points specific to Marine Mammal Ecology are provided in Table 11-2 below, which sets out how these points have been addressed within the EIAR.

Further consultation has been undertaken throughout the pre-application phase. The list below summarises the consultation activities carried out relevant to marine mammals:

1. Meeting with NatureScot, 2nd October 2024, where the approach to marine mammal population modelling was presented and discussed. As agreed with NatureScot, the JNCC (2020b) EDRs have been used to estimate number of animals disturbed by piling in other projects where this information is not yet available. The 26 km EDR has been used for monopiling; and the 15 km EDR has been used for pin-piling/anchor piling for floating developments. As a precautionary measure, these EDRs (defined for harbour porpoise) have also been applied to other species for which Interim Population Consequences of Disturbance (iPCoD) modelling was undertaken (i.e. minke whale, grey seal);
2. Email from NatureScot, 14th October 2024, confirming NatureScot's position on screening of projects for cumulative effects assessment and the likelihood of significant effects on marine mammal European sites, following discussion on this topic in the meeting held on 2nd October 2024. The list of projects for cumulative assessment comprises eight planned OWFs and one subsea cable project. Cenos agreed with NatureScot that there is no potential for Likely Significant Effect (LSE) from the Project on the Moray Firth SAC, and as a result no in-combination effects assessment is required for this protected site (see RIAA); and
3. Email from NatureScot, 4th November 2024, confirming that, with respect to population modelling, auditory injury could be considered to be fully avoided (mitigated) and that the population modelling should only include the effects of disturbance. As a result, iPCoD modelling has been carried out, both for the Project alone and cumulative with other developments, without including an estimate for number of animals likely to experience Permanent Threshold Shift (PTS).

The advice received during this further consultation has been incorporated into this chapter.

Table 11-2 Comments from the Scoping Opinion relevant to Marine Mammal Ecology

CONSULTEE	COMMENT	RESPONSE
Scottish Ministers	The Developer considers the potential impact of the Proposed Development on marine mammals in chapter 10 of the Scoping Report. The Scottish Ministers are satisfied with the Study Area presented in Section 10.3 of the Scoping Report and that the data sources listed in table 10-4 are sufficient to inform the baseline characterisation, however, for the avoidance of doubt, this should also include Carter *et al*. (2022) as highlighted by NatureScot in its representation.	Noted. Carter *et al*. (2022) data has been included in the list of data and information sources presented in Table 11-3.
Scottish Ministers	The Scottish Ministers are broadly content with the impacts proposed to be scoped in and out of the EIA Report as detailed in table 10-8 of the Scoping Report with the following additions. Changes to prey resources should be scoped in for the operation and maintenance phase of the Proposed Development. The Scottish Ministers do not agree with the proposal to scope out secondary entanglement and advise that this must be scoped in for the operation and maintenance phase of the Proposed Development and direct the Developer to the NatureScot representation in this regard.	Noted. This advice has been considered and an assessment of potential long-term changes to prey resources have been considered as part of the operation and maintenance assessment (Section 11.6.2.2). Following the Scoping Response, secondary entanglement has been scoped in and assessed accordingly in Section 11.6.2.3.
Scottish Ministers	Section 10.11 of the Scoping Report sets out the Developer's proposed approach to assessing the potential significant effects to marine mammals as a result of the Proposed Development. In line with the NatureScot representation, the Scottish Ministers advise the use of population estimates for the UK portion of the Inter-Agency Marine Mammal Working Group Management Units ("MU") for species with very large MUs. However, the entire MU should be used in the assessment for species with smaller MUs such as bottlenose dolphin and seals.	Noted. This advice has been incorporated into the relevant impact assessments and is presented throughout Section 11.4.4.

CONSULTEE	COMMENT	RESPONSE
Scottish Ministers	The Scottish Ministers direct the Developer to the NatureScot representation in relation to the use of density estimates from SCANS-IV or Digital Aerial Survey ("DAS") data and advise that the appropriate approach is implemented in the EIA Report. For impacts within the cable route, block NS-D estimates should be used.	Noted. This advice has been incorporated into the relevant impact assessments and is presented throughout Section 11.4.4.
Scottish Ministers	In relation to the approach to underwater noise assessment, the Scottish Ministers are unable to provide specific advice and advise that the Developer further engage with NatureScot to agree the assessment methodology.	Noted. Meetings and email correspondence with NatureScot in October 2024 informed the approach to the underwater noise impact assessment.
Scottish Ministers	The Scottish Ministers note the embedded mitigation measures detailed in Section 10.7 of the Scoping Report and advise that further mitigation may be required following assessment should impacts be predicted. This is in line with the NatureScot representation.	Noted. This advice has been considered and further mitigation has been reviewed following assessment.
Scottish Ministers	The Scottish Ministers agree with the Developer's proposal to scope in cumulative effects on marine mammals. However, highlight the NatureScot representation in relation to the potential requirement to consider more than the immediate ZoI in undertaking the cumulative effects assessment on marine mammals.	Noted. As with the NatureScot response, the cumulative assessment has considered a reasonable and relevant list of plans and projects occurring within each relevant marine mammals MU. As agreed with NatureScot, the cumulative Zone of Influence (ZoI) has been identified as a 200 km radius around the Project; this is approximately two times the maximum range of marine mammal impacts associated with impact piling. This approach was agreed with NatureScot by email.
Scottish Ministers	In Section 10.10 of the Scoping Report, the Developer proposes to scope in transboundary effects on marine mammals. The Scottish Ministers agree with this approach.	Noted.
NatureScot	Study Area	Noted.

CONSULTEE	COMMENT	RESPONSE
	The Study Area for marine mammals is described in Section 10.3 of the Scoping Report. We agree with the use of UK marine mammal mitigation units (MMMUs) to define the Study Area.	
NatureScot	NatureScot agree that all the marine mammal protected areas within the Study Area have been identified. We note that the Habitats Regulation Assessment (HRA) screening report is not presented with the Scoping Report, so there is no information about Special Areas of Conservation (SACs) with marine mammal features. The only Nature Conservation Marine Protected Area (NCMPA) with marine mammal features is the Southern Trench MPA.	Noted.
NatureScot	Baseline characterisation We agree that the data sources listed in Table 10-4 are sufficient to inform the baseline characterisation for marine mammals. We note that Carter et al. (2022) is not listed in Table 10-4, although it is referred to elsewhere in the text.	Noted. Carter *et al*. (2022) data has been included in the list of data and information sources presented in Table 11-3.
NatureScot	Impact pathways The potential impacts on marine mammals are summarised in Table 10-8. We advise that all potential impacts have been identified for marine mammals.	Noted.
NatureScot	"Changes to prey resources" has been scoped in for construction and decommissioning, but scoped out for the operation and maintenance phase. We advise that changes to prey resources should be scoped in for the operation and maintenance phase. This is because there may be ongoing impacts to prey due to EMF, hydrodynamics, scour, etc. "Subsea mooring systems may cause entanglement resulting in injury and/or mortality" is proposed to be scoped out. The information presented in Appendix 5G (Approach to secondary entanglement as a potential impact)	Noted. This advice has been considered and an assessment of potential long-term changes to prey resources have been considered as part of the operation and maintenance assessment (Section 11.6.2.2). As requested by NatureScot, secondary entanglement has been included in the impact assessment for the operation and maintenance phase.

CONSULTEE	COMMENT	RESPONSE
	is helpful and indicates that risk of secondary entanglement is likely to be low. However, we advise that this impact pathway (secondary entanglement) should be scoped into the EIA for marine mammals, due to the high uncertainty around this potential impact, the lack of monitoring to date, and the scale of the development which is greater than previous infrastructure projects in the area. We would not expect to see a quantitative assessment, rather the information provided in the Scoping Report could be used in the EIA to support qualitative assessment of sensitivity and magnitude of impacts.	
NatureScot	Approach to assessment For those impacts scoped in (Table 10-8), do you agree that the methods described are sufficient to inform a robust impact assessment? Based on the information presented in Section 10.11 on the proposed approach to the assessment for marine mammals, we agree in principle that the methods described are sufficient to inform a robust impact assessment. This is with the caveat that there is not much detail on the methodology.	Noted. Additional detail on relevant methodologies is included in the impact assessments in Section 11.5 and also in EIAR Vol. 4, Appendix 18: Interim Population Consequences of Disturbance (iPCoD) Modelling Report. This has also been considered through further consultation with NatureScot in a meeting and by email during October/November 2024, where the assessment approach was agreed.
NatureScot	Reference Populations Note that, for impact assessment, we advise use of population estimates for the UK portion of the Inter-Agency Marine Mammal Working Group (IAMMWG) Management Units (MUs), rather than the full MUs, for species with very large MUs. The reasoning for this is to try to present the most realistic assessment of numbers of animals affected by developments in Scottish waters. The MUs for most species are very large areas, and in most cases are too big for a meaningful understanding of impacts to affected populations. Although we know this is based on a non-biological	Noted. This advice has been incorporated into the relevant impact assessments and is presented throughout Section 11.4.4.

CONSULTEE	COMMENT	RESPONSE
	delineation, we think that using the UK portion of the MU better reflects the likely size of populations affected by the potential impact pathways. For species with smaller MUs, such as bottlenose dolphin in the Coastal East Scotland MU, and seals, the entire MU should be used in the assessment.	
NatureScot	The Cenos site straddles the boundary of two SCANS-IV blocks (NS-D or NS-G). We advise using the more precautionary of the density estimates from the two SCANS-IV blocks for each species. However, if the DAS data are sufficiently robust to provide a density estimate, and are more precautionary than the SCANS-IV estimates, then the DAS estimates should be used instead. For any impacts within the cable route, block NS-D estimates should be used, as the cable is entirely within this block.	Noted. This advice has been incorporated into the relevant impact assessments, and is presented throughout Section 11.4.4.
NatureScot	Sensitivity Scoring The approach to receptor sensitivity is outlined in Section 5.7.3 within the Assessment Methodology. Regarding sensitivity scoring, we agree that this should take their ability to tolerate, recover and adapt behaviour to maintain vital rates in response to assessed pressures into account. We also expect sensitivity scoring to take conservation value into account as is the case for the other ecological receptor assessments, e.g. ornithology and benthic interests. As such, we welcome the inclusion of value within Section 5.7.3.	Noted. See section 11.5 for further information on the assessment methodology.
NatureScot	The proposed approach to the underwater noise modelling and assessment methodology is discussed in Section 10.11.2 and 10.11.3 of the Scoping Report. We require further information about the choice of a 1% threshold for determining significance of effects and evidence of where it is “generally accepted” (see Section 10.11.2.2). The references provided in relation to this in Paragraph 10.11.2.2 do not refer to this threshold. The significance will depend on a number of factors, including the natural variability of the population and the duration of the potential impact. Therefore, other	The 1% threshold for determining significance proposed at scoping has been disregarded, and further justification of how significance is determined has been provided at relevant locations within this chapter. Each quantitative assessment presented herein has been considered with respect to a number of factors which could impact on the favourable conservation status of each species.

CONSULTEE	COMMENT	RESPONSE
	factors will also need to be considered, not just a percentage threshold. Use of any threshold must be discussed and agreed during pre-application.	For clarity, a 1% threshold has not been used in this chapter to determine significance.
NatureScot	Cumulative assessment The approach to the cumulative effects assessment is discussed in Section 10.9. We caution that the cumulative assessment may need to consider more than the immediate Zone of Influence (ZoI) (i.e. there can be cumulative impacts even where ZoIs don't directly overlap).	Noted. The cumulative assessment (Section 11.7) has taken into account a reasonable and relevant list of plans and project occurring within each relevant marine mammals MU. The cumulative ZoI has been identified as a 200 km radius around the Project; this is approximately two times the maximum range of marine mammal impacts associated with impact piling. This was agreed with NatureScot in a meeting on 2 October 2024 and subsequent email correspondence.
NatureScot	Mitigation and monitoring The embedded mitigation measures are detailed in Section 10.7 of the Scoping Report. In principle, we agree that the embedded mitigation measures described provide a suitable means for managing and mitigating the potential effects of the Project on marine mammal receptors. However, we note that most proposed mitigation measures are based around future plans rather than specific measures. In addition, further mitigation and monitoring may be needed if impacts are predicted.	An outline Marine Mammal Mitigation Protocol (MMMP) has been developed and submitted alongside the Cenos EIAR (EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol). This MMMP outlines the mitigation measures to be implemented during various activities, including geophysical survey, UXO clearance and impact piling.
NatureScot	Transboundary impacts Potential for transboundary effects on marine mammals is considered in Section 10.10 of the Scoping Report and Appendix 5D: Transboundary Screening Matrix. We agree that marine mammals should be scoped in for the assessment of transboundary effects.	Noted. The assessment of transboundary effects is presented in Section 11.9.
Scoping Workshop – 29th February 2024		
NatureScot	Requests clarification around reaching 1% of reference population threshold. Need to take into account duration and extent of piling which is	The 1% threshold for determining significance proposed at scoping has been disregarded, and further justification of how

CONSULTEE	COMMENT	RESPONSE
	unknown for now. Looking at realistic worst case, space to incorporate number of days et	significance is determined has been provided at relevant locations within this chapter. Each quantitative assessment presented herein has been considered with respect to a number of factors which could impact on the favourable conservation status of each species.
NatureScot	Request a clear explanation and justification for scoping out collision, and discussion of mitigation measures to be put in place.	Justification for scoping out risk of collisions is provided in Section 11.5.2.
NatureScot	Suggest scoping in secondary entanglement as there is a rapid scaling up of number of turbines in water which may have a cumulative risk effect.	Secondary entanglement has been scoped in as an impact for the operation and maintenance phase in Section 11.7.3.3.

11.4 Baseline characterisation

This Section outlines the current baseline for marine mammals within the Study Area (as defined within Section 11.4.1). The characterisation of the marine mammal baseline environment was undertaken by a desk-based review of publicly available data and information sources (as outlined within Section 11.4.2) and is supplemented by site-specific aerial surveys which included marine mammal observations, including the Cenos digital video aerial surveys of seabirds and marine mammals, which is appended to EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report. The detailed baseline for marine mammals is presented in EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report; which considers the species which are occur throughout the Study Area and, where applicable, the wider marine region.

11.4.1 Study Area

The Study Area (as presented within Figure 11-1) has been defined on two spatial scales in consideration of the highly mobile nature of marine mammals and the potential for effects associated with the Project to impact animals at both a local and regional scale.

The Project Study Area is defined as the Project Area plus a 100 km buffer, selected on the basis of potential far-field effects of sound emissions associated with impact piling (specifically, the cumulative sound exposure range for a temporary change in hearing sensitivity at certain frequencies (known as Temporary Threshold Shift; TTS) for low frequency (LF) cetaceans. This range (100 km) was selected not on the basis of likely significant effects at this range, but to capture the greatest plausible (modelled) range of impact from activities associated with the Project; specifically, sound emissions from percussive piling. Given the highly mobile nature of marine mammal species, it is considered that this Study Area is sufficient to describe and assess the potential effects of the Project.

Additionally, the characterisation of the existing baseline environment considers the Inter-Agency Marine Mammal Working Group (IAMMWG, 2023) cetacean Management Units (MUs) and the Special Committee on Seals (SCOS) Seal Management Units (SMUs). These species-specific Regional Study Area aim to capture the potential effects of the Project on marine mammal populations. In line with NatureScot's comments on the Cenos OWF EIA Scoping Report (see Section 11.3), marine mammal population estimates presented within this EIAR consider the UK portion of the IAMMWG cetacean MUs, rather than the full MU population. It is deemed that by considering only the UK portion of the MUs, a realistic assessment of the number of animals affected by works associated with the Project within Scottish waters will be presented.

The MUs and SMUs which are relevant to the Project are listed below:

- The UK portion of the North Sea (NS) MU for harbour porpoise (*Phocoena phocoena*);
- The UK portion of the Celtic and Greater North Seas (CGNS) MU for Atlantic white-sided dolphin (*Lagenorhynchus acutus*), white-beaked dolphin (*Lagenorhynchus albirostris*) and minke whale (*Balaenoptera acutorostrata*);
- The UK portion of the Greater North Sea (GNS) MU, and the Coastal East Scotland (CES) MU for bottlenose dolphin (*Tursiops truncatus*); and
- The East Scotland SMU (ES SMU) for grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*).

The Marine Mammal Ecology temporal scope is defined as the entire lifetime of the Project including construction, operation and maintenance and decommissioning.

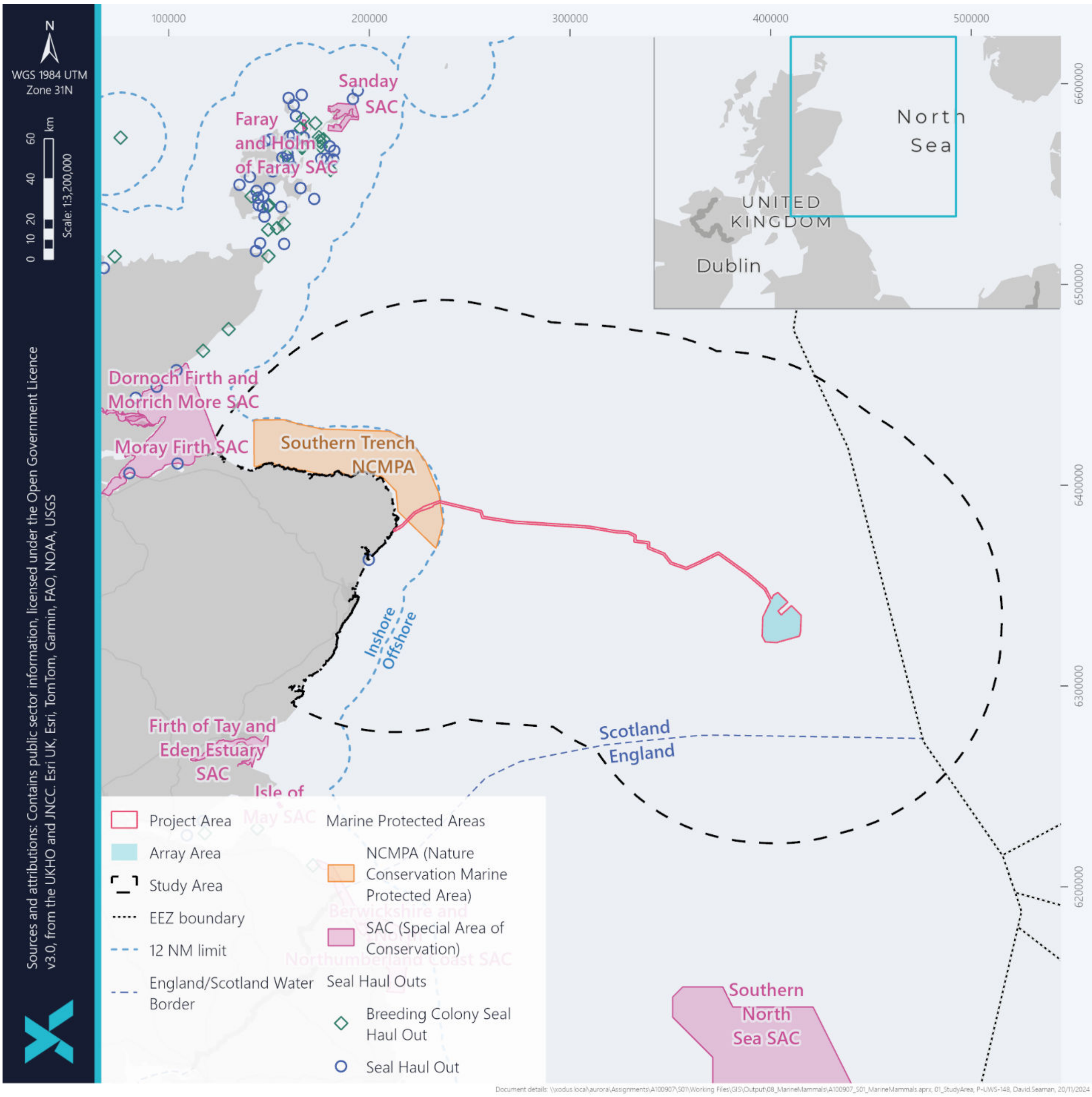

Figure 11-1 Study Area

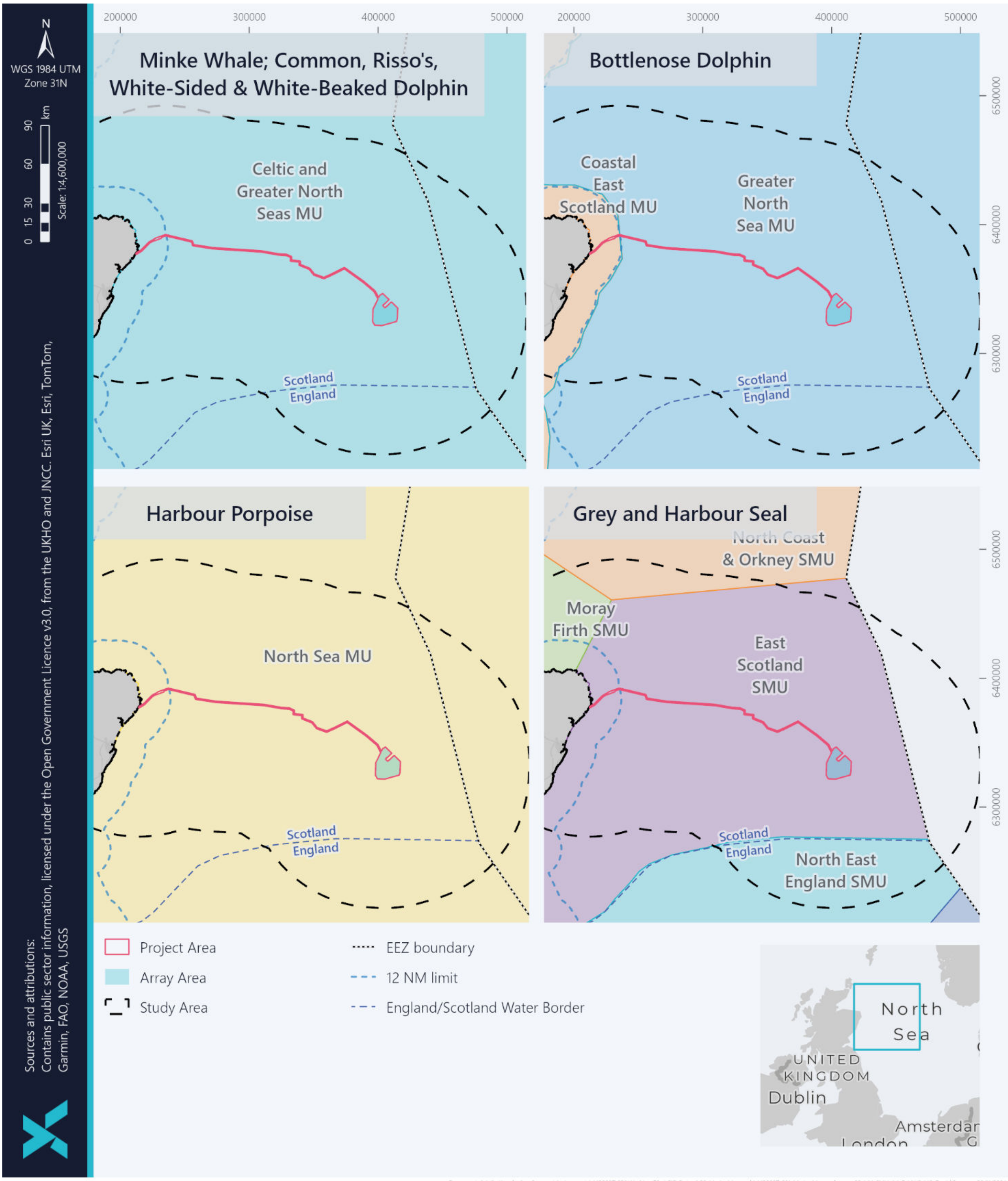

Figure 11-2 Cetacean MUs (IAMMWG, 2023) and seal SMUs of relevance to the Project

11.4.2 Data sources

The existing data sets and literature with relevant coverage to the Project, which have been used to inform the baseline characterisation for Marine Mammal Ecology are outlined in Table 11-3. Project specific data obtained and used to inform this topic assessment are presented in Section 11.4.3. More details are presented in the Marine Mammal Baseline Report (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report).

Table 11-3 Summary of key datasets and reports

TITLE	SOURCE	YEAR	AUTHOR
Descriptions of Scottish Priority Marine Features (PMFs). Scottish Natural Heritage Commissioned Report No. 406.	https://www.nature.scot/doc/naturescot-commissioned-report-406-descriptions-scottish-priority-marine-features-pmfs	2016	Tyler-Walters *et al.*
East Coast Scotland Marine Mammal Acoustic Study (ECOMMAS)	https://data.marine.gov.scot/dataset/east-coast-marine-mammal-acoustic-study	2017	Brookes *et al.*
Designated haul-out sites for seals (Protection of Seals Orders)	https://marine.gov.scot/maps/446	2019	Marine Scotland
Distribution maps of cetacean and seabird populations in the North-East Atlantic	https://doi.org/10.1111/1365-2664.13525	2019	Waggitt *et al.*
Regional baselines for marine mammal density across the North Sea and Atlantic areas of Scottish waters	https://data.marine.gov.scot/dataset/regional-baselines-marine-mammal-knowledge-across-north-sea-and-atlantic-areas-scottish	2020	Hague *et al.*
The protection of Marine European Protected Species from injury and disturbance Guidance for Scottish Inshore Waters (July 2020 Version)	https://www.gov.scot/publications/marine-european-protected-species-protection-from-injury-and-disturbance/	2020	Marine Scotland
Improving understanding of bottlenose dolphin movements along the east coast of Scotland (Final Report)	https://risweb.st-andrews.ac.uk/portal/en/researchoutput/improving-understanding-of-bottlenose-dolphin-movements-along-the-east-coast-	2021	Arso Civil *et al.*

TITLE	SOURCE	YEAR	AUTHOR
	of-scotland-final-report(f49a6c03-60c2-4e71-9c8f-5a3476ff216f)/export.html		
Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation 2017-2022. NatureScot Research Report 1360.	https://www.nature.scot/doc/naturescot-research-report-1360-site-condition-monitoring-bottlenose-dolphins-within-moray-firth	2024	Cheney *et al.*
Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys	https://www.tiho-hannover.de/en/clinics-institutes/institutes/institute-for-terrestrial-and-aquatic-wildlife-research-itaw/scans-iv-survey	2023	Gilles *et al.*
Digital aerial seabird and cetacean surveys off the east coast of Scotland	https://www.gov.scot/publications/digital-aerial-seabird-cetacean-surveys-east-coast-scotland/	2022	Scottish Government
Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS III aerial and shipboard surveys	https://scans3.wp.st-andrews.ac.uk/files/2021/06/SCANS-III_design-based_estimates_final_report_revised_June_2021.pdf	2021	Hammond *et al.*
Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS III aerial and shipboard surveys	https://scans3.wp.st-andrews.ac.uk/files/2022/08/SCANS-III_density_surface_modelling_report_final_20220815.pdf	2022	Lacey *et al.*
Scientific Advice on Matters Related to the Management of Seal Populations	http://www.smru.st-andrews.ac.uk/files/2023/09/SCOS-2022.pdf	2022	SCOS
UK Offshore Energy Strategic Environmental Assessment 4 (OESEA4): Appendix 1a.8 Marine mammals	https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-4-oesea4	2022	Department for Business, Energy & Industrial Strategy (BEIS)

TITLE	SOURCE	YEAR	AUTHOR
Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management	https://doi.org/10.3389/fmars.2022.875869	2022	Carter *et al.*
JNCC Report 734 Review of Management Unit boundaries for cetaceans in UK waters (2023)	https://data.jncc.gov.uk/data/b48b8332-349f-4358-b080-b4506384f4f7/jncc-report-734.pdf	2023	IAMMWG
Culzean Floating Offshore Wind Turbine Pilot Project	https://marine.gov.scot/data/marine-licence-application-culzean-floating-offshore-wind-turbine-pilot-project-east-aberdeen	2024	TotalEnergies
Green Volt Offshore Wind Farm	https://marine.gov.scot/sites/default/files/231b3a1.pdf	2023	Royal Haskoning DHV
National Whale and Dolphin Watch Sightings	https://www.seawatchfoundation.org.uk/recentsightings/	2023	Sea Watch Foundation

11.4.3 Project site-specific surveys

Digital video aerial surveys for seabirds and marine mammals have been undertaken for the Project between April 2021 and March 2023 (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report). These surveys, carried out by HiDef Aerial Surveying Limited (HiDef), comprised a programme of high-resolution digital video aerial surveys over a total of 24 months. The survey utilised 2.5 km-spaced transects across the Array Area plus a 4 km surrounding buffer to cover a total survey area of 835.97 km^2 (Figure 11-3).

The survey was undertaken using an aircraft equipped with four HiDef Gen II cameras, with sensors set at a resolution of 2 cm Ground Sample Distance (GSD). Each camera sampled a 125 metre (m) wide strip separated from the next by sample strip by a distance of approximately 25 m. As such this survey method provided a combined sampled width of 500 m within an overall 575 m strip. Two of the four cameras were analysed from the completion of the survey campaign, achieving approximately 10% coverage of the survey area within each site.

The surveys identified a total of 180 marine mammals of four different species within boundary of the survey area. The overall animal identification rate to species level was 96.81% throughout the 24-month survey period.

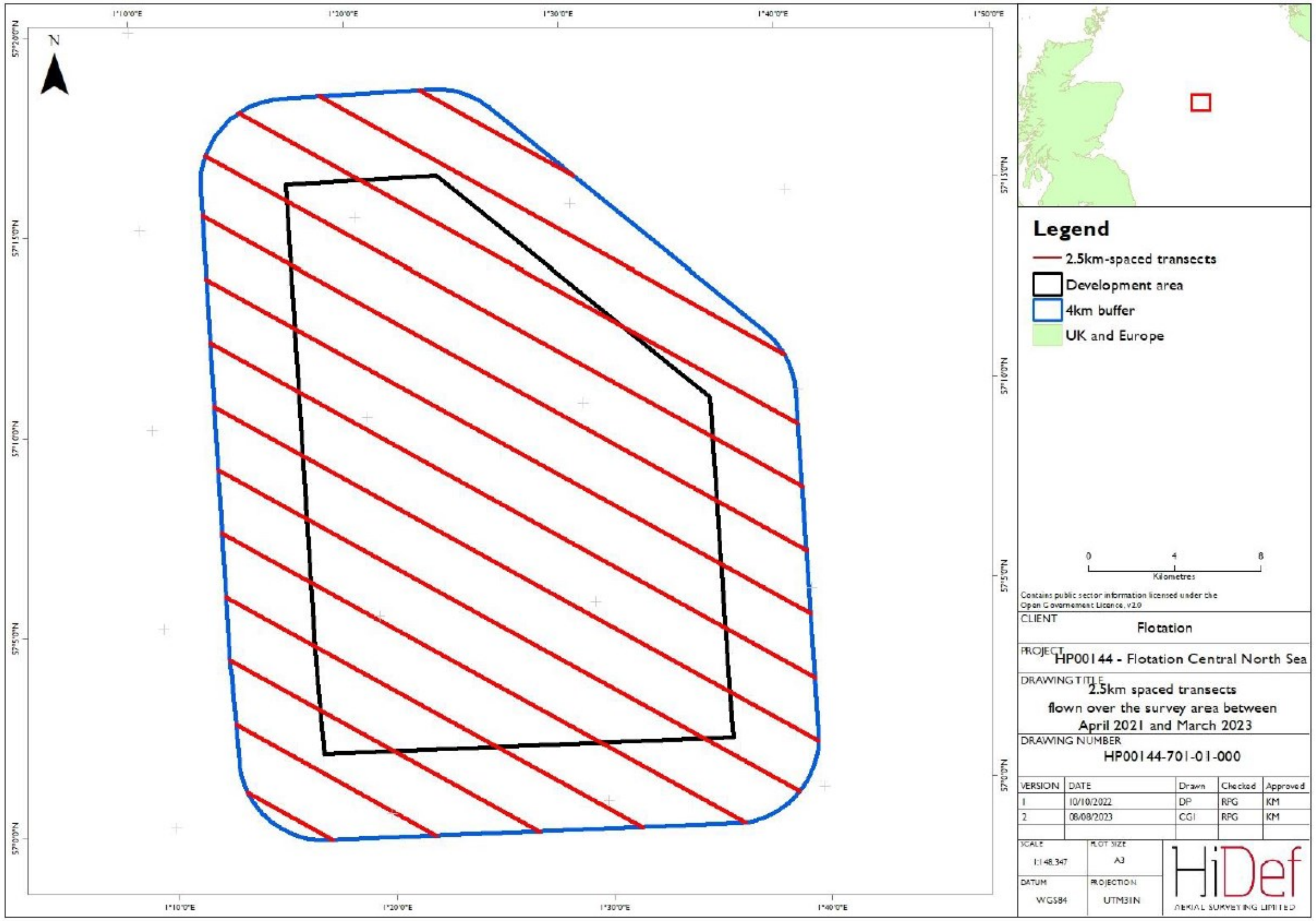

Figure 11-3 HiDef Central North Sea survey campaign survey area

11.4.4 Existing baseline

A review of literature and available data sources, augmented by consultation and the digital video aerial surveys report (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report), has been undertaken to describe the current baseline environment for marine mammals. More details are presented in the Marine Mammal Baseline Report (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report).

11.4.4.1 Cetaceans

Cetaceans are an entirely aquatic group of marine mammals, comprising all species of dolphins, porpoises and whales. There are more than 20 species of cetaceans within Scottish waters, four of which are considered commonly occurring species: harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale.

As detailed within Table 11-3 there are a number of key data sources, which provide information on the spatial distribution and abundance of marine mammals within the Project and Regional Study Area and wider UK waters. These sources include the most recent IAMMWG (2023) cetacean MU populations, the Small Cetaceans in European Atlantic waters and the North Sea (SCANS)-IV cetacean survey for European Atlantic waters (Gilles *et al.*, 2023), the earlier SCANS III surveys (Hammond *et al.*, 2021), and Project-specific aerial surveys (as detailed in Section 11.4.3). The abundance and distribution of cetacean species within European Waters and Project Study Area have been defined using broad scale (e.g. SCANS-IV and SCANS III survey blocks and species estimates from Project-specific aerial surveys). The Project directly overlaps with SCANS-IV blocks NS-D and NS-G (Figure 11-4).

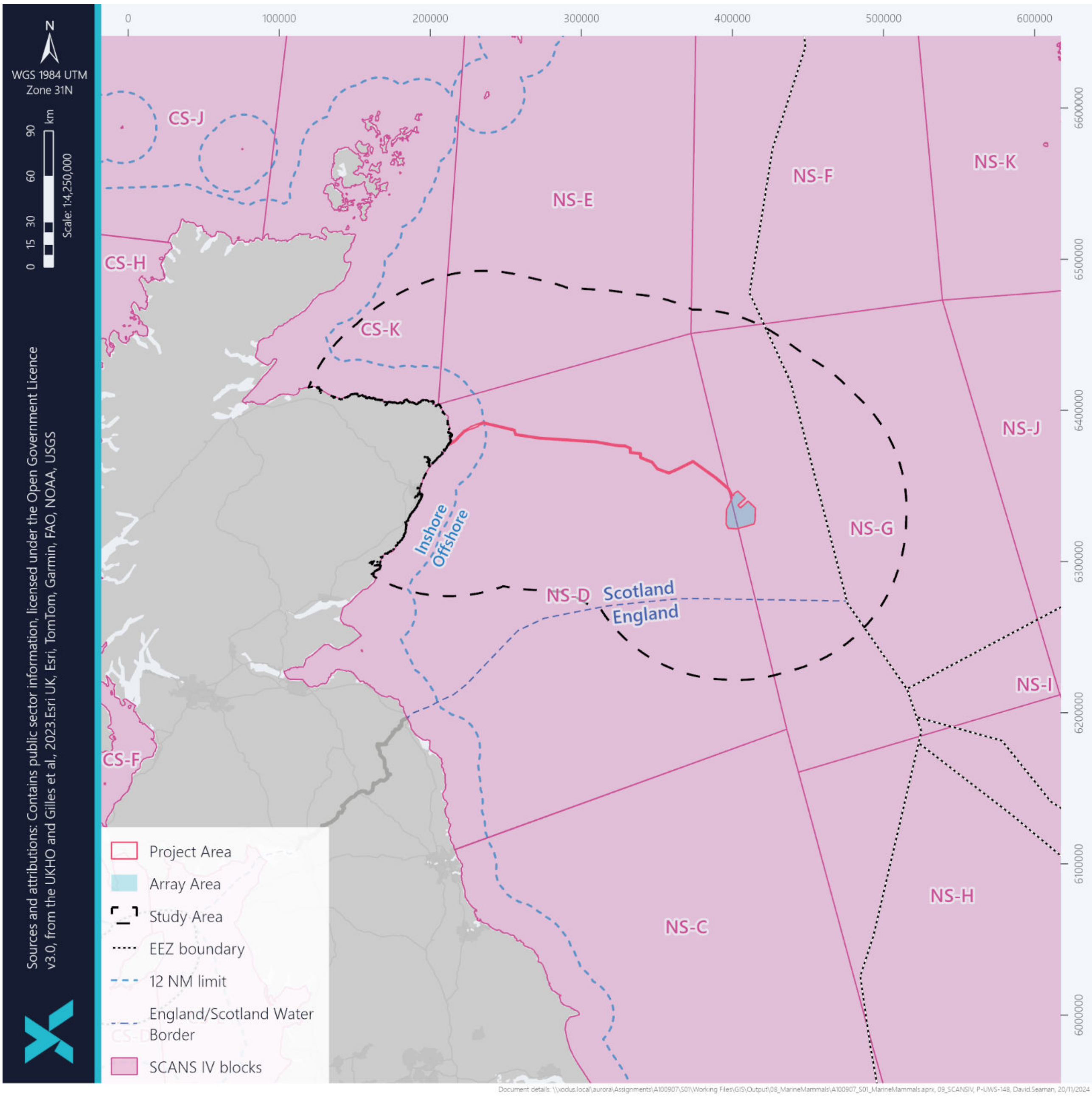

Figure 11-4 SCANS-IV blocks in relation to the Project Study Area (Gilles et al., 2023)

The abundance and density estimates for the four commonly-occurring cetacean species within the Project Study Area are summarised in Table 11-4 below. Animal density data for these species is presented as the most conservative estimate from either the Project-specific aerial surveys or SCANS density estimates.

Table 11-4 Abundance and density estimates for the four commonly occurring cetacean species within Scottish waters (Hammond et al., 2021; Gilles et al., 2023; IAMMWG, 2023; Cheney et al., 2024; Palmer et al., 2017; HiDef, 2024)

SPECIES	ANIMAL DENSITY (ANIMALS/km^2)	PROJECT-SPECIFIC SURVEY DENSITY ESTIMATES (ANIMALS/km^2)	ANIMAL ABUNDANCE	MU POPULATION	ANIMAL DENSITY TAKEN FORWARD FOR ASSESSMENT
Harbour porpoise	Block NS-D: 0.5985 Block NS-G: 1.0398	0.33	Block NS-D: 38,577 Block NS-G:51,646	NS MU: 346,601 UK portion of MU: 159,632	1.0398
Bottlenose dolphin (offshore)	Block R*: 0.0289	Unknown	Block R*: 1,924	GNS MU: 2,022 UK portion of MU: 1,885	0.0289
Bottlenose dolphin (coastal)	0.625 (Palmer *et al.*, 2017)	n/a	n/a	CES MU: 224	0.625
White-beaked dolphin	Block NS-D: 0.0799 Block NS-G: 0.1051	0.12	Block NS-D: 5,149 Block NS-G: 5,218	CGNS MU: 43,951 UK portion of MU: 34,025	0.12
Minke whale	Block NS-D: 0.0419 Block NS-G: 0.0103	0.01	Block NS-D: 2,702 Block NS-G: 510	CGNS MU: 20,118 UK portion of MU: 10,288	0.0419

*In the absence of a SCANS-IV density estimate, the relevant SCANS-III data (Hammond et al., 2021) has been presented

It is noted that while the Study Area will directly interact with a portion of SCANS-IV Blocks CS-K and NS-E, the animal density and abundance estimates for these blocks have not been considered further as part of this chapter as these blocks are not representative of the location and spatial extent of the Project. Furthermore, the most precautionary SCANS-IV block density estimate has been selected to inform the impact assessment.

The SCANS-IV density estimates are expected to be the most representative density and abundance estimates for cetacean occurrence within the Study Area, as they were undertaken using a robust, standardised methodology. As such these estimates have been taken forward for the quantitative impact assessment undertaken within Section 11.6. As the Study Area extends across the boundaries of two SCANS-IV blocks, the abundance and density estimates for the block with the highest reported value will be used as part of the assessment of potential effects as a most conservative scenario. This approach is consistent with comments received from NatureScot on the Cenos OWF EIA Scoping Report (as detailed in Table 11-2).

During Project site-specific surveys (as detailed in Section 11.4.3) a total of 180 marine mammals were identified. Harbour porpoise were the most frequently-observed cetacean species across the survey region, with numbers of animals peaking in November 2021 with 57 animals recorded at an absolute density of 2.12 animals/km^2 (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report). Throughout the survey period, 21 white-beaked dolphins, six grey seals and one minke whale were also recorded (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report). There were several unidentified cetacean observations throughout the survey period.

11.4.4.1.1 Harbour porpoise

Harbour porpoise are widespread throughout the North Sea (Hague, Sinclair, & Sparling, 2020; Scottish Wildlife Trust, 2024), favouring the waters of the continental shelf and making seasonal migration to the shallower waters of the coast to feed and calve (JNCC, 2024a). Over 90% of the global population of harbour porpoise are found within UK waters, with animals present in Scottish waters year-round (Waggitt *et al.*, 2019).

There is growing evidence to suggest that the spatial distribution of harbour porpoise within the North Sea is shifting southwards (Hammond *et al*. 2013; Hammond *et al*. 2021; Nachtsheim *et al*. 2021; Ijsseldijk *et al*. 2020), with a significant return in harbour porpoise numbers to the Southern Bight of the North Sea and the English Channel over the last 25 years (Bouveroux *et al*., 2020). While the ecological drivers of this shift in spatial distribution are unclear (Bouveroux *et al*., 2020), there is evidence to suggest that this trend is magnified by shifts in prey distribution and availability in response to climate change (Hammond *et al*. 2013; Williamson *et al*. 2021). Despite this however there is no evidence of large-scale changes in the distribution of harbour porpoise within the North Sea, with some studies suggesting that observed shifts in animal distribution are seasonal and are not evidence of long-term population changes (Nachtsheim *et al*., 2021, Hammond *et al*., 2021, Gilles *et al*., 2023).

The NS MU for harbour porpoise has a total estimated abundance of 346,601 animals, with the total abundance of harbour porpoise within the UK portion of the NS MU estimated at 159,632 animals (IAMMWG, 2023). SCANS-IV animal density estimates for harbour porpoise within Blocks NS-D and NS-G are 0.5985 animals/km^2 and 1.0398 animals/km^2 respectively, with animal abundance within Blocks NS-D and NS-G estimated at 38,577 and 51,646 respectively (Gilles *et al*., 2023). During the SCANS-IV survey, harbour porpoise were the most frequently sighted cetacean species during primary search effort, with observed distribution of harbour porpoise during SCANS-IV closely reflecting observed distribution during the previous SCANS-III surveys (Gilles *et al*., 2023; Hammond *et al*., 2021) where the greatest densities occur in the southern North Sea.

In 2008, the OSPAR Commission case reports for the OSPAR list of threatened and/or declining species and habitats reported declines in the abundance of harbour porpoise since the 1940s in the Greater North Sea ecoregion (OSPAR Commission, 2008). Harbour porpoise were most recently assessed for the International Union for Conservation of Nature (IUCN) Red List of Threatened Species in 2020. The assessment considered the global population of harbour porpoise and concluded that the species was of Least Concern (Braulik *et al*., 2023).

In the UK, harbour porpoise are a EPS listed under Annex IV of the Habitats Directive, which gives them protection from killing, injury and disturbance throughout their range. Additionally, harbour porpoise are listed on Annex II of the Habitats Directive, which affords this species protection through the designation of protected areas. The largest designated site with harbour porpoise as a qualifying feature within UK waters is the Southern North Sea (SNS) SAC, located off the east coast of England and covering a total area of 36,951 km^2, making it the largest SAC in European waters (JNCC, 2024b). The SNS SAC, located approximately 180 km to the south of the Project, affords protection to approximately 17.5% of the NS MU population of harbour porpoise (JNCC, 2024b). In Scottish waters, the Inner Hebrides and Minches SAC was designated for the conservation of harbour porpoise, covering a total area of 13,800 km^2 and affording protection to over 5,000 animals (Scottish Wildlife Trust, 2024), however this site lies off western Scotland, approximately 480 km from the Project. There are no designated sites with harbour porpoise as a qualifying feature intersecting with the Project Study Area.

11.4.4.1.2 Bottlenose dolphin

There is a semi-resident population of approximately 226 bottlenose dolphin which occurs around the east coast of Scotland, including the Moray Firth (Quick *et al.*, 2014; JNCC, 2024c; SeaWatch Foundation, 2020a; Cheney, *et al.*, 2024). Bottlenose dolphins are found globally in both coastal and offshore waters, exhibiting a wide distributional range from the sheltered habitats of harbours and bays seawards into exposed offshore waters (National Oceanic and Atmospheric Administration (NOAA), 2024a), with evidence of the Moray Firth population extending their range eastwards and southwards since the mid-1990s (JNCC, 2024c). Bottlenose dolphins are highly mobile and regularly occur offshore in smaller numbers (Cheney *et al.*, 2013; NMPi, 2024).

The GNS MU for bottlenose dolphin has a total estimated abundance of 2,022 animals, with the total abundance of bottlenose dolphin within the UK portion of the GNS MU estimated at 1,885 animals (IAMMWG, 2023). The CES MU for bottlenose dolphin, which lies entirely within UK waters, has a total estimated abundance of 226 animals (Cheney *et al.*, 2024). Density estimates for bottlenose dolphin were not produced for SCANS-IV survey blocks NS-D and NS-G (Figure 11-4), as there were no sightings of bottlenose dolphin in these blocks during the survey campaign (Gilles *et al.*, 2023). However, during the SCANS-III survey, abundance estimates for bottlenose dolphin within Block R (within which the Project and Study Area are wholly located) were provided (Hammond *et al.*, 2021). These density and abundance estimates are provided in Table 11-4.In the absence of SCANS-IV data for bottlenose dolphin, density and abundance estimates obtained from the SCANS-III Block R survey will be used as part of the assessment of potential effects to bottlenose dolphins in offshore waters. However, for inshore waters representative of the CES MU, a density of 0.625 bottlenose dolphins/km^2 is carried through the assessment, which is derived for the area close to the Export/Import Cable landfall from the work of Palmer *et al.* (2017) on the inshore population.

Bottlenose dolphin was most recently assessed for the IUCN Red List of Threatened Species in 2018. The assessment considered the global population of bottlenose dolphin and concluded that the species was of Least Concern (Wells *et al.*, 2019). There is evidence to suggest that bottlenose dolphin population along the east coast of Scotland and England has been increasing slowly, with future projections indicating a continuing range expansion and shifts in population distribution are likely to occur (Arso Civil *et al.*, 2019).

Bottlenose dolphins are listed under Annexes II and IV of the European Union (EU) Habitats Directive and as such are considered an EPS, and are additionally afforded protection through the designation of SACs. The closest SAC designated for the conservation of bottlenose dolphin is the Moray Firth SAC, located approximately 93.7 km from the Project Area at its nearest point (and ca. 300 km from the Array Area). The condition of the resident bottlenose dolphin population located within the Moray Firth SAC was last assessed in 2024 where it was concluded that the population status was 'favourable, maintained' (NatureScot, 2024a). Within wider UK waters, bottlenose dolphins are considered to be of 'favourable' conservation status (JNCC, 2019a).

11.4.4.1.3 White-beaked dolphin

The white-beaked dolphin, which is considered to be the second most abundant cetacean species in the North Sea after harbour porpoise (Banhuera-Hinestroza *et al*., 2009; Hammond *et al*., 2021) favours the colder temperate and subpolar waters of the North Atlantic, with a preference for waters less than 300 m deep (NOAA, 2024b; Waggitt *et al*., 2019). White-beaked dolphins are common within the waters of the central and northern NS, around the Northern Isles and Hebrides, with most recorded sightings occurring off the north, north-east and north-west coasts of Scotland (Cetacean Research and Rescue Unit (CRRU), 2024). Spatial models for cetaceans suggest that there are moderately high densities of white-beaked dolphin throughout the northern and Central North Sea (CNS), with a predicted high density of this species occurring off the north coast of Scotland (Waggitt *et al*., 2019).

The CGNS MU for white-beaked dolphin has a total estimated abundance for 43,951 animals, with the total abundance of white-beaked dolphin within the UK portion of the CGNS MU estimated at 34,025 animals (IAMMWG, 2023). SCANS-IV animal density estimates for white-beaked dolphin within Blocks NS-D and NS-G are 0.0799 animals/km^2 and 0.1051 animals/km^2 respectively, with animal abundance within Blocks NS-D and NS-G estimated at 5,149 and 5,218 respectively (Gilles *et al*., 2023).

White-beaked dolphin was most recently assessed for the IUCN Red List of Threatened Species in 2018. The assessment considered the global population of white-beaked dolphin and concluded that the species was of Least Concern (Kiska *et al*., 2018). White-beaked dolphins are listed as EPS under Annex IV of the EU Habitats Directive. Within UK waters, white-beaked dolphin is considered to be of 'favourable' conservation status (JNCC, 2019b).

11.4.4.1.4 Minke whale

Minke whales have a global distribution, however in the UK the majority of sightings occur off the coast of Scotland in shallower, continental shelf waters (<200 m depth; NatureScot, 2024b). Minke whales are most commonly spotted around Scotland between the months of July and September, however there is evidence of animal presence throughout the year (NatureScot, 2024b), with particularly high densities of animals recorded around the Moray Firth (Lacey *et al*., 2022). Within the Moray Firth, minke whales are typically observed between May and June before they migrate to inshore feeding grounds (NatureScot, 2024b). A study which analysed passive acoustic data for the presence of minke whales off eastern Scotland noted that most acoustic detections were made between May and November, with most detections coming in June, July and October (Risch *et al*., 2019a). The year-round presence of minke whales in the waters of the Moray Firth influenced the designation of the Southern North Trench Nature Conservation Marine Protected Area (NCMPA), located off the Aberdeenshire coast between Buckie and Peterhead. Owing to the mixing of warm and cool waters within the Southern Trench NCMPA, shoals of fish which are considered prey for minke whales (including sandeel, herring (*Culpea harengus*), mackerel and cod (*Gadus morhua*)) are abundant.

The CGNS MU for minke whale has a total estimated abundance of 20,118 animals, with the total abundance of minke whale within the UK portion of the CGNS MU estimated at 10,288 animals (IAMMWG, 2023). SCANS-IV animal density estimates for minke whale within Blocks NS-D and NS-G are 0.0419 animals/km^2 and 0.0103 animals/km^2 respectively, with animal abundance within Blocks NS-D and NS-G estimated at 2,702 and 510 respectively (Gilles *et al*., 2023).

Minke whale is an EPS under Annex IV of the Habitats Directive. The species was most recently assessed for the IUCN Red List of Threatened Species in 2018. The assessment considered the global population of minke whale and concluded that the species was of Least Concern (Cooke, 2018a). Within UK waters, minke whale is considered to be of ‘favourable’ conservation status (JNCC, 2019c).

11.4.4.2 Other cetacean species

In addition to the four key cetacean species identified and described above, a further six cetacean species are known to occur throughout the North Sea. While these species are considered to be less common, there is the potential for animals to occur within the vicinity of the Project. These species include:

- Atlantic white-sided dolphin (*Lagenorhynchus acutus*);
- Short-beaked common dolphin (*Delphinus delphis*);
- Long-finned pilot whale (*Globicephala melas*);
- Humpback whale (*Megaptera novaeangliae*);
- Killer whale (*Orcinus orca)*; and
- Risso’s dolphin (*Grampus griseus*).

Given that these cetacean species infrequently occur within the waters of the North Sea, there is generally a lack of data and information available to describe their presence and/or distribution within the Study Area. Uncertainty over their abundance and distribution/density precludes a meaningful quantitative impact assessment, therefore any impacts to these species considered in Section 11.6 will be assessed qualitatively. Nevertheless, any measures proposed to mitigate effects on marine mammals will apply equally to these lesser-known species as they do to those species previously mentioned in Section 11.4.4.1. A summary of these species has been provided below.

11.4.4.2.1 Atlantic white-sided dolphin

Atlantic white-sided dolphin are commonly observed in the deep offshore waters off the coast of Norway around Iceland, the Faroe Islands and the Northern Isles and Outer Hebrides of Scotland (Sea Watch Foundation, 2024). While there have been sightings of this species within the Northern North Sea (NNS), Atlantic white-sided dolphins are generally considered rare in this area (Sea Watch Foundation, 2024).

The CGNS MU for Atlantic white-sided dolphin has a total estimated abundance of 18,128 animals, with the total abundance of Atlantic white-sided dolphin within the UK portion of the CGNS MU estimated at 12,293 animals (IAMMWG, 2023). Density estimates for Atlantic white-sided dolphin were not produced for SCANS-IV survey blocks NS-D and NS-G, as there were no sightings of this species in these blocks during the survey campaign (Gilles *et al.*, 2023). However, during the SCANS-III survey, abundance estimates for Atlantic white-sided dolphin within Block R (which overlaps with the Project and Study Area) were provided (Hammond *et al.*, 2021). These density and abundance estimates have been provided in Table 11-5 below.

Table 11-5 Abundance and density estimates for Atlantic white-sided dolphin from SCANS-III surveys

SPECIES	ANIMAL DENSITY (ANIMALS/km^2)	ANIMAL ABUNDANCE	MU POPULATION
Atlantic white-sided dolphin	SCANS-III density and abundance estimate (Hammond *et al.*, 2021)		CGNS MU: 18,128 UK portion of MU: 12,293
	Block R: 0.0100	Block R: 644	

Atlantic white-sided dolphin were most recently assessed for the IUCN Red List of Threatened Species in 2019. The assessment considered the global population of Atlantic white-sided dolphin and concluded that the species was of Least Concern (Braulik, 2019). Within UK waters, the conservation status of Atlantic white-sided dolphin is unknown (JNCC, 2019d).

11.4.4.2.2 Short-beaked common dolphin

The short-beaked common dolphin is the most abundant dolphin species in the world, ranging from tropical waters to the cooler temperate waters off the south and west coasts of the UK (NOAA, 2024c; The Wildlife Trust (TWT), 2024a). Within the North Sea the short-beaked common dolphin is considered to be rare, however there is evidence to suggest that, as a result of increasing regional ocean temperatures, sightings are increasing (Robinson *et al.*, 2010). Between 2001 and 2009 a systematic survey of the outer Moray Firth provided the first evidence of a long-term presence of short-beaked common dolphins in this region (Robinson *et al.*, 2010). Animals were present throughout the warmer summer months, with a total of 13 encounters of groups ranging between 2 to 450+ animals recorded throughout the survey period (Robinson *et al.*, 2010).

The CGNS MU for short-beaked common dolphin has a total estimated abundance of 102,656 animals, with the total abundance of short-beaked common dolphin within the UK portion of the CGNS MU estimated at 57,417 animals (IAMMWG, 2023). There were no sightings of short-beaked common dolphin recorded within the survey blocks relevant to the Project Study Area, during either the SCANS-IV or SCANS-III survey campaigns (Gilles *et al.*, 2023; Hammond *et al.*, 2021), therefore no density estimates were produced.

Short-beaked common dolphin were most recently assessed for the IUCN Red List of Threatened Species in 2020. The assessment considered the global population of short-beaked common dolphin and concluded that the species was of Least Concern (Braulik *et al.*, 2021). Within UK waters, the conservation status of short-beaked common dolphin is unknown (JNCC, 2019e).

11.4.4.2.3 Long-finned pilot whale

Long-finned pilot whales are found throughout the cold and temperate waters of the southern hemisphere and within the North Atlantic Ocean (Whale and Dolphin Conservation (WDC), 2024). The long-finned pilot whale is one of the most common cetacean species along the edge of the continental shelf and in the deep offshore waters off the shelf (SeaWatch Foundation, 2020b). Within the North Sea long-finned pilot whales are considered rare except within the northernmost sector (SeaWatch Foundation, 2020b).

There were no sightings of long-finned pilot whales recorded within the survey blocks relevant to the Project Study Area, during either the SCANS-IV or SCANS-III survey campaigns (Gilles *et al.*, 2023; Hammond *et al.*, 2021), therefore no density estimates were produced.

Long-finned pilot whales were most recently assessed for the IUCN Red List of Threatened Species in 2018. The assessment considered the global population of long-finned pilot whales and concluded that the species was of Least Concern (Minton *et al*., 2018). Within UK waters, the conservation status of long-fined pilot whales is unknown (JNCC, 2019f).

11.4.4.2.4 Humpback whale

The humpback whale is a cosmopolitan large whale species, undertaking long migrations from tropical breeding grounds to summer foraging grounds at higher latitudes (Kettemer *et al.*, 2022). There is evidence that some humpback whales spend time in Scottish waters at certain times of the year (O'Neil *et al.*, 2019; Risch *et al.*, 2019b; van Geel *et al.*, 2022) and sightings in summer are reasonably common. However, their relative rarity and offshore distribution means that little is known about numbers of animals occurring in Scottish waters, and the majority of sightings occur off western Scotland.

There were no sightings of humpback whales recorded within the survey blocks relevant to the Project Study Area, during either the SCANS-IV or SCANS-III survey campaigns (Gilles *et al*., 2023; Hammond *et al*., 2021), therefore no density estimates were produced.

Humpback whales were most recently assessed for the IUCN Red List of Threatened Species in 2018. The assessment considered the global population of humpback whales and concluded that the species was of Least Concern (Cooke, 2018b). Within UK waters, the conservation status of humpback whales is unknown (JNCC, 2019g).

11.4.4.2.5 Killer whale

Killer whales are found globally and are considered the most widely distributed cetacean species, however they are most common in temperate coastal waters and at high latitudes (NOAA, 2024d; Matthews, *et al*., 2021). In Scottish waters there are several semi-resident pods of killer whales commonly sighted off the coasts of Shetland, Orkney and the North coast of Scotland, however there is evidence of northern pods of killer whales travelling south along the East coast of Scotland to feed (Scottish Seabird Centre, 2024).

Modelling undertaken by Waggitt *et al.* (2019) suggests that densities of killer whales within the NNS and off the east coast of Scotland are low (Waggitt *et al*., 2019). There were no sightings of killer whales within the survey blocks relevant to the Project Study Area, during either the SCANS-IV or SCANS-III survey campaigns (Gilles *et al*., 2023; Hammond *et al*., 2021), therefore no density estimates were produced.

Killer whales were most recently assessed for the IUCN Red List of Threatened Species in 2017. The assessment considered the global population of killer whales and concluded that the species was Data Deficient (Reeves *et al*., 2017). Within UK waters, the conservation status of killer whales is unknown (JNCC, 2019h).

11.4.4.2.6 Risso's dolphin

Risso's dolphins are present in all temperate and tropical waters across the world, with evidence suggesting that animals prefer the deeper offshore waters associated with the continental shelves and slopes (NOAAe, 2024) where they prey predominantly on cephalopods. Within European waters, Risso's dolphin range from the tropics off the coast of Africa to the Shetland Isles (SeaWatch Foundation, 2020c). There are few recorded sightings of Risso's dolphin within the CNS and SNS during the summer months, with sightings off the coast of Scotland most numerous during the winter months (Reid, Evans and Northridge, 2003).

The CGNS MU for Risso's dolphin has a total estimated abundance of 12,262 animals, with the total abundance of Risso's dolphin within the UK portion of the CGNS MU estimated at 8,687 animals (IAMMWG, 2023). There were no sightings of Risso's dolphins within the survey blocks relevant to the Project Study Area, during either the SCANS-IV or SCANS-III survey campaigns (Gilles *et al.*, 2023; Hammond *et al.*, 2021), therefore no density estimates were produced.

Risso's dolphin were most recently assessed for the IUCN Red List of Threatened Species in 2018. The assessment considered the global population of Risso's dolphin and concluded that the species was of Least Concern (Kiszka *et al.*, 2018). Within UK waters, the conservation status of Risso's dolphin is unknown (JNCC, 2019i).

11.4.4.3 Pinnipeds

There are two species of pinnipeds (seals) which live and breed within UK waters, these are harbour seal and grey seal.

During Project site-specific surveys (as detailed in Section 11.4.3) six grey seals were recorded over the 24-month survey period. Additionally, there were several unidentified seal species during the survey campaign, this was primarily associated with difficulties differentiating between seal species.

11.4.4.3.1 Harbour seal

Harbour seals have a near circumpolar distribution, with four subspecies located from the eastern and western Pacific and the eastern and western Atlantic (JNCC, 2024d). The UK population of the harbour seal (approximately 42,900 animals; SCOS, 2022) represents approximately 5% of the global population, approximately 50% of the European population and approximately 45% of the European subspecies (JNCC, 2024d). The harbour seal is the smaller of the two seal species that breed in the UK, with animals found around the coasts of Scotland, Northern Ireland and eastern England (TWT, 2024b). Harbour seals are commonly found around sheltered shores and estuaries, where they haul out on sandbank and beach habitats (TWT, 2024b).

Harbour seals are generally considered to be a more sedentary species when compared to grey seals, with animals generally remaining closer to coastlines and to their haul out sites. However, there is evidence of harbour seals foraging out to distances greater than 100 km from their nearest haul out site (SCOS, 2022). There is evidence to suggest that variations in activity from haul out sites is influenced by the sex of the animal, with female harbour seals spending a greater time hauled out between June and September, and less time hauled out between October and May (Cunningham *et al.*, 2009). There are a total of 194 designated seal haul out sites within Scotland, six of which are located along the east coast of Scotland (and of which four are located within the Firth of Forth; SCOS, 2022). There are no harbour seal haul out sites within the Project Study Area. The closest harbour seal haul out site, Kinghorn Rocks in Fife, is located approximately 141 km to the south of the landfall and approximately 290 km to the southwest of the Array Area.

There have been major declines in northeast Scotland and Orkney harbour seal populations, with counts around the Moray Firth showing an apparent decline of 50% before 2005, and fluctuating in the years following (SCOS, 2022). The Project lies wholly within the ES SMU, with the inshore portion of the Export/Import Cable Corridor (EICC) directly interacting with the ES SMU sub-unit 1: Fraserburgh to Ythan Estuary (Morris *et al.*, 2021). Based on surveys undertaken between 2016 and 2021, the total UK harbour seal population is estimated at 42,900 animals, with the total population of Scotland estimated at 36,600 animals (SCOS, 2022); however, the majority of this Scottish population occurs around the west coast and Western Isles. It was reported that based on 2021 counts, the total number of harbour seals within the ES SMU was 262 animals (SCOS, 2022). August counts for harbour seals within the ES SMU between 1996 and 2021 are presented in Table 11-6 below, demonstrating part of the dramatic decline in the species in this SMU during this time. Within the ES SMU sub-unit 1, harbour seal counts have varied significantly throughout survey campaigns between 1997 and 2018, as presented within Table 11-7.

Table 11-6 August counts for harbour seals within the ES SMU between 1996 and 2021 (SCOS, 2022)

SMU	YEAR					
	1996-1997	2000-2006	2007-2009	2011-2015	2016-2019	2021
East Scotland	764	667	283	224	343	262

Table 11-7 Harbour seal counts within ES SMU sub-unit 1 between 1997 and 2018 (SCOS., 2022)

ES SMU Sub-Unit	YEAR						
	1997	2005	2007	2013	2015	2016	2018
Sub-unit 1	0	14	22	2	-	8	-

Carter *et al.* (2022) published distribution maps based on modelled habitat preference, using telemetry data from harbour seals and grey seals. The study adopted telemetry tracking methodologies (e.g. satellite transmitters, and Global Positioning System (GPS)/GSM/Ultra-High Frequency (UHF) tags) to map the spatial extent and at-sea distribution of seals over a multi-regional scale (Carter *et al.*, 2022). Throughout the Study Area the at-sea population density of harbour seals is approximately 0.04 animals per km^2, with an increase in at-sea population density close to the coastline within the EICC to approximately 0.2 animals per km^2 (Carter *et al.*, 2022).

Harbour seal were most recently assessed for the IUCN Red List of Threatened Species in 2016. The assessment considered the global population of harbour seal and concluded that the species was of Least Concern (Lowry *et al.*, 2016). Within UK waters, the conservation status of harbour seals is considered to be ‘favourable’ (JNCC, 2019j).

Harbour seals are listed as an Annex II species under the EU Habitats Directive and are afforded further protection in Scotland under the Marine (Scotland) Act 2010 (which provides Scottish Ministers with the ability to designate Seal Management Areas), the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) and The Protection of Seals (Designation of Haul-Out Sites (Scotland) Order 2014. Within UK waters, there are a total of 16 SACs designated for the conservation of harbour seals, nine of which are located within Scottish waters (Morris *et al.*, 2021). These sites are selected either for their importance as haul-out sites and/or moulting and pupping sites (JNCC, 2024d). Along the east coast of Scotland there are two SACs with harbour seal as a qualifying feature: the Dornoch Firth and Morrich More SAC (located approximately 135 km to the northwest of the landfall) and the Firth of Tay and Eden Estuary SAC (located approximately 135 km to the southwest of the landfall), both of which lie outwith the Project Study Area.

11.4.4.3.2 Grey seal

Approximately 40% of the global population and 95% of the EU population of grey seals resides within UK waters (JNCC, 2024e). The main concentrations of grey seals within UK waters are located in the Inner and Outer Hebrides and Orkney (Scottish Government, 2011).

Grey seals forage in the open sea and return regularly to land to rest, moult and breed (SCOS, 2022). Grey seals can forage at significant distances from their haulout sites, with evidence suggesting that animals can travel over 100 km from land for periods of between 1 and 30 days. However, there is further evidence of seal tracking data recording grey seals feeding several hundred kilometres offshore (Carter *et al.*, 2022).

The Project lies wholly within the ES SMU, with the inshore portion of the EICC directly interacting with the ES SMU sub-unit 1: Fraserburgh to Ythan Estuary. The grey seal population of the ES SMU is continuing to increase rapidly owing to maintained pup production at the Isle of May SAC and Berwickshire and North Northumberland Coast SAC (SCOS, 2022). The most recent synoptic census of the grey seals within UK waters was undertaken in 2019, concluding that the total grey seal pup production from North Sea colonies is increasing at a rate of approximately 7% per year (SCOS, 2022). Based on surveys undertaken between 2016 and 2021, the total UK grey seal population is estimated at 162,000 animals, with the total population of Scotland estimated at 129,100 animals (SCOS, 2022). It was concluded that in 2021 the total number of grey seals within the ES SMU was 2,712 animals (SCOS, 2022). August counts for grey seals within the ES SMU between 1996 and 2021 are presented in Table 11-8 below, however these August counts only represent the proportion of the population hauled out at the time of the survey, which averages approximately 25% of the total population in the region (SCOS, 2022). Within the ES SMU sub-unit 1, grey seal counts have varied significantly throughout survey campaigns between 1997 and 2018, as presented within Table 11-9.

Table 11-8 August counts for grey seals within the ES SMU between 1996 and 2021 (SCOS, 2022)

SMU	YEAR					
	1996-1997	2000-2006	2007-2009	2011-2015	2016-2019	2021
East Scotland	2,328	1,898	1,238	2,296	3,686	2,712

Table 11-9 Grey seal counts within ES SMU sub-unit 1 between 1997 and 2018 (SCOS, 2022)

ES SMU Sub-Unit	YEAR						
	1997	2005	2007	2013	2015	2016	2018
Sub-unit 1	130	400	388	987	-	2,197	-

The grey seal habitat preference modelling undertaken by Carter *et al.* (2022) indicates that the at-sea population density of grey seals varies significantly across the marine mammal study. Between Mean High Water Spring (MHWS) and approximately 30 km offshore the at sea density ranges between 0.4 – 3 animals/km^2. Between approximately 30 km and 80 km offshore the at sea density of grey seals ranges between 0.4 – 1 individuals/km^2. Between 80 km offshore and the Array Area the at sea density of grey seals is significantly reduced, varying between 0 – 0.2 individuals/km^2 (Carter *et al.*, 2022).

Grey seals were most recently assessed for the IUCN Red List of Threatened Species in 2016. The assessment considered the global population of grey seals and concluded that the species was of Least Concern (Bowen, 2016). Within UK waters, the conservation status of grey seals is considered to be 'favourable' (JNCC, 2019k).

Grey seals are listed as an Annex II species under the Habitats Directive and are afforded protection in Scotland under the Marine (Scotland) Act 2010 (which provides Scottish Ministers with the ability to designate Seal Management Areas), the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) and The Protection of Seals (Designation of Haul-Out Sites (Scotland) Order 2014. Within Scottish waters, there are a total of 16 SACs designated for the conservation of grey seals (JNCC, 2024e), four of which are located along the east coast of Scotland. The closest European site with a grey seal qualifying feature is located at the Isle of May SAC, located within the Firth of Forth, approximately 180 km to the south of the Project at the nearest point. However, the Ythan River Mouth, designated as a haul-out site for grey seals, lies just 20 km south of the Export/Import Cable landfall.

11.4.5 Future baseline

Marine mammals are highly mobile in nature, with their abundance and distribution within the Study Area and wider marine environment influenced by a number of biological and anthropogenic factors, including prey availability, resource competition, broad-scale habitat change, development within the marine and coastal environment, and climate change. These factors have the potential to impact marine mammals throughout their lifecycle.

Throughout the North Sea, trends in increasing water temperature and the subsequent shifts in the presence and distribution of warmer-waters species and native fish species compound observed shifts in the presence and distribution of marine mammals. Recent research has concluded that ocean warming resulting in shifts in the timings of fish spawning has the potential to result in the seasonal distribution of marine mammals throughout the marine environment (Mitchell *et al.*, 2020). Furthermore, competition between marine mammals and humans for resources, including commercially valuable fish species and access to coastal habitats will continue as a result of ongoing coastal and marine development, therefore influencing the shape of marine mammal distributions within the marine environment.

The nature and potential impacts of environmental and anthropogenically pressures on marine mammals is complex and influenced by variables on a local, national and international scale. As such it is not possible to make accurate predictions on changes to the existing baseline for marine mammals over the anticipated lifecycle of the Project.

11.4.6 Summary and key issues

Table 11-10 Summary and key issues for marine mammals

	STUDY AREA
SUMMARY AND KEY ISSUES	• There are four cetacean species which regularly occur throughout the Study Area, these species are: harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale. These species are listed as EPS under Annex IV of the Habitats Directive; • The Project overlaps with the Southern Trench NCMPA which is designated for minke whale (amongst other non-marine mammal features). The Project does not overlap with any other marine protected areas for cetaceans; the closest are the Moray Firth SAC (designated for bottlenose dolphins), located ~100 km west of the Project, and the Southern North Sea SAC (designated for harbour porpoise), located ~300 km south of the Project; • Population, abundance and density estimated for each cetacean species were obtained from SCANS surveys (SCANS-III and SCANS-IV), cetacean MU data, and other sources; • Harbour porpoise are found at the highest densities throughout the Project Area across all cetaceans. They are a relatively abundant species within the North Sea, with ca. 159,000 individuals in the UK portion of the NS MU; • Of the other regularly-occurring cetacean species, white-beaked dolphin are likely to occur at comparatively lower densities. Minke whale are found at very low densities in the Project Area, even in the coastal waters of the Southern Trench NCMPA. Bottlenose dolphin are found at low densities offshore, but occur at higher densities close (<2 km) to the coast, and are the least likely to be found within the Project Area compared to the other regularly-occurring cetacean species; • Several other cetacean species are known to occur in the Study Area, although their distributions and occurrence are poorly understood. These species are Risso's dolphin, short-beaked common dolphin, Atlantic white sided dolphin, long-finned pilot whale, killer whale, and humpback whale; and • Harbour and grey seals live and breed in UK waters. Of these two species, harbour seals have a typically coastal distribution and rarely occur in offshore (>50 km) waters. Within the ES SMU, there were an estimated 262 harbour seals in 2021. The 2021 grey seal August count for the ES SMU was 2,712 animals, and this species is distributed more widely across the Study Area.

11.4.7 Data limitations and uncertainties

As part of the development of the existing baseline for marine mammals, an extensive review of publicly available data and information (as summarised in Table 11-3) and Project site-specific surveys (as summarised in Section 11.4.3) has been undertaken. The development of the existing baseline considered the Study Area and, where appropriate, the wider marine environment. More details are presented in the Marine Mammal Baseline Report (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report).

The publicly available data and information sources used to inform the characterisation of the existing baseline environment for this chapter of the EIAR are considered sufficient to define the abundance and distribution of marine mammal species within the vicinity of the Project.

Project site-specific digital video aerial surveys (EIAR Vol. 4, Appendix 16: Marine Mammal Baseline Report), have been used to define the presence/absence of marine mammals within the immediate vicinity of the Project. While these surveys are extensive in their spatial and temporal coverage, they provide only a snapshot of marine mammal distribution on one day per month throughout the survey campaign. As marine mammals spend much of their time underwater, density estimates produced from aerial survey data rely on correction factors to estimate the number of animals that were not seen because they were below the surface, and thus to derive absolute (rather than relative) densities.

There is some uncertainty with respect to the physiological (e.g. auditory injury) and behavioural responses (i.e. disturbance) of marine mammals due to underwater noise. The majority of sound emissions arising from Project activities that marine mammals will be exposed to will be temporary or transitory, as opposed to permanent and continuous (with the exception of operational wind turbine sound). The underwater noise propagation modelling (EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report) uses the best available scientific evidence (e.g. Southall *et al.*, 2019) as the basis of thresholds for impacts which are then considered within the impact assessments (see Section 11.6.1.1). Additionally, sound exposure calculations are based around the assumption that the sound source is active throughout a pre-determined worst-case scenario (i.e. for piling) or over a 24-hour period (i.e. for operational sound); however, reality is more complex and there are likely to be breaks in activities. This presents a highly precautionary level of sound exposure, as it is likely that the intervals between operations or variations in Sound Pressure Level (SPL) at the source could allow some recovery from temporary hearing threshold shifts for animals exposed to the sound. Therefore, the assessment of cumulative sound exposure (SEL_{cum}) is conservative. These SEL_{cum} calculations also assume that animals will swim away at a fairly constant slow (1.5 m/s) speed, however marine mammals are highly mobile and are likely to move in a more complex manner with varying speed and direction.

There is a considerable degree of uncertainty in relation to what sound pressure or exposure level will elicit behavioural disturbance and therefore any disturbance ranges should be treated as estimates informed by the best available evidence (e.g. Graham *et al.*, 2019; JNCC, 2020b). Uncertainty in the sound level predictions will be greater over larger propagation distances (i.e. in relation to disturbance thresholds) and much lower over shorter distances (i.e. in relation to injury thresholds), which leads to a typically conservative estimate of impact ranges.

The population consequences of disturbance have been modelled for some receptors using iPCoD framework (EIAR Vol. 4, Appendix 18: Interim Population Consequences of Disturbance (iPCoD) Modelling Report). Due to an absence of empirical data to parametrise marine mammal population models, several of the parameters in the model are based on expert elicitation to predict the effects of disturbance on marine mammals, therefore it is likely that these parameters may differ from reality (Donovan *et al.*, 2016). Additionally, the model does not account for density dependence or environmental stochasticity, which is considered biologically unrealistic and may lead to an over- or under-estimate of the consequences of disturbance.

Given the inherent uncertainty in several of the elements of assessing the effects on marine mammals, the impact assessment in this chapter has taken a precautionary approach, with several conservative assumptions, to inform the determination of significance of effects, in relation to the magnitude and significance of those effects. Where a conservative assumption is made as part of this impact assessment, a clear reference is made.

11.5 Impact assessment methodology

11.5.1 Impacts requiring assessment

The impacts identified as requiring consideration for marine mammals are listed in Table 11-11. Information on the nature of impact (i.e. direct or indirect) is also described.

Table 11-11 Impacts requiring assessment for marine mammals

POTENTIAL IMPACT	NATURE OF IMPACT
Construction (including pre-construction activities)	
Injury and disturbance from underwater noise generating activities	Direct
Changes to prey distribution	Indirect
Operation and maintenance	
Injury and disturbance from underwater noise -generating activities	Direct
Secondary entanglement	Direct
Long-term changes to prey resources	Indirect
Decommissioning*	

*In the absence of detailed information regarding decommissioning works, and unless otherwise stated, the impacts during decommissioning are considered analogous with, or likely less than, those of the construction phase. Where this is not the case, decommissioning impacts have been listed separately and have been assessed in Section 11.6.3.

11.5.2 Impacts scoped out of the assessment

The impacts scoped out of the assessment during EIA scoping, and the justification for this, are listed in Table 11-12.

Table 11-12 Impacts scoped out for marine mammals

IMPACT SCOPED OUT	JUSTIFICATION
Construction	
Accidental releases to the marine environment	Accidental releases to the marine environment will be limited to the chemical or hydrocarbon inventory on construction vessels. All vessels involved in the Project will be required to comply with best practice management. This includes the application of strict environmental controls through the implementation of the Environmental Management Plan (EMP), which will include a Marine Pollution Contingency Plan (MPCP), to be secured through Section 36 and Marine Licence conditions. These plans will detail procedures in the event of an accidental release, characterise all sources for potential contaminant releases and provide key emergency contact details for use in the event of a release. Measures detailed in the EMP and MPCP will be in accordance with OSPAR Convention and Marine Pollution (MARPOL) Convention guidelines for preventing pollution at sea. Individual vessels will also have a Ship Oil Pollution Emergency Plan (SOPEP) in place. For these reasons, the potential for accidental release of contaminants from vessels is extremely unlikely and any incidents would be responded to quickly, with strict controls to effectively minimise the scale and impact of any accidental release on the marine environment. As this embedded mitigation minimises the likelihood of a significant effect to negligible, accidental releases to the marine environment has been scoped out of the EIA as a potential impact pathway.
Offshore vessels interaction with marine mammals resulting in injury and/or mortality	The likelihood for vessel interactions to result in injury or mortality to marine mammals during construction is extremely low. The most important factors influencing severity of any potential impact are vessel size and speed (Peltier *et al.*, 2019; Schoeman *et al.*, 2020). The majority of the vessels during construction (including pre-construction) phase are relatively small in size (e.g. tugs, vessels carrying Remotely Operated Vehicles (ROVs), Crew Transfer Vessels (CTVs), barges and RIBs), which may have higher speeds than larger vessels but are also highly manoeuvrable so can more easily stop or move to avoid animals, when detected. Larger vessels, whilst less manoeuvrable, will be travelling at lower speeds meaning they have more time to detect and avoid animals, and for any animals themselves to take evasive action (Schoeman *et al.*, 2020). Slower vessels following a consistent trajectory allow marine mammals the opportunity to avoid collisions. Fatal collisions are more likely when vessels are transiting at higher speeds (Alleaume *et al.*,2011, Conn *et al.*, 2013), and the probability of collision is estimated to decrease by 50% when large vessels reduce speeds to below 11.8

IMPACT SCOPED OUT	JUSTIFICATION
	knots (Vanderlaan *et al.*, 2007). The risk of collision increases in areas of high animal density and with species that are more likely to spend time close to the surface (Caruso *et al.*, 2020), such as large baleen whales. Species such as harbour porpoise, which are the most frequently sighted species within the Project Area, are highly manoeuvrable and have been recorded to dive deeper in the presence of vessels (Dyndo *et al.*, 2015) reducing the potential for collision. Vessel activity will be managed under the EMP (EIAR Vol. 4, Appendix 32: Outline Environmental Management Plan) as part of the Project's embedded mitigation (see Section 11.5.4), which includes adherence to best practice guidance and protocols for vessels and wildlife, such as the Scottish Marine Wildlife Watching Code (SMWWC) (Scottish Natural Heritage (SNH), 2017a), the Codes of Conduct provided by the WiSe (Wildlife-Safe) Scheme (The WiSe Scheme, 2024) and Guide to Best Practice for Watching Marine Wildlife (SNH, 2017b). This includes measures that will reduce the risk of collision with marine mammals, such as to maintain a steady speed and direction in the presence of marine mammals. The risk to the more susceptible species (minke whale) is negligible. Given the extremely low likelihood of interaction between any project vessels and marine mammal receptors, and the embedded mitigation measures which minimise the likelihood of a collision, the impact has been scoped out of the EIA.
Potential changes to Suspended Sediment Concentrations (SSC)	Water quality changes such as increased turbidity may impact the ability of marine mammals to locate prey and may also impact fish prey species presence and distribution. Increased turbidity associated with installation activities (e.g. ploughing, trenching, mass flow excavation) will be temporary and localised, and sediments are expected to be rapidly dispersed, hence there will be no noticeable effect on marine mammals' ability to locate prey. Moreover, any changes will be limited to the base of the water column, and unlikely to propagate to the upper levels of the water column, predominantly used by cetaceans. It is very unlikely for marine mammals to be significantly affected by temporary increases in turbidity which will occur near the seabed. Therefore, this impact has been scoped out of the EIA.
Operation and maintenance	
Accidental releases to the marine environment	Accidental releases to the marine environment will be limited to the chemical or hydrocarbon inventory on construction vessels. All vessels involved in the Project will be required to comply with best practice management. This includes the application of strict environmental controls through the implementation of the EMP, which will include a MPCP, to be secured through Section 36 and Marine Licence conditions. These plans will detail procedures in the event of an accidental release, characterise all sources for potential contaminant releases and provide key emergency contact details for use in the event of a release. Measures detailed in the EMP and MPCP will be in accordance with OSPAR

IMPACT SCOPED OUT	JUSTIFICATION
	Convention and Marine Pollution (MARPOL) Convention guidelines for preventing pollution at sea. Individual vessels will also have a Ship Oil Pollution Emergency Plan (SOPEP) in place. For these reasons, the potential for accidental release of contaminants from vessels is extremely unlikely and any incidents would be responded to quickly, with strict controls to effectively minimise the scale and impact of any accidental release on the marine environment. As this embedded mitigation minimises the likelihood of a significant effect to negligible, accidental releases to the marine environment has been scoped out of the EIA as a potential impact pathway.
Offshore vessels interaction with marine mammals resulting in injury and/or mortality	The likelihood for vessel interactions resulting in injury or mortality to marine mammals during operation and maintenance is extremely low. Vessels will be following a consistent trajectory, at a certain speed, which allows marine mammals the opportunity to avoid collisions. Fatal collisions are more likely when vessels are transiting at higher speeds (Alleaume *et al.*,2011, Conn *et al.*, 2013), and the probability of collision is estimated to decrease by 50% when large vessels reduce speeds to below 11.8 knots (Vanderlaan *et al.*, 2007). The risk of collision increases in areas of high animal density and with species that are more likely to spend time close to the surface (Caruso *et al.*, 2020), such as baleen whales. Species such as harbour porpoise, which are the most frequently sighted species within the Project Area, have been recorded to dive deeper in the presence of vessels (Dyndo *et al.*, 2015) reducing the potential for collision. Operation and maintenance vessel activity will be managed under the EMP (EIAR Vol. 4, Appendix 32: Outline Environmental Management Plan) as part of the standard embedded mitigation (see Section 11.5.4), including adherence to wildlife best practice guidance and protocols such as the SMWWC (SNH, 2017a), the Codes of Conduct provided by the WiSe (Wildlife-Safe) Scheme (The WiSe Scheme, 2024) and Guide to Best Practice for Watching Marine Wildlife (SNH, 2017b). This includes measures that will reduce the risk of collision with marine mammals, such as to maintain a steady speed and direction in the presence of marine mammals. The risk to the more susceptible species (minke whale) is negligible. Given the extremely low likelihood of interaction between any project vessels and marine mammal receptors, and the embedded mitigation measures which minimise the likelihood of a significant effect, the impact has been scoped out of the EIA.
Presence of offshore structures creating a physical barrier effect	While marine structures may theoretically form barriers to movement and migration of marine biota, the wide spacing (target of at least 1 km) between turbine structures at the sea surface and a minimum of 50 m between anchors will allow passage of marine mammals through the area unimpeded. There will be a maximum of 6 mooring lines per Floating Turbine Unit (FTU) with a mooring radius of approximately 850 m. The footprint of the infrastructure is minimal compared to the available space within the Array Area, allowing

IMPACT SCOPED OUT	JUSTIFICATION
	mammals to pass through the area unimpeded and unhindered by the presence of the structures. Accordingly, there is no realistic mechanism for the Project to act as a physical barrier for marine mammals movements and the impact has been scoped out of the EIA.
Electromagnetic Fields (EMF) and heat from energised cables	Marine mammals are not known to be sensitive to electric fields, although there is some evidence that bottlenose dolphins can perceive weak electrical fields which they may use in short-range prey detection (Hüttner *et al.*, 2023). However, there is greater evidence of magnetoreception in a range of cetacean species (e.g. humpback whales, bottlenose dolphins, harbour porpoises) meaning the B-field component of EMF can affect these species (Kremers *et al.*, 2014; Kirschvink *et al.*, 1986). It is considered that many cetaceans and some pinnipeds use the Earth's geomagnetic field (GMF) to navigate, particularly during long migrations, with implications that EMF may interfere with the navigational cues. Modelling conducted by Tricas and Gill (2011) on bottlenose dolphins indicated that they could detect B-fields from a subsea cable up to 50 m away when directly above the cable, causing alteration to the direction of travel. However, due to the high mobility of marine mammal species and capability to move away from the influence of EMF, it is not considered that they would experience long-term impacts. Marine mammals will not be directly affected by heat emitted from operational buried or dynamic cables, as they spend most of their time in the water column, are highly mobile and may only approach the seabed during foraging activity. They generally range over large areas and so will not be in contact with cables and the potential heat emissions for any great length of time. Therefore, any impacts related to EMF and heat emissions have been scoped out of the EIA. (Changes to prey availability due to EMF and heat from energised cables has been scoped in, as requested by Scottish Ministers).
Decommissioning	
Accidental releases to the marine environment	Accidental releases to the marine environment will be limited to the chemical or hydrocarbon inventory on construction vessels. All vessels involved in the Project will be required to comply with best practice management. This includes the application of strict environmental controls through the implementation of the EMP, which will include a MPCP, to be secured through Section 36 and Marine Licence conditions. These plans will detail procedures in the event of an accidental release, characterise all sources for potential contaminant releases and provide key emergency contact details for use in the event of a release. Measures detailed in the EMP and MPCP will be in accordance with OSPAR Convention and Marine Pollution (MARPOL) Convention guidelines for preventing pollution at sea. Individual vessels will also have a Ship Oil Pollution Emergency Plan (SOPEP) in place. For these reasons, the potential for accidental release of contaminants from vessels is extremely unlikely and any incidents

IMPACT SCOPED OUT	JUSTIFICATION
	would be responded to quickly, with strict controls to effectively minimise the scale and impact of any accidental release on the marine environment. As this embedded mitigation minimises the likelihood of a significant effect to negligible, accidental releases to the marine environment has been scoped out of the EIA as a potential impact pathway.
Offshore vessels interaction with marine mammals resulting in injury and/or mortality	The likelihood for vessel interactions resulting in injury or mortality to marine mammals during decommissioning activities is extremely low. Decommissioning vessels activity will be captured under The Decommissioning Programme and will comply with all relevant legislation at that time and best practice at the time of decommissioning will be followed, such as adherence to wildlife best practice guidance and protocols such as the SMWWC (SNH, 2017a), the Codes of Conduct provided by the WiSe Scheme (The WiSe Scheme, 2024) and Guide to Best Practice for Watching Marine Wildlife (SNH, 2017b). This includes measures that will reduce the risk of collision with marine mammals, such as to maintain a steady speed and direction in the presence of marine mammals. The risk to the more susceptible species (minke whale) is negligible. Given the extremely low likelihood of interaction between any project vessels and marine mammal receptors, and the embedded mitigation measures which minimise the likelihood of a significant effect, the impact has been scoped out of the EIA.
Potential changes to SSC	Water quality changes such as increased turbidity may impact the ability of marine mammals to locate prey and may also impact fish prey species presence and distribution. Increased turbidity associated with decommissioning activities will be temporary and localised, and sediments are expected to be rapidly dispersed, hence there will be no noticeable effect on marine mammals' ability to locate prey. Moreover, any changes will be limited to the base of the water column, and unlikely to propagate to the upper levels of the water column, predominantly used by cetaceans. It is very unlikely for marine mammals to be significantly affected by temporary increases in turbidity which will occur near the seabed. Therefore, this impact has been scoped out of the EIA.

11.5.3 Assessment methodology

An assessment of potential effects is provided separately for the construction, operation and maintenance and decommissioning phases.

The assessment for marine mammals is undertaken following the principles set out in EIAR Vol. 2, Chapter 7: EIA Methodology. The sensitivity of the receptor is combined with the magnitude to determine the impact significance. Topic-specific sensitivity and magnitude criteria are assigned based on professional judgement (as described in Table 11-13 and Table 11-14) with the proposed outline for each discussed below:

- Receptor sensitivity - the sensitivity of a marine mammal can be viewed as the ability of that species to tolerate change. The sensitivities of the marine mammal species under consideration have been delineated using available data. The approach taken in this assessment is that a marine mammal considered to be of high sensitivity is one which has no ability to adapt, tolerate or recover from any potential environmental changes arising due to impacts from the project activities. If a marine mammal is of low sensitivity, works associated with the project are not anticipated to result in any important effect on individuals of that species. The approach taken within this assessment aims to determine the sensitivity of individual marine mammals (and their supporting habitats) to any possible impacts arising as a result of the proposed project activities. Table 11-13 summarises the criteria used to define receptor sensitivity for the marine mammal assessment.
- Receptor value - the value or importance of a marine mammal is based on a pre-defined judgement based on legislative requirements, guidance, or policy, which are shaped by the views of stakeholders, experts, and specialists. All marine mammal receptors are of intrinsically 'high' conservation value due to their inclusion in Annex IV of the Habitats Directive as an EPS and/or as qualifying interests of UK and European protected sites (i.e., SACs). All marine mammal species considered in this assessment are listed as PMFs in Scotland. For this reason, all marine mammal receptors are considered to have a high conservation value and therefore the receptor value has not been used to differentiate impact outcomes to the marine mammal populations considered as part of this assessment. Rather, the assessment considered individual species' sensitivities to the impact pathways being assessed.
- Magnitude of effect – the magnitude of effect for the marine mammal assessment requires that consideration of how the following factors will impact on baseline conditions and is defined by the extent of the impact outcomes and their duration and take into account:
  - Spatial Extent: The area over which the effect will occur;
  - Duration: The period of time over which the effect will occur;
  - Frequency: The number of times the effect will occur over the Project life cycle;
  - Intensity: The severity of the effect;
  - Likelihood: The probability that the effect will occur and the probability that the receptor will be present; and
  - Reversibility: The ability for the receiving environment / exposed receptor to return to baseline conditions.
- Based on these parameters and expert judgement, a summarised description of magnitude of effect is provided in Table 11-14.

The benchmark conservation status for the assessment of impacts to marine mammal sensitivity is 'Favourable Conservation Status', as defined within the 'Favourable Conservation Status: UK Statutory Nature Conservation Bodies Common Statement' (JNCC, 2018). The magnitude of effect is defined by the extent of the effect outcomes and the duration of the effects on marine mammal populations (at the scale of their MUs, or where relevant, the UK portion of their respective MUs), and whether activities will consequentially effect the conservation status of those populations. A High effect magnitude relates to an irreversible change to a marine mammal population or its habitat area. A Low effect magnitude is defined as a minor shift from established baseline conditions for a marine mammal species, including short-term changes, which will not result in an overall change to the character, nature or conservation status of the marine mammal receptor.

Table 11-13 Sensitivity criteria

SENSITIVITY OF RECEPTOR	DEFINITION
High	• Receptor has no ability to tolerate a particular effect causing a significant change in individual vital rates (survival and reproduction); • Receptor has no ability to recover from any effect on vital rate (survival and reproduction); and/or Receptor has no ability to adapt behaviour so that individual vital rates (survival and reproduction) are highly likely to be significantly affected.
Medium	• Receptor has a limited ability to tolerate a particular effect which may cause a significant change in individual vital rates (survival and reproduction); • Receptor has a limited ability to recover from any effect on vital rates (survival and reproduction); and/or • Receptor has a limited ability to adapt behaviour so that individual vital rates (survival and reproduction) may be significantly affected.
Low	• Receptor has some tolerance to a particular effect with no significant change in individual vital rates (survival and reproduction); • Receptor is able to recover from any effect on vital rates (survival and reproduction); and/or • Receptor has a limited ability to adapt behaviour so that individual vital rates (survival and reproduction) may be affected, but not at a significant level.
Negligible	• Receptor is able to tolerate a particular effect without any effect on individual vital rates (survival and reproduction); • Receptor is able to return to previous behavioural states / activities once the effect has ceased; and/or • Receptor is able to adapt behaviour so that individual vital rates (survival and reproduction) are not affected.

Table 11-14 Magnitude criteria

MAGNITUDE CRITERIA	DEFINITION
High	Total loss of, or major alteration to conservation status or integrity of a marine mammal receptor with likely long-term of irreversible results. Fundamental alteration to the character and composition of any proposed or designated protected sites.
Medium	Observed effect on the conservation status or integrity of a marine mammal receptor over the short to medium term. For this assessment the duration of a medium magnitude of effect is considered to be no more than two breeding cycles of an individual of a species. This effect is likely to be reversible in the longer term through replacement.
Low	A minor shift away from baseline conditions. The effect may be detectable, but any effects are unlikely to be on a scale or for a duration that would result in a significant effect on the conservation status or integrity of the marine mammal receptor and would be reversible in the short-term i.e., within one breeding cycle of an individual of a species.
Negligible	A very slight change from baseline conditions. Any effects are likely to be reversible either immediately following (or soon after) the cessation of the effect and will not affect the conservation status or integrity of the marine mammal receptor.
No Change	The effect is highly localised and short-term with full rapid recovery expected to result in very slight or imperceptible changes to baseline conditions or receptor population.

The consequence and significance of effect is then determined using the matrix provided in EIAR Vol. 2, Chapter 7: EIA Methodology.

11.5.4 Embedded mitigation

As described in EIAR Vol. 2, Chapter 7: EIA Methodology certain measures have been adopted as part of the Project development process to reduce the potential for effects to the environment, as presented in Table 11-15. These have been accounted for in the assessment presented below. The requirement for additional mitigation measures (secondary mitigation) will be dependent on the significance of the effects on marine mammal receptors.

Table 11-15 Embedded mitigation measures relevant to marine mammals

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
MM-005	Target Depth of Lowering (DoL)	Primary	Static cables will be trenched and buried to a minimum depth of 0.4 m. Where this cannot be achieved, remedial cable protection will be applied. The cable burial target depth is informed by a Cable Burial Risk Assessment (CBRA) and implemented through the Cable Plan (CaP), which will be produced post-consent. EMF emissions associated with the cabling will be reduced by burial of between 90-100% of the cables at the depth between 0.4 – 1.5 m.	Final cable design will be informed by the CBRA and detailed within the CaP, required under Section 36 Consent and/or Marine Licence conditions.
MM-006	EMP	Tertiary	The EMP will set out procedures to ensure all activities with the potential to affect the environment are appropriately managed and will include a description of planned activities and procedures, roles and responsibilities, pollution control and spillage response plans, incident reporting, chemical usage requirements, waste management plans, plant service procedures, communication and reporting structures, and programme of work. It will detail the final design selected and take into account Marine Licence conditions and commitments. The EMP will additionally include an Invasive Non Native Species (INNS) Management Plan (INNSMP) and a MPCP and will be developed in consultation with stakeholders.	The EMP, including the INNSMP and MPCP, will be required under Section 36 Consent and/or Marine Licence conditions. An outline EMP is provided as part of the Application EIAR Vol. 4 Appendix 32: Outline EMP.
MM-009	Decommissioning Programme	Tertiary	The development of, and adherence to, a Decommissioning Programme, approved by Scottish Ministers prior to construction and updated throughout the Project's operational life. This will be written in accordance with applicable guidance and will detail the required activities, programme and environmental management for decommissioning.	The Decommissioning Programme will be required under Section 105 of the Energy Act 2004 (as amended) and a condition of the Section 36 Consent.

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
MM-016	Minimum spacing between FTUs	Primary	928 m spacing between FTU structures at the surface and a minimum of 50 m between anchors. The minimum spacing will allow passage of marine mammals through the area, avoiding the potential for a physical barrier effect and reducing the likelihood of any acoustic barrier effect.	The final layout will be detailed within the Development Specification and Layout Plan (DSLP), required under Section 36 and/or Marine Licence conditions.
MM-017	Mooring lines will be sufficiently taut and rigid to prevent formation of loops, preventing primary entanglement	Primary	Mooring lines will be taut and rigid, avoiding the risk of primary entanglement (i.e. in the mooring lines themselves) to marine mammals.	The final mooring design will be detailed within the DSLP required under Section 36 Consent and/or Marine Licence conditions.
MM-018	UXO clearance approach	Primary	In the event that a UXO is identified within the Project construction area, a hierarchy of mitigation will be applied: • Micro-siting/micro-rerouteing will be used to avoid UXO in the first instance. • Where micro- siting/micro-rerouting is not possible, the UXO will be moved to a safe location outwith the corridor or working area; • In cases where UXO cannot be avoided or pose a safety concern, Low Order clearance methods, such as deflagration will be applied. • In cases where UXO cannot be avoided or pose a safety concern and Low Order clearance methods have not been successful, High Order (i.e. detonation) may be required. However, this method will only be used where absolutely necessary, in agreement with Scottish Ministers.	Any clearance activity will be subject to a separate Marine Licence and EPS Licence, which will be accompanied by supporting environmental information.

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
MM-019	Piling Strategy (PS) (if impact piling is required)	Tertiary	If impact piling is selected as the optimal installation mechanism for the FTUs/Offshore Substation Converter Platforms (OSCPs), a PS will be produced for the Project and implemented in line with relevant guidance. The strategy will provide details on the piling activities and parameters, expected noise levels, duration of activities and any required mitigations associated with this installation technique. The PS will delineate the requirement for and nature of noise mitigation measures to be implemented (documented in the MMMP, see below) during piling activities (including soft-start and ramp-up procedures).	The PS will be required under Section 36 Consent and/or Marine Licence conditions, An outline MMMP is provided as part of the Application EIAR Vol. 4 Appendix 33: Outline MMMP.
MM-020	MMMP	Tertiary	The MMMP will outline protocols to reduce underwater noise impacts on marine mammals in relation to pre-construction and construction activities, including geophysical surveys, UXO clearance and pile driving. This will include the use of Acoustic Deterrent Devices (ADDs) to deter marine mammals from the zone within which they could experience acoustic injury, visual observations undertaken by Marine Mammal Observers (MMOs) prior to the commencement of impact piling to ensure that no marine mammals will be exposed to the highest levels of underwater noise, in line with JNCC (2010) guidelines. During hours of darkness or in poor weather conditions, observation of marine mammals within the mitigation zone will be undertaken using a Passive Acoustic Monitoring (PAM) system by a qualified PAM Operator (PAMO).	The MMMP will be required under Section 36 Consent and/or Marine Licence conditions. An outline MMMP is provided as part of the Application EIAR Vol. 4 Appendix 33: Outline MMMP.
MM-021	Vessel Management Plan (VMP)	Tertiary	A VMP will be developed and adhered to for the Project. The VMP will detail types, specifications and numbers of vessels, how vessel management will be coordinated and the location of ports, routes of passage and number of transits for the Project. The VMP will refer to the Scottish Marine Wildlife Watching Code and Guide to Best Practice for Watching Marine Wildlife for guidance on how vessels should behave around Marine Wildlife.	A VMP will be required under the Section 36 Consent and/or Marine Licence conditions.

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
			To reduce potential for collision risk or injury to marine species, the Scottish Marine Wildlife Watching Code will be issued to all Marine Scheme vessels to be adhered to at all times, including a toolbox talk with the vessel crew ahead of mobilisation. This will include requirements to: • Not deliberately approach marine mammals or basking sharks; • Maintain a minimum vessel speed; and • Avoid abrupt changes to vessel speed or direction should a marine mammal approach the vessel.	
MM-022	Removal of debris from floating lines and cables to minimise potential for secondary entanglement	Primary	Mooring lines and dynamic Inter-Array Cables (IACs) will be inspected with a risk-based frequency using a Service Operations Vessel (SOV) which may be equipped with ROV used for subsea inspections. Over the operational life-cycle of the Project, inspections will be completed, starting at a higher frequency and likely declining after a number of years, based on evidence gathered during inspections. Any observed/detected debris on the floating lines and cables will be recovered based on a risk assessment which considers impact on environment, risk to asset integrity, risk to personnel and equipment, and cost of intervention.	This measure will be secured through production and approval of an EMP and Operations and Maintenance Programme (OMP) required under Section 36 Consent and/or Marine Licence conditions.
MM-032	DSLP	Tertiary	The DSLP will confirm the final specification and layout of the Project Area. The Plan will include location and coordinates of all OWF infrastructure including cables and the final design parameters of the OWF.	The DSLP is required under Section 36 Consent and/or Marine Licence consent conditions.

11.5.5 Worst-case scenario

As detailed in EIAR Vol. 2, Chapter 7: EIA Methodology, this assessment considers the worst-case scenario for the Project parameters which are predicted to result in the greatest environmental impact, known as the 'realistic worst-case scenario'. The worst-case scenario represents, for any given receptor, potential effect on that receptor that would result in the greatest potential for change.

Given that the worst-case scenario is based on the design option (or combination of options) that represents the greatest potential for change, the development of any alternative options within the design parameters will give rise to no worse effects than assessed in this impact assessment. Table 11-16 presents the worst-case scenario for potential effects on marine mammals during construction (including pre-construction), operation and maintenance and decommissioning.

Table 11-16 Worst-case scenario specific to marine mammal impact assessment

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
Construction (including pre – construction)		
Injury and disturbance from underwater noise generating activities	• The geophysical surveys will be conducted under the assumption that up to two campaigns will be required. The survey methods/equipment will include: - Two-dimensional (2D) and three-dimensional (3D) seismic surveys; - Multibeam Echo Sounder (MBES); - Side Scan Sonar (SSS); - Magnetometer; - Sub-Bottom Profiler (SBP); and - ROVs. • Geotechnical surveys will be conducted under the assumption that there will be two survey campaigns. The survey methods/ equipment will include: - Deep push seabed Cone Penetration Test (CPT) frames; - Shallow CPT; - Vibrocores; and - Boreholes. • UXO clearance: - Maximum one High-Order Deflagration (HOD) of UXO: charge weight of 227 kg and a 5 kg donor charge; and - Up to 50 low-noise clearances i.e., Low-Order Deflagration (LOD) with a donor charge of 0.08 kg.	These parameters represent the greatest potential for underwater noise generation and specifically, the maximum duration and number of piles which will be installed as part of the Project. FTU anchor and OSCPs piling hammer energy parameters are defined by Seiche (2024) (EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report) and described in Section 13.6.1.2.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	• FTU anchor piling: - Up to nine piles per FTU (up to 855 piles in total); - Maximum 4.5 m diameter pile (semi-submersible FTU), maximum 57 m pile penetration depth (TLP FTU); - Maximum strike rate of 30 strikes per minute; - Maximum hammer energy 2,500 kJ (TLP FTU) or 2,000 kJ (semi-submersible FTU); - Total piling duration 106 minutes (TLP FTU) or 300 minutes (semi-submersible FTU); - Maximum of nine piles installed over 24 hours (TLP FTU) or three piles installed over 24 hours (semi-submersible FTU); and - Maximum of 285 days (average of 95 days of piling per year), over three years. • OSCPs piling: - Up to 12 piles per OSCP (up to 24 piles in total); - Maximum 3.05 m diameter pile, maximum 57 m pile penetration depth; - Maximum strike rate of 30 strikes per minute; - Maximum hammer energy of 4400 kJ; - Maximum of 12 piles installed over 24 hours (average of 4); and - Maximum of 14 days duration.	
Underwater noise generated by vessels during construction	• A maximum offshore construction period of six calendar years (including one year pre-construction).	These parameters represent the expected maximum worst-case scenario with regards to vessel movement during construction.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	• Maximum of 22 vessels at the site simultaneously, making a total of 319 transits per year (across the six-year pre-construction and construction period).	
Changes to prey distribution	The worst-case scenarios for marine mammals are also considered to represent the worst-case scenario for prey related impacts, where the impacts which have been scoped into assessment are the same. As further detailed in the assessment (Section 11.6.1.2), many relevant prey species to marine mammals have been assessed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology Therefore, the worst-case scenario for impacts which are specific to fish and shellfish, and which may therefore have an indirect effect on marine mammals, are presented within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology.	
Operation and maintenance		
Underwater noise related to geophysical and geotechnical surveys	• Up to an annual 10-day inspection of Export/Import Cable using side-scan sonar or other similar means (e.g. geophysical survey); and • Up to an annual 30-day survey of IACs using underwater drone, side-scan sonar or other similar means (e.g. geophysical survey).	Minimum survey frequency every five years; annual surveys represent the maximum worst-case scenario.
Operational underwater noise	• Low level continuous sound generated by gearbox and impulsive transients generated by mooring lines; • Maximum of 95 FTUs; and • Operational life of 35 years.	These parameters represent the expected maximum worst-case scenario with regards to underwater operational sound, with maximum number of FTU's considered being in operation and generating underwater noise over maximum expected operational life.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
Underwater noise generated by vessels related to operation and maintenance	• Operational life of 35 years; • Up to 10 vessels operating simultaneously during operation and maintenance phase; and • Operation and maintenance activities including: - Routine inspections of FTUs, OSCPs, foundations and cables; - Up to two major component exchanges per FTU involving a tow back to shore (i.e. up to 190 operations); - Up to three major component exchanges per FTU conducted in-situ; - Re-tensioning of each mooring line twice over the operation and maintenance phase with up to 10% of mooring lines requiring replacement; - Up to 10% of IACs requiring repair (e.g. deburial and reburial) and up to 10% of IACs requiring replacement; and - Up to four Export/Import Cable repairs.	These parameters represent the maximum duration of operation and maintenance vessel activities which have the potential to produce underwater noise profile which may result in injury and/or disturbance to marine mammals.
Long-term changes to prey resources	The worst-case scenarios for marine mammals are also considered to represent the worst-case scenario for prey related impacts, where the impacts which have been scoped into assessment are the same. As further detailed in the assessment (Section 11.6.2.2), many relevant prey species to marine mammals have been assessed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology. Therefore, the worst-case scenario for impacts which are specific to fish and shellfish, and which may therefore have an indirect effect on marine mammals, are presented within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology.	
Secondary entanglement resulting in injury and/or mortality	• Maximum of 95 FTUs: - Maximum of 570 mooring lines, with a total length of 376,200 m; • Operational life of 35 years.	These parameters represent the maximum number of FTUs and associated mooring line systems with a long-term presence within the marine environment.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
Decommissioning		
In the absence of detailed information regarding decommissioning works, the implications for Marine Mammal Ecology are considered analogous to or likely less than those of the construction phase. Therefore, the worst-case parameters defined for the construction phase also apply to decommissioning. The decommissioning approach is set out in EIAR, Vol. 2, Chapter 5: Project Description.		

11.6 Assessment of potential effects

11.6.1 Potential effects during construction

11.6.1.1 Underwater noise

11.6.1.1.1 Injury and disturbance from underwater noise generating activities

During the pre-construction and construction phase of the Project, several activities have the potential to generate underwater noise, which has the potential to result in acoustic effects (including injury and/or disturbance) to marine mammal receptors. The potential effects of underwater noise on marine mammals can be experienced at an individual level, however this assessment considers the consequences of these effects to marine mammal populations.

The following activities have been identified as have the potential to result in injury and/or disturbance to marine mammals and have been taken forward for assessment as part of this EIAR:

- Percussive (also known as impact, or hammer) pile driving;
- UXO clearance;
- Geophysical and geotechnical survey; and
- Underwater noise from construction vessels.

It is anticipated that UXO clearance campaigns, piling campaigns and geophysical surveys may have additional marine licensing and EPS licensing requirements. These requirements will be assessed and applied for separately to the Section 36 consent application. Nevertheless, the effects of these activities are considered within this chapter.

The potential effects of anthropogenic underwater noise on marine mammals are influenced by the nature of the sound source (i.e., the frequency and intensity of the sound), the duration of the sound against baseline background levels and the sensitivity of the marine mammal receptor. Underwater noises can either be impulsive (for example, geophysical survey equipment; piling); or non-impulsive (also called 'continuous'; such are those generated by trenching and from vessel movements). The characteristics of sound signals can change with increasing distance from the source, with typically impulsive sounds losing their impulsive characteristics (e.g. short rise time and rapid decay) as sounds attenuate with increasing distance (Hastie *et al.*, 2019).

The principal metrics used to describe the intensity of underwater noise are the SPL and Sound Exposure Level (SEL). The SPL is a measure of the amplitude or intensity of a sound and, for impulsive sounds, is usually measured as the (zero-to-) peak value of the waveform. Continuous sounds can also be reported as a SPL but are typically presented as the root-mean-square (rms) of the sound pressure wave. The SEL is a time-integrated measurement of sound energy which considers the intensity as well as the duration of the sound exposure. SEL is often "weighted" by the hearing sensitivity of a species (as a constituent of one of a number of species groups, clustered by their generalised hearing ranges; Southall *et al.*, 2019) at different frequencies.

The severity of the effect of underwater noise on marine mammals is related to their hearing sensitivity. The hearing range of marine mammals varies depending on the species; however, there are a lack of species-specific hearing range and sensitivity data for many species. Therefore, marine mammals have been grouped into functional hearing groups (Southall *et al.*, 2019), based on available evidence such as audiogram data, anatomy, phylogenetic relationships, and the frequencies at which they generally vocalise, which are presented in Table 11-17. For each species group, Southall *et al.*, (2019) provides a generalised hearing range and estimated greatest sensitivity hearing range for each group Table 11-17.

Table 11-17 Functional hearing groups of marine mammal receptors relevant to the project

HEARING GROUP	SPECIES	ESTIMATED HEARING RANGE	ESTIMATED REGION OF GREATEST SENSITIVITY*
Low-frequency (LF) cetaceans	• Minke whale • Humpback whale	7 Hz – 35 kHz	200 Hz – 19 kHz
High-frequency (HF) cetaceans	• White-beaked dolphin • Atlantic white-sided dolphin • Bottlenose dolphin • Risso's dolphin • Killer whale • Long-finned pilot whale • Short-beaked common dolphin	150 Hz – 160 kHz	8.8 – 110 kHz
Very High-Frequency (VHF) cetacean	• Harbour porpoise	275 Hz – 160 kHz	12 – 140 kHz
Phocid Carnivores in Water (PCW)	• Harbour seal; and • Grey seal	50 Hz – 86 kHz	1.9 – 30 kHz

*Region of greatest sensitivity represents low-frequency (F1) and high-frequency (F2) inflection points (from Southall et al., 2019).

High-amplitude sounds can result in auditory injury to marine mammals, whereby there is a reduction in the hearing sensitivity, generally at certain frequencies. PTS is a permanent change in hearing sensitivity at certain frequencies and is assumed to be irreversible. Underpinning the assessment of auditory injury are the thresholds defined for marine mammal functional hearing groups in Southall *et al.* (2019) (Table 11-18). PTS-onset impact ranges are calculated for both 'instantaneous' PTS, brought about by high-amplitude peak sound pressure levels (SPL_{peak}) due to the sound pressure of a single pulse, and 'cumulative' PTS, brought about by the cumulative sound energy an animal is exposed to over a standard time period (referred to as SEL_{cum} and commonly estimated over a 24-hour period of sound exposure, or over the duration of a noisy activity e.g. the installation of a pile; Southall *et al.*, 2019).

Table 11-18 PTS-onset thresholds for impulsive sound (from Southall et al., 2019)

HEARING GROUP	SPECIES THAT OCCUR IN PROJECT STUDY AREA	CUMULATIVE PTS THRESHOLD (SEL_{CUM} DB RE 1 µPA²S; FREQUENCY-WEIGHTED)	INSTANTANEOUS PTS THRESHOLD (SPL_{PEAK} DB RE 1 µPA; UNWEIGHTED)
VHF Cetaceans	• Harbour porpoise	155	202
HF Cetaceans	• White-beaked dolphin • Atlantic white-sided dolphin • Bottlenose dolphin • Risso's dolphin • Killer whale • Long-finned pilot whale • Short-beaked common dolphin	185	230
Low Frequency (LF) Cetaceans	• Minke whale • Humpback whale	183	219
Phocid Carnivores in Water (PCW)	• Harbour seal • Grey seal	185	218

Underwater noise can also result in behavioural responses, which may vary by a range of factors such as species, individual, location, season as well as per construction and pre-construction activity. To determine the extent of disturbance from underwater noise associated with various construction and pre-construction activities, a range of approaches have been applied to quantify injury based on the best available evidence and guidance (e.g. PTS-onset ranges using Southall *et al.* (2019) for piling and UXO clearance) and disturbance (e.g. dose-response functions for piling and TTS-onset for UXO clearance).

The assessment of potential effects from underwater noise on marine mammals is supported by the outputs of the Underwater Noise Technical Report produced by Seiche Group on behalf of the Cenos OWF (EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report). The report uses underwater noise propagation models to calculate the impact ranges to marine mammals as a result of key Project activities which have the potential to generate underwater noise. The outputs of this report have been referenced, where relevant, throughout this impact assessment, with outputs from the sound propagation modelling used to inform the overall evaluation of significance for marine mammal receptors.

11.6.1.1.1.1 Potential effects of underwater noise during pile driving

Pile installation has the potential to generate underwater noise which could result in injury or disturbance to marine mammals during the construction phase. Underwater noise propagation modelling has been undertaken to determine the extent of underwater noise propagation from impact piling of FTUs and OSCPs from three representative locations in the north, south and the centre of the Array Area (Figure 8.1 in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report).

At this stage, it is unknown if FTUs will be installed with semi-submersible or Tension Leg Platform (TLP) technology, and therefore both scenarios were considered, but only the worst-case scenario was carried through the assessment.

Harbour seal have a highly coastal distribution and are not expected to experience disturbance due to piling at the Array Area (Carter *et al.*, 2022). Due to the distance of the piling operations from the coast, the range over which sound levels have the potential to affect phocid seals, and the very low predicted density of harbour seals within this offshore area of impact, harbour seal has not been considered further with respect to PTS and disturbance due to sound emissions from piling.

11.6.1.1.1.2 Pile driving scenarios

As detailed in EIAR Vol. 2, Chapter 5: Project Description, the FTUs will be supported by floating substructure foundations which are attached to the seabed via mooring and anchor systems. At present two designs are considered for the FTUs: TLP and semi-submersible platforms.

The FTU piling scenarios used in the underwater noise propagation modelling to assess the potential for auditory injury and disturbance to marine mammals are provided in Table 11-19 and Table 11-20. Modelled peak sound pressure levels (SPL_{peak}) for the semi-submersible foundation pile installation, representing the worst-case scenario for FTU piling, can be seen in Figure 11-5.

Table 11-19 TLP foundation pile installation parameters

ACTIVITY/STAGE	DURATION (MINUTES)	HAMMER ENERGY (kJ)	STRIKE RATE (STRIKE PER MINUTE)	NUMBER OF STRIKES
Initiation	1	350	3	15
Soft start	20	350	30	200
Ramp up	5	350 - 2,500	30	750
Full power piling	80	2,500	30	3,000
Total piling duration, mins		106		
Total piling duration, hours		1.77		
Total no. of strikes		3,153		
Pile diameter, d (m)		2.6		
Pile length, m		60		
Final pile penetration, m		57		

Table 11-20 Semi-submersible foundation pile installation parameters

ACTIVITY/STAGE	DURATION (MINUTES)	HAMMER ENERGY (Kj)	STRIKE RATE (STRIKES PER MINUTE)	NUMBER OF STRIKES
Initiation	1	200	3	15
Soft start	20	200	30	200
Ramp up	10	200 – 2,000	30	750
Full power piling	269	2,000	30	3,000
Total piling duration, mins		300		
Total piling duration, hours		5		
Total no. of strikes		8,973		
Pile diameter, d (m)		4.5		
Pile length, m		34		
Final pile penetration, m		32.5		

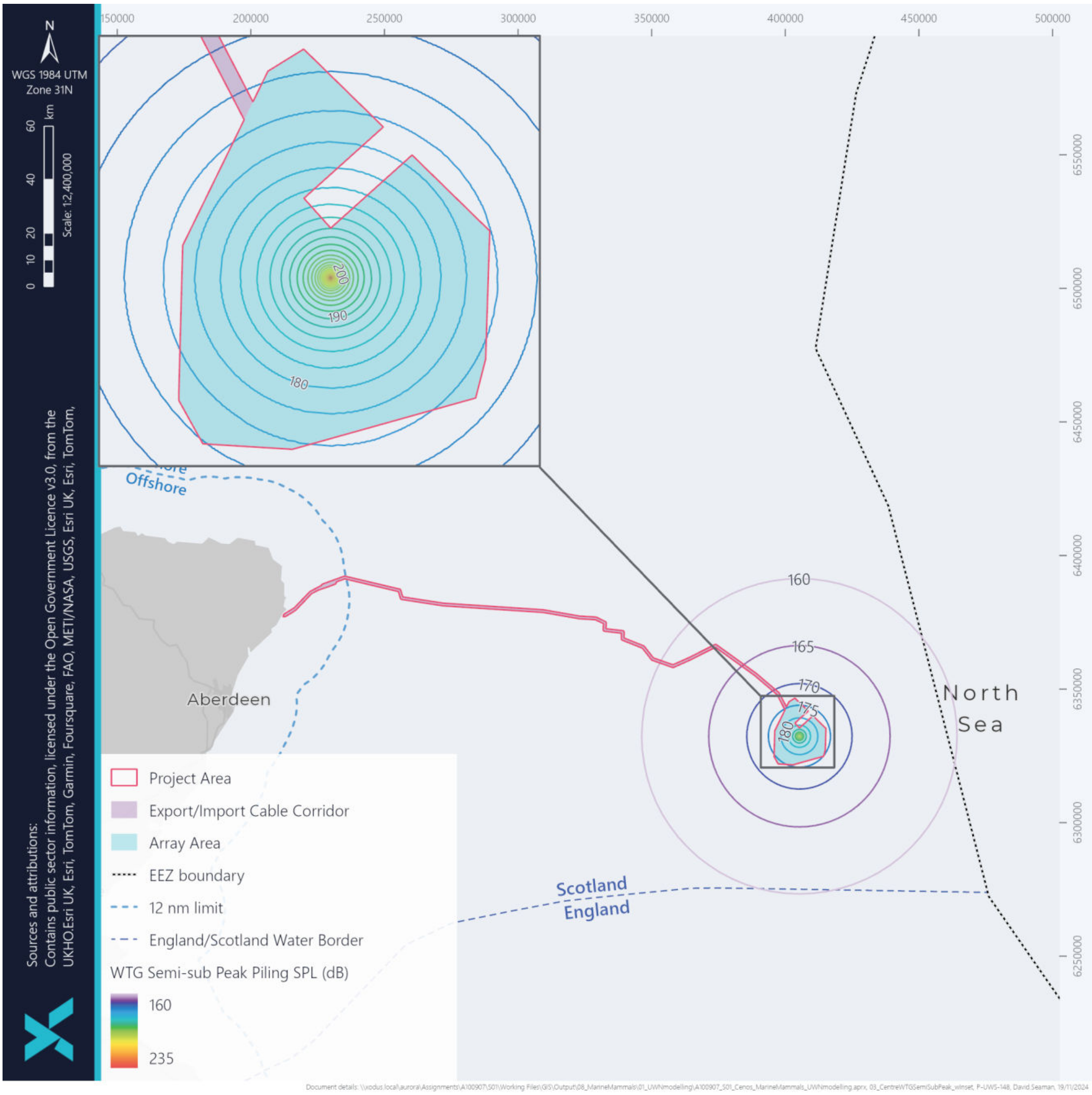

Figure 11-5 Modelled SPL_{peak} for the semi-submersible foundation pile installation

Up to two OSCPs will be installed on jacket foundations that will require pile driving. The piling scenarios used in the underwater noise propagation modelling to assess the potential for auditory injury and disturbance due to OSCPs pile driving to marine mammals are provided in Table 11-21. Modelled SPL_{peak} can be seen in Figure 11-6.

Table 11-21 OSCPs pile installation parameters

ACTIVITY/STAGE	DURATION (MINUTES)	HAMMER ENERGY (kJ)	STRIKE RATE (STRIKES PER MINUTE)	NUMBER OF STRIKES
Initiation	1	350	3	3
Soft start	20	350	30	600
Ramp up	5	350 - 2,500	30	150
Full power piling	70	3,500	30	2,100
Driving to refusal	10	4,400	30	300
Total piling duration, mins		106		
Total piling duration, hours		1.77		
Total no. of strikes		3,153		
Pile diameter, d (m)		3.05		
Pile length, m		75		
Final pile penetration, m		57		

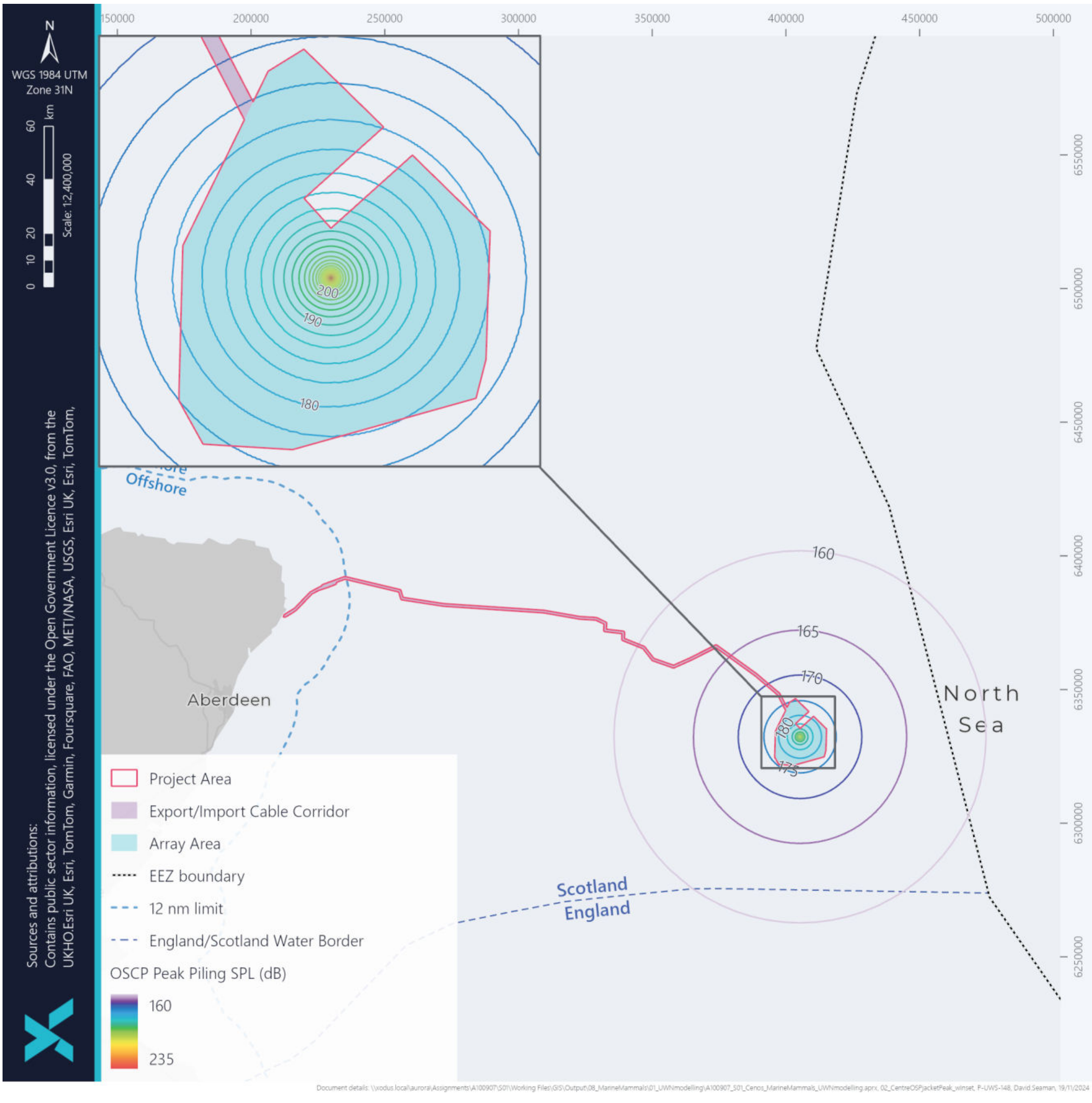

Figure 11-6 Modelled SPL_{peak} for the OSCPs pile installation

11.6.1.1.1.2.1 Auditory injury due to pile driving

The following Section provides the quantitative assessment of the effect of auditory injury (PTS) from FTU and OSCPs pile driving on marine mammal species.

Although PTS refers to a permanent change in hearing sensitivity at certain frequencies, the ecological consequences of PTS for marine mammals are uncertain. For piling sound, most energy is concentrated between ~30 – 500 Hz, with a peak usually between 100 – 300 Hz and some energy at frequencies above 2 kHz (Kastelein *et al.*, 2015; Kastelein *et al.*, 2016). Studies have shown that exposure to impulsive pile driving sound induces TTS in a relatively narrow frequency band in harbour porpoise and harbour seals (reviewed in Finneran, 2015), with statistically significant TTS occurring at 4 and 8 kHz (Kastelein *et al.*, 2016) and centred at 4 kHz (Kastelein *et al.*, 2012a; Kastelein *et al.*, 2012b; Kastelein *et al.*, 2013b; Kastelein *et al.*, 2017a). Therefore, any threshold shifts in porpoises as a result of pile driving would likely occur in the 2 - 10 kHz range (Kastelein *et al.*, 2017b) and a PTS 'notch' of 6 – 18 dB (decibel; Booth and Heinis, 2018) in a narrow frequency band in the 2 - 10 kHz region is unlikely to significantly affect the ability of this species to survive and reproduce.

Furthermore, data collected during windfarm construction have demonstrated that porpoise detections around the pile driving site decline several hours prior to the start of pile driving, most probably due to the increase in other construction related activities and vessel presence in advance of the commencement of pile driving (Brandt *et al.*, 2018; Graham *et al.*, 2019; Benhemma-Le Gall *et al.*, 2021). Therefore, the presence of construction related vessels prior to the start of piling can act as a local scale deterrent for harbour porpoise and reduce the risk of auditory injury. Assumptions that harbour porpoise are present in the vicinity of the pile driving at the start of the soft start are therefore likely to be very conservative. Whilst PTS is a permanent effect which cannot be recovered from, and harbour porpoise are a species of high conservation value, the evidence does not suggest that PTS from piling will cause a significant impact on either survival or reproductive rates. Therefore, the harbour porpoise has been assessed as having a low sensitivity to PTS from pile driving.

There are no data available on the sensitivity of white-beaked dolphins to PTS from pile driving. There is, however, evidence on PTS in bottlenose dolphins (Booth and Heinis, 2018), which can be used as a proxy for other dolphin species since they belong to the HF cetacean hearing group (Southall *et al.*, 2019) and are therefore expected to have similar sensitivity to underwater noise. The median predicted decline in survival in bottlenose dolphin from the effect of a 6 dB PTS in the 2-10 kHz band was estimated between 1.6% for a mature individual and 2.96% for dependant calf, and a PTS of this magnitude may cause a decline in fertility of 0.43% (Booth and Heinis, 2018). Whilst PTS is a permanent effect which cannot be recovered from, the evidence does not suggest that PTS from piling is likely to cause a significant impact on either survival or reproductive rates of dolphin species. It is noted however, that the likely effect of PTS from pile driving on bottlenose dolphins is considerably less certain than for harbour porpoise. Additionally, the peak hearing sensitivity of dolphin species is centred at lower frequencies than in harbour porpoise, therefore a PTS at lower frequencies, caused by sound emissions from piling, may affect a more important frequency range than in VHF cetaceans. Therefore, for the dolphin species most likely to occur in the vicinity of the project, the white-beaked dolphin and bottlenose dolphin have been conservatively assessed as of medium sensitivity to PTS from pile driving.

The LF sound produced during piling may overlap with the hearing range of LF cetacean species such as minke whales. Minke whale communication signals have been demonstrated to be below 2 kHz (Edds-Walton, 2000, Mellinger *et al.*, 2000, Gedamke *et al.*,2001, Risch *et al.*, 2013, Risch *et al.*, 2014). Tubelli *et al.*, (2012) estimated the most sensitive hearing range for this species (the region with thresholds within 40 dB of best sensitivity) to extend from 30 to 100 Hz up to 7.5 to 25 kHz, depending on the specific model used. Whilst PTS is a permanent effect which cannot be recovered from, a 2-10 kHz notch of 6 dB will affect only a small region of minke whale hearing, which is unlikely to have a significant impact on either survival or reproductive rates. Given the lack of data, and acknowledging their low-frequency hearing abilities, minke whale have been conservatively assessed as having a medium sensitivity to PTS from pile driving.

The median predicted decline in the grey seal (pinniped) survival rate due to the effect of a 6 dB PTS in the 2-10 kHz band was estimated between 0.39% for a mature individual and 0.53% for seal pup/juvenile and may cause a decline in female fertility by 0.27% (Booth and Heinis, 2018). Whilst PTS is a permanent effect which cannot be recovered from, the evidence does not suggest that a PTS of this magnitude caused by exposure to piling sound will cause a significant impact on either survival or reproductive rates; therefore, **grey seal** has been assessed as having a **low sensitivity** to PTS from piling.

FTU piling

The maximum modelled instantaneous PTS-onset range for harbour porpoises due to FTU pile driving was obtained for semi-submersible anchor piling, resulting in a PTS range (at full hammer energy) of 355 m based on the SPL_{peak} metric. Consecutive piling over 24 hours at a single location was also modelled, with the assumption that a marine mammal will swim away (i.e. flee) from the sound source at the onset of activities. The maximum cumulative PTS-onset range, for TLP anchor piling, was 15 m based on the frequency-weighted SEL metric.

This is predicted to expose <1 harbour porpoise per day to sound levels that could cause PTS, which equates to 0.00025% of the UK proportion of the NS MU. Furthermore, consecutive piling over 24 hours at a single location might affect <1 one individual per day, equalling to <0.000001% of the UK portion of the NS MU (Table 11-22).

Table 11-22 Impact area, maximum range, number of harbour porpoises predicted to experience auditory injury (PTS-onset) from FTU piling

SPECIES	IMPACT RANGE (m)	AREA (km^2)	DENSITY (INDIVIDUALS/km^2)	NUMBER OF ANIMALS IMPACTED	UK PORTION OF NORTH SEA MU ABUNDANCE	% OF UK PROPORTION OF MU
Harbour porpoise	INSTANTENOUS PTS (SPL_{peak})					
	355	0.395	1.0398	0.411	159,632	0.00025%
	CUMULATIVE PTS (SEL_{CUM})					
	15	0.0007	1.0398	0.0007	159,632	<0.000001%

Overall, the effect of auditory injury from FTU pile driving to the **harbour porpoise** population is considered to be a **negligible magnitude** as there is expected to be no change to the conservation status or integrity of the harbour porpoise receptor given the very low proportion of the MU impacted.

The sensitivity of harbour porpoise to auditory injury from piling has been assessed as Low and the magnitude of auditory injury (PTS-onset) to harbour porpoise from FTU piling has been assessed as negligible.

Therefore, the consequence of auditory injury from FTU piling to the harbour porpoise population is **negligible,** which is **not significant** in EIA terms.

When considering potential FTU piling parameter configurations, the maximum modelled instantaneous PTS-onset range for dolphin species was obtained for semi-submersible anchor piling, resulting in a PTS range (at full hammer energy) of 21 m based on SPL_{peak} metric. Consecutive piling over 24 hours at a single location was also modelled, with the assumption that a marine mammal will swim away from the sound source at the onset of activities. The modelling results concluded that the frequency-weighted SEL_{cum} threshold was not exceeded for HF cetaceans (including all dolphin species).

Across all scenarios considered, <1 individual dolphin (of any species) would experience auditory injury (PTS-onset), which constitutes less than 0.00001% of the UK portion of the CGNS MU population for white-beaked dolphin and 0.0002% of the UK portion of the GNS MU for bottlenose dolphin. No cumulative PTS is expected due to 24 hour piling at a single location (Table 11-23). Taking above into account the **magnitude** of the effect of auditory injury (PTS-onset) on **white-beaked dolphin** and **bottlenose dolphin** populations from FTU piling sound has been assessed as **negligible**.

Table 11-23 Impact area, maximum range, number of white-beaked dolphins and bottlenose dolphins predicted to experience auditory injury (PTS-onset) from FTU piling

SPECIES	IMPACT RANGE (M)	AREA (KM^2)	DENSITY (INDIVIDUALS/KM^2)	NUMBER OF ANIMALS IMPACTED	UK PORTION OF MU ABUNDANCE (MU)	% OF UK PROPORTION OF MU
White-beaked dolphin	INSTANTENOUS PTS (SPL_{peak})					
	21	0.014	0.1051	0.0014	34,025 (CGNS MU)	<0.00001%
	CUMULATIVE PTS (SEL_{CUM})					
	N/E	N/E	0.1051	0	34,025 (CGNS MU)	0
Bottlenose dolphin	INSTANTENOUS PTS (SPL_{peak})					
	21	0.014	0.0289	0.0004	1,885 (GNS MU)	0.0002%
	CUMULATIVE PTS (SEL_{CUM})					
	N/E	N/E	0.0289	0	1,885 (GNS MU)	0

The sensitivity of dolphin species to auditory injury from piling has been conservatively assessed as **medium**. The magnitude of auditory injury (PTS-onset) to bottlenose dolphin and white-beaked dolphin populations from FTU piling has been assessed as Negligible. Therefore, the consequence of auditory injury from FTU piling to the populations of these dolphin species is **negligible,** which is **not significant** in EIA terms.

Maximum instantaneous PTS-onset range for minke whales from FTU pile driving (at full hammer energy) was predicted for TLP anchor pile driving, estimated at 57 m. Maximum cumulative PTS-onset range of 137 m was obtained for semi-submersible anchor piling at a single location for minke whales moving away from the sound source (Table 11-24). This is predicted to affect <1 individual, which equates to 0.000004% of the UK portion of the CGNS MU, and up to 0.00002% of UK portion of the CGNS MU for consecutive piling.

Table 11-24 Impact area, maximum range, number of minke whales predicted to experience auditory injury (PTS-onset) from FTU piling

SPECIES	IMPACT RANGE (M)	AREA (KM^2)	DENSITY ($INDIVIDUALS/KM^2$)	NUMBER OF ANIMALS IMPACTED	UK PORTION OF CGNS MU ABUNDANCE	% OF UK PROPORTION OF MU
Minke whale	INSTANTENOUS PTS (SPL_{peak})					
	57	0.01	0.0419	0.000419	10,288	0.000004%
	CUMULATIVE PTS (SEL_{CUM})					
	137	0.058	0.0419	0.0024	10,288	0.00002%

Taking above into account, the effect of auditory injury from FTU pile driving on the **minke whale** population is considered to be of **negligible magnitude** as there is expected to be no change to the conservation status or integrity of the receptor given the very small proportion of the MU impacted.

The sensitivity of minke whales to auditory injury from piling has been assessed as **medium**. The magnitude of auditory injury (PTS-onset) to minke whales from FTU piling has been assessed as negligible. Therefore, the consequence of auditory injury from piling to minke whales is **negligible**, which is **not significant** in EIA terms.

Across all scenarios considered for FTUs, the predicted auditory injury (PTS-onset) range for grey seal is <100 m (Table 11-25). The greatest instantaneous PTS impact range was modelled for piling of a semi-submersible platform anchor pile, where <1 individual grey seal might experience PTS. This comprises 0.00011% of relevant SMU for grey seals. No auditory injury is expected due to consecutive piling, based on the frequency-weighted SEL_{cum} metric. Taking above into account the **magnitude** of auditory injury (PTS-onset) to the **grey seal** population from piling has been assessed as **negligible.**

Table 11-25 Impact area, maximum range, number of grey seals predicted to experience auditory injury (PTS-onset) from FTU piling

SPECIES	IMPACT RANGE (M)	AREA (KM^2)	DENSITY (INDIVIDUALS/KM^2)	NUMBER OF ANIMALS IMPACTED	UK MU ABUNDANCE	% OF UK PROPORTION OF MU
Grey seal	INSTANTENOUS PTS (SPL_{peak})					
	71	0.0158	0.2	0.00316	2,712	0.00011%
	CUMULATIVE PTS (SEL_{CUM})					
	N/E	N/E	0.2	N/E	2,712	N/E

The sensitivity of grey seal to auditory injury from piling has been assessed as **low**. The **magnitude** of auditory injury (PTS-onset) to grey seal from FTU piling has been assessed as **negligible**. Therefore, the consequence of auditory injury from piling to the population of grey seal is **negligible**, which is **not significant** in EIA terms.

Evaluation of significance

Considering the low or medium sensitivity and the negligible magnitude of the effect due to FTU piling for all species, the overall effect on the populations of all marine mammals from auditory injury caused by pile driving during construction is considered to be **Negligible** and **Not Significant** in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
Harbour porpoise	Low	Negligible	Negligible
White-beaked dolphin	Medium	Negligible	Negligible
Bottlenose dolphin	Medium	Negligible	Negligible
Minke whale	Medium	Negligible	Negligible
Grey seal	Low	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

OSCPs piling

The maximum modelled instantaneous PTS-onset range for harbour porpoises due to OSCPs pile driving was 508 m at the highest hammer energy based on the SPL_{peak} metric. Consecutive piling over 24 hours at a single location was also modelled, with the assumption that a marine mammal will swim away (i.e. flee) from the sound source at the onset of activities. The maximum cumulative PTS-onset range was 20 m based on the frequency-weighted SEL metric.

This is predicted to expose <1 harbour porpoise per day to sound levels that could cause PTS, which equates to 0.0004% of the UK proportion of the North Sea MU. Furthermore, consecutive piling over 24 hours at a single location might affect <0.01 one individual per day, equalling to <0.000001% of the UK portion of the North Sea MU (Table 11-26).

Table 11-26 Impact area, maximum range, number of harbour porpoises predicted to experience auditory injury (PTS-onset) from OSCPs piling

SPECIES	IMPACT RANGE (m)	AREA (km^2)	DENSITY (INDIVIDUALS/km^2)	NUMBER OF ANIMALS IMPACTED	UK PORTION OF NORTH SEA MU ABUNDANCE	% OF UK PROPORTION OF MU
Harbour porpoise	INSTANTENOUS PTS (SPL_{peak})					
	508	0.785	1.0398	0.816	159,632	0.0004%
	CUMULATIVE PTS (SEL_{CUM})					
	20	0.0012	1.0398	0.0012	159,632	<0.000001%

Overall, the risk of auditory injury from pile driving to the harbour porpoise population is considered to be a negligible magnitude as there is expected to be no change to the conservation status or integrity of the harbour porpoise receptor given the very low proportion of the MU impacted.

The sensitivity of harbour porpoise to auditory injury from piling has been assessed as low and the magnitude of auditory injury (PTS-onset) to harbour porpoise from OSCPs piling has been assessed as negligible. Therefore, the consequence of auditory injury from OSCPs piling to the harbour porpoise population is negligible, which is not significant in EIA terms.

When considering potential OSCPs piling parameters, the maximum modelled instantaneous PTS-onset range for dolphin species at full hammer energy was of 31 m based on SPL_{peak} metric. Consecutive piling over 24 hours at a single location was also modelled, with the assumption that a marine mammal will swim away from the sound source at the onset of activities. The modelling results concluded that the frequency-weighted SEL_{cum} threshold was not exceeded for HF cetaceans (including all dolphin species).

Across all scenarios considered, <0.001 individual dolphin (of any species) would experience auditory injury (PTS-onset), which constitutes less than <0.0000001% of the UK portion of the CGNS MU population for white-beaked dolphin and 0.000006% of the UK portion of the GNS MU for bottlenose dolphin. No cumulative PTS is expected due to piling at a single location (Table 11-27).

Table 11-27 Impact area, maximum range, number of white-beaked dolphins and bottlenose dolphins predicted to experience auditory injury (PTS-onset) from OSCPs piling

SPECIES	IMPACT RANGE (M)	AREA (KM^2)	DENSITY (INDIVIDUALS/KM^2)	NUMBER OF ANIMALS IMPACTED	UK PORTION OF MU ABUNDANCE (MU)	% OF UK PROPORTION OF MU
White-beaked dolphin	INSTANTENOUS PTS (SPL_{peak})					
	31	0.003	0.1051	0.0003	34,025 (CGNS MU)	<0.0000001%
	CUMULATIVE PTS (SEL_{CUM})					
	N/E	N/E	0.1051	0	34,025 (CGNS MU)	0
Bottlenose dolphin	INSTANTENOUS PTS (SPL_{peak})					
	31	0.003	0.0289	0.00008	1,885 (GNS MU)	0.000006%
	CUMULATIVE PTS (SEL_{CUM})					
	N/E	N/E	0.0289	0	1,885 (GNS MU)	0

Taking above into account the **magnitude** of the effect of auditory injury (PTS-onset) on **white-beaked dolphin** and **bottlenose dolphin** populations from OSCPs piling sound has been assessed as **negligible**.

The sensitivity of dolphin species to auditory injury from piling has been conservatively assessed as **medium** and the magnitude of auditory injury (PTS-onset) to dolphin species has been assessed as negligible. Therefore, the consequence of auditory injury from FTU piling to the populations of these dolphin species is **negligible,** which is **not significant** in EIA terms.

Maximum instantaneous PTS-onset range for minke whales from OSCPs pile driving (at full hammer energy) was predicted at 168 m and a maximum cumulative PTS-onset range of 815 m for piling at a single location for minke whales moving away from the sound source (Table 11-28). This is predicted to impact <0.1 individual, which equates to 0.000035% of the UK portion of the CGNS MU, and 0.00084% of UK portion of the CGNS MU as a result of cumulative sound exposure.

Table 11-28 Impact area, maximum range, number of minke whales predicted to experience auditory injury (PTS-onset) from OSCPs piling

SPECIES	IMPACT RANGE (M)	AREA (KM^2)	DENSITY (INDIVIDUALS/KM^2)	NUMBER OF ANIMALS IMPACTED	UK PORTION OF CGNS MU ABUNDANCE	% OF UK PROPORTION OF MU
Minke whale	INSTANTENOUS PTS (SPL_{peak})					
	168	0.0886	0.0419	0.0037	10,288	0.000035%
	CUMULATIVE PTS (SEL_{CUM})					
	815	2.09	0.0419	0.087	10,288	0.00084%

Taking above into account, the risk of auditory injury from OSCPs pile driving on the minke whale population is considered to be of negligible magnitude as there is expected to be no change to the conservation status or integrity of the receptor given the very small proportion of the MU impacted.

The sensitivity of minke whales to auditory injury from piling has been assessed as medium. The magnitude of auditory injury (PTS-onset) to minke whales from OSCPs piling has been assessed as negligible. Therefore, the consequence of auditory injury from piling to minke whales is negligible, which is not significant in EIA terms.

The predicted auditory injury (PTS-onset) range for grey seal species due to OSCPs piling is 102 m (Table 11-29), where <1 individual grey seal might experience PTS, which comprises 0.00024% of relevant SMU for grey seals. No auditory injury is expected due to consecutive piling, based on the frequency-weighted SEL_{cum} metric.

Table 11-29 Impact area, maximum range, number of grey seals predicted to experience auditory injury (PTS-onset) from OSCPs piling

SPECIES	IMPACT RANGE (M)	AREA (KM^2)	DENSITY (INDIVIDUALS/KM^2)	NUMBER OF ANIMALS IMPACTED	UK MU ABUNDANCE	% OF UK PROPORTION OF MU
Grey seal	INSTANTENOUS PTS (SPL_{peak})					
	102	0.0326	0.2	0.00652	2,712	0.00024%
	CUMULATIVE PTS (SEL_{CUM})					
	N/E	N/E	0.2	N/E	2,712	N/E

Taking above into account the **magnitude** of auditory injury (PTS-onset) to the **grey seal** population from OSCPs piling has been assessed as **negligible.**

The sensitivity of grey seal to auditory injury from piling has been assessed as **low**. The magnitude of auditory injury (PTS-onset) to grey seal from OSCPs piling has been assessed as negligible. Therefore, the consequence of auditory injury from piling to the population of grey seal is **negligible**, which is **not significant** in EIA terms.

Evaluation of significance

Considering the low or medium sensitivity and the negligible magnitude of the effect due to OSCPs piling for all species, the overall effect on the populations of all marine mammals from auditory injury caused by pile driving during construction is considered to be **negligible** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
Harbour porpoise	Low	Negligible	Negligible
White-beaked dolphin	Medium	Negligible	Negligible
Bottlenose dolphin	Medium	Negligible	Negligible
Minke whale	Medium	Negligible	Negligible
Grey seal	Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT			

Other species

As described in Section 11.4.4.2 other cetacean species could be present in the vicinity of the Array Area, however other species are likely to occur at lower densities than those described in more detail above.

These species include LF cetaceans (i.e. humpback whale) and HF cetaceans (killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, Risso's dolphin). There are very limited data on each of these species with respect to their sensitivity to auditory injury due to sound emissions from impact piling. Nevertheless, as a precautionary assessment, it can be considered that these species share similar sensitivity to PTS as the species described in more detail above. Therefore, **humpback whale, killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin,** and **Risso's dolphin** are likely to be of **medium** sensitivity to auditory injury from piling sound. As these species are all considered to occur scarcely in the vicinity of the Array Area, at low densities, and due to the small PTS ranges based on both the SPL_{peak} and SEL_{cum} metrics, the magnitude of any effects on the populations of these species is likely to be **negligible**.

The sensitivity of humpback whale, killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, and Risso's dolphin to auditory injury from piling has been assessed as Mmdium. The magnitude of auditory injury (PTS-onset) to any of these species from both FTU and OSCPs piling has been assessed as negligible. Therefore, the consequence of auditory injury from piling to the populations of these other cetacean species is negligible, which is not significant in EIA terms.

Evaluation of significance

Considering medium sensitivity and the negligible magnitude of the effect due to FTU and OSCPs piling for all species, the overall effect on the populations of all marine mammals from auditory injury caused by pile driving during construction is considered to be negligible and not significant in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
Humpback whale	Medium	Negligible	Negligible
Killer whale	Medium	Negligible	Negligible
Long-finned pilot whale	Medium	Negligible	Negligible
Atlantic white-sided dolphin	Medium	Negligible	Negligible
Short-beaked common dolphin,	Medium	Negligible	Negligible
Risso's dolphin	Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT			

11.6.1.1.1.2.2 Disturbance due to FTU pile driving

The latest guidance in Southall *et al.* (2019), based on the work of Tyack and Thomas (2019) recommend using a dose response function to assess disturbance to marine mammals rather than all-or-nothing 'thresholds', such as Effective Deterrent Range (EDR; JNCC 2020) or fixed sound threshold approaches, such as the NOAA Level B harassment threshold (NOAA, 2005). This allows for more realistic assumptions about the response of animals at different doses to be incorporated.

For harbour porpoise, previous studies have shown the species experienced short-term displacement from the vicinity of piling events, such as at windfarms in the German North Sea ((Brandt *et al.*, 2011, Dähne *et al.*, 2013, Brandt *et al.*, 2016, Brandt *et al.*, 2018) and Beatrice OWF (Graham *et al.*, 2019). Whilst harbour porpoise may exhibit negative effects on foraging efficiency due to disturbance, it is also suggested they are resilient to short-term reductions in food intake (Wisniewska *et al.*, 2018). Benhemma-Le Gall *et al.* (2021) also suggest that harbour porpoise may not be completely displaced from an area during piling, and that displaced animals may resume foraging at a greater distance from the piling location with increased foraging activities to compensate for the effect of the disturbance. High levels of repeated exposure were unlikely to affect harbour porpoise fertility (Booth *et al*., 2019). Additionally, whilst repeated exposure may have the potential to effect calf survival it would be highly unlikely for a mother and calf to repeatedly return to an area in order to experience repeated levels of disturbance (Booth *et al*., 2019). Given their high conservation value and considering the evidence demonstrated from various studies on their behavioural response to acoustic disturbance, harbour porpoises are assessed as having medium sensitivity to disturbance from pile driving.

There is limited species-specific evidence to support assessment of white-beaked dolphins sensitivity, thus information available on bottlenose dolphins were used as a proxy to assess sensitivity for both species. Small effects from piling activities have been observed in bottlenose dolphins, such as a short-term reduction in presence (but not complete displacement) from piling at an inshore harbour development in the Moray Firth (Graham *et al*., 2017b). During expert elicitation, it was concluded that bottlenose dolphin calf survival could be affected by disturbance over 30-50 days, where calves may be separated from their mothers thus impacting the amount of milk received (Harwood *et al*., 2014a). Whilst bottlenose dolphin may be sensitive to disturbance, studies of their response to increased vessel presence suggested that they are able to compensate for such disturbance with no overall impact to individual energy budgets (New *et al*., 2013). Therefore, no change to vital rates is anticipated as a result of piling as part of the Project and, based on this assessment both white-beaked dolphin and bottlenose dolphin are assessed as having low sensitivity to disturbance from pile driving.

There are limited studies which consider the behavioural response of minke whales to underwater noise. Animals may alter their behaviour, such as diving patterns, in response to whale-watching vessels (Christiansen *et al*., 2013), and may avoid the sound source during emission of sonar signals (Doksæter Sivle *et al*., 2015) and ADD (McGarry *et al*., 2017). Whilst there is the potential for displacement of minke whales, which could affect foraging and reproductive rates, due to their large size and capacity for energy storage it is considered likely that they will be able to tolerate any short-term displacement better than harbour porpoise and other smaller animals and are highly mobile and thus able to exploit prey patches in other parts of their range. Therefore, minke whales are assessed as having low sensitivity to disturbance from pile driving.

Twenty tagged grey seals in the Wadden Sea showed varied responses to pile driving activities, from no response to change in swimming/diving behaviour with responses evident from between 12 and 45 km, although seals returned to the area once the activity ceased (Aarts *et al*., 2017ar). This varied response may be related to a range of individual sensitivity or environmental factors. Hastie *et al*., (2019) suggests that seal avoidance rates to piling were dependent on the quality of the prey patch. Based on expert elicitation, Booth *et al*. (2019) concluded that grey seals have a reasonable ability to compensate for lost foraging opportunities given their fat stores, mobility and generalist diets. As with harbour seals, juvenile animals are thought to be most vulnerable (Booth *et al*., 2019). However, grey seals are much more robust to harbour seal due to their larger energy stores, high mobility and adaptable foraging strategies (Beck *et al*., 2003, Sparling *et al*., 2006; Russel *et al*., 2013). Overall, grey seals were assessed as having negligible sensitivity to disturbance from pile driving.

Piling may commence with the use of an ADD to deter marine mammals from the zone of potential auditory injury. This is a form of intentional disturbance. However, as the source SPL of commonly used ADDs (e.g. Lofitech Seal Scarer) is significantly lower than the source SPL of impact piling activity, and the proposed 15-minute duration of

ADD activation (see EIAR, Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol), the additional effect of disturbance is inconsequential when ADDs are used alongside impact piling. The magnitude of disturbance to marine mammals from pile driving has been determined using dose-response functions. A dose-response function is used to quantify the probability of a response from an animal to a dose of a certain stimulus or stressor (Dunlop *et al.*, 2017) and is based on the assumption that not all animals in an impact zone will respond. 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). To estimate the number of animals disturbed per day, for all relevant cetacean species and grey seal, the dose-response curve based on harbour porpoise responses to impact piling at Beatrice OWF has been used (Graham *et al.*, 2019; Figure 11-7).

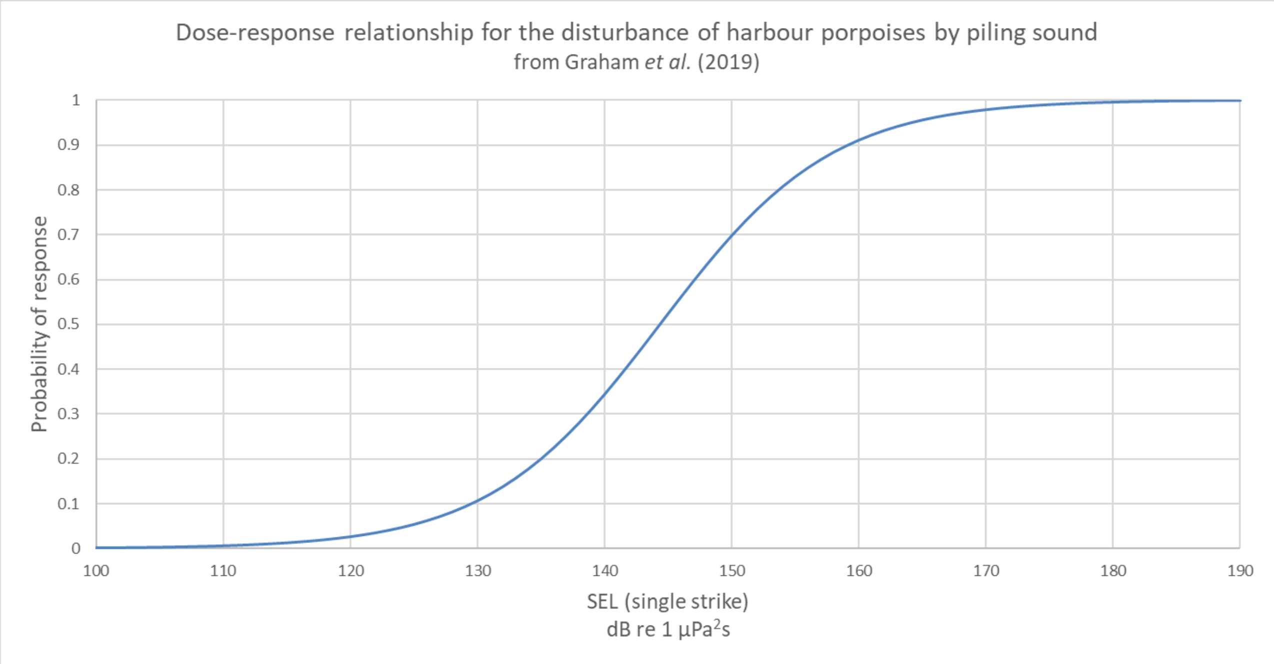

Figure 11-7 Dose-response relationship for the disturbance of harbour porpoise. This curve was used to estimate the number of individual marine mammals that would be disturbed at each single-strike SEL. Reproduced from Graham et al. (2019).

The piling schedule used in iPCoD for the Project spanned between 2031 and 2033 and assumed four days of piling for each of the two OSCPs (eight days total) in March 2031, and subsequent piling for FTUs occurring for 23 days each month starting 1st April 2031. The piling window was assumed to occur between 1st April and 30th September in each year with 75% of this time expected to be viable for piling.

OSCPs and FTU piling were included as separate piling operations as each are predicted to disturb different numbers of animals and require different numbers of piles. For each piling year (2031 - 2033) one third of FTU piles were assumed to be installed. Separate models were run for the two FTU piling options, i.e. semi-submersible and TLP scenarios.

For all species, three years of piling were assumed, 100% of animals were assumed to be disturbed, and two piling operations were included (one for OSCPs and one for FTU piles).

The maximum disturbance in relation to FTU pile driving has been predicted for semi-submersible anchors (Table 11-30). Disturbance in relation to OSCPs piling is presented in Table 11-31. The declining probability of disturbance with increasing distance from the piling location, determined through the use of the Graham *et al.* (2019) dose-response relationship (Figure 11-7) can be visualised in Figure 11-8 for FTU piling and Figure 11-9 for OSCPs piling.

Table 11-30 Summary of the underwater noise modelling results for disturbance to marine mammals from FTU piling (Semi-submersible anchor)

SPECIES	DENSITY (INDIVIDUALS PER KM^2)	NUMBER OF INDIVIDUALS DISTURBED PER DAY OF PILING	% UK PORTION OF RELEVANT MU (MU) PREDICTED TO EXPERIENCE DISTURBANCE PER DAY
Harbour porpoise	1.0398	8862.5	5.55% (NS)
Bottlenose dolphin (offshore MU)*	0.0298	254.0	13.47% (GNS)
White-beaked dolphin	0.1051	895.8	2.63% (CGNS)
Minke whale	0.0419	357.1	3.47% (CGNS)
Grey seal	0.2	126.3	4.66% (ES)
*Coastal bottlenose dolphins were not considered with respect to piling disturbance due to the distance of the piling operations from the coast and the range over which sound levels had the potential to disturb marine mammals.			

Table 11-31 Summary of the underwater noise modelling results for disturbance to marine mammals from OSCPs piling

SPECIES	DENSITY (INDIVIDUALS PER KM^2)	NUMBER OF INDIVIDUALS DISTURBED PER DAY OF PILING	% UK PORTION OF RELEVANT MU (MU) PREDICTED TO EXPERIENCE DISTURBANCE PER DAY
Harbour porpoise	1.0398	9528.9	5.97% (NS)
Bottlenose dolphin (offshore MU)*	0.0298	273	14.48% (GNS)
White-beaked dolphin	0.1051	963.2	2.83% (CGNS)
Minke whale	0.0419	384	3.73% (CGNS)
Grey seal	0.2	136.3	5.02% (ES)
*Coastal bottlenose dolphins were not further considered with respect to piling disturbance due to the distance of the piling operations from the coast and the range over which sound levels had the potential to disturb marine mammals.			

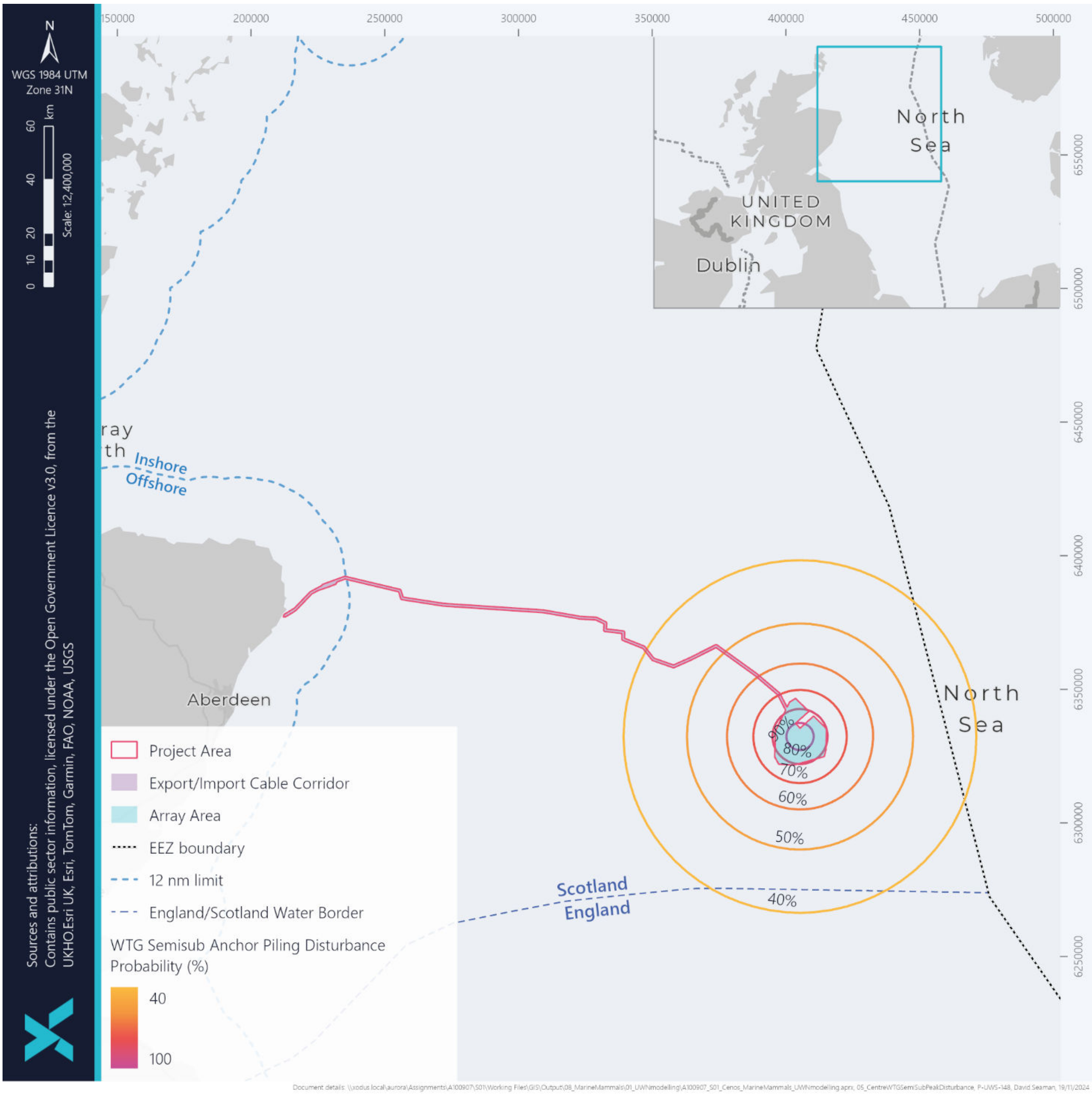

Figure 11-8 Probability of disturbance with increasing distance from the FTU piling (semi-submersible anchor) location. Disturbance estimates were clipped to a distance of 75 km from the piling location, because at range behavioural effects are highly implausible.

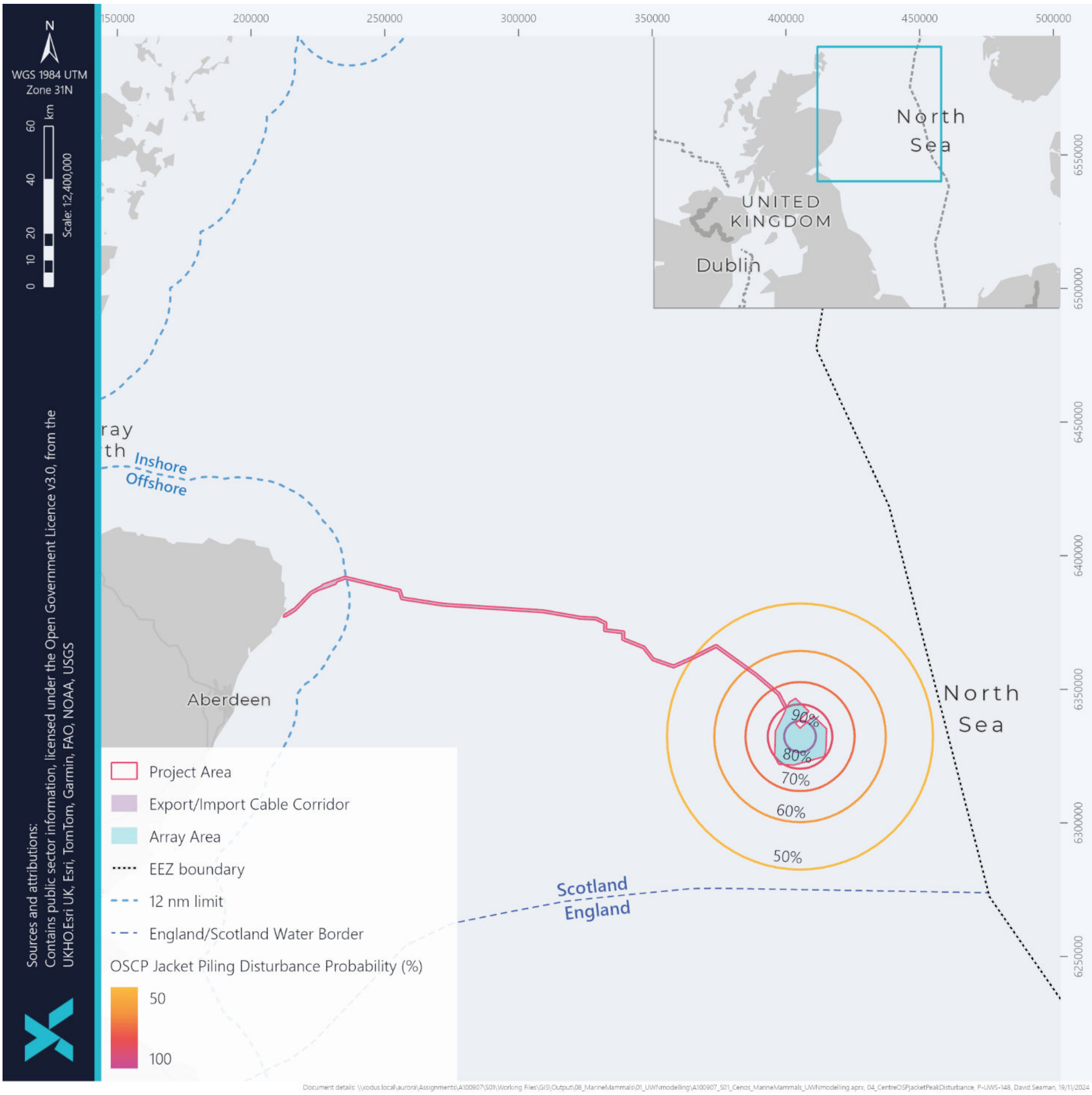

Figure 11-9 Probability of disturbance with increasing distance from the OSCPs piling location. Disturbance estimates were clipped to a distance of 75 km from the piling location, because at range behavioural effects are highly implausible.

These estimated numbers of animals predicted to experience disturbance per day of piling were used in population modelling scenarios using the iPCoD framework (Harwood *et al.*, 2014b; King *et al.*, 2015), to predict the potential population-level consequences of disturbance. The model runs a defined number of simulations, with elements of stochasticity (randomness) to predict the population trajectory both with and without the predicted level of impact, in this case, disturbance due to impact piling at the Project, using information about the population dynamics including calf/pup, juvenile and adult survival, fertility, age at independence and age at first birth. A full description of the method and parameters used in the modelling are presented in iPCoD Technical Note (EIAR Vol. 4, Appendix 18: Interim Population Consequences of Disturbance (iPCoD) Modelling Report).

Harbour porpoise

The iPCoD modelling results for disturbance to harbour porpoise from semi-submersible anchor piling is summarised in Table 11-32.

Table 11-32 Summary of the results of iPCoD modelling for harbour porpoise

SPECIES	SIMULATION YEAR	UN-IMPACTED MEAN POPULATION SIZE	IMPACTED MEAN POPULATION SIZE	IMPACTED AS % OF UN-IMPACTED POPULATION SIZE	MEDIAN RATIO IMPACTED UN-IMPACTED GROWTH RATE
Harbour porpoise	Population after 1 year	159,331	158,788	99.66%	0.997
	Population after 6 years	159,386	157,281	98.68%	0.988
	Population after 12 years)	159,727	157,527	98.62%	0.989
	Population after 25 years	160,327	158,115	98.62%	0.988

Underwater noise propagation modelling results used in conjunction with the dose response curve published by Graham *et al*. (2019) reported that number of individual harbour porpoises predicted to be disturbed by FTU pile driving on any given day reaching a maximum of 8862.5 individuals, representing 5.55% of the UK portion of the NS MU (Table 11-30). This daily level of impact was included within an iPCoD scenario for a 25 year model run[2], whereby the piling of semi-submersible anchors occurs over 285 days across a three year piling campaign. Assuming that disturbed animals experience one day of residual disturbance, this resulted in a 1.38% change (reduction) in the population size over the course of 25 years (2,212 individuals). The results of the iPCoD modelling show that although a change of -1.38% is predicted to occur at the population level, it is not anticipated that this level of disturbance over the construction period would have a major effect on the conservation status of harbour porpoise population (Figure 11-10), as this level of change is well within the confidence limits for both the impacted and unimpacted populations. Taking into account above, the magnitude of effect on the harbour porpoise population due to construction of Cenos FTUs is considered to be of low.

[2] *Note that the Project lifetime is 35 years. However, iPCoD modelling is undertaken to investigate the effect of the construction phase (particularly piling) on marine mammal populations, and thus extrapolations beyond a default 25-year modelling scenario are not necessary.*

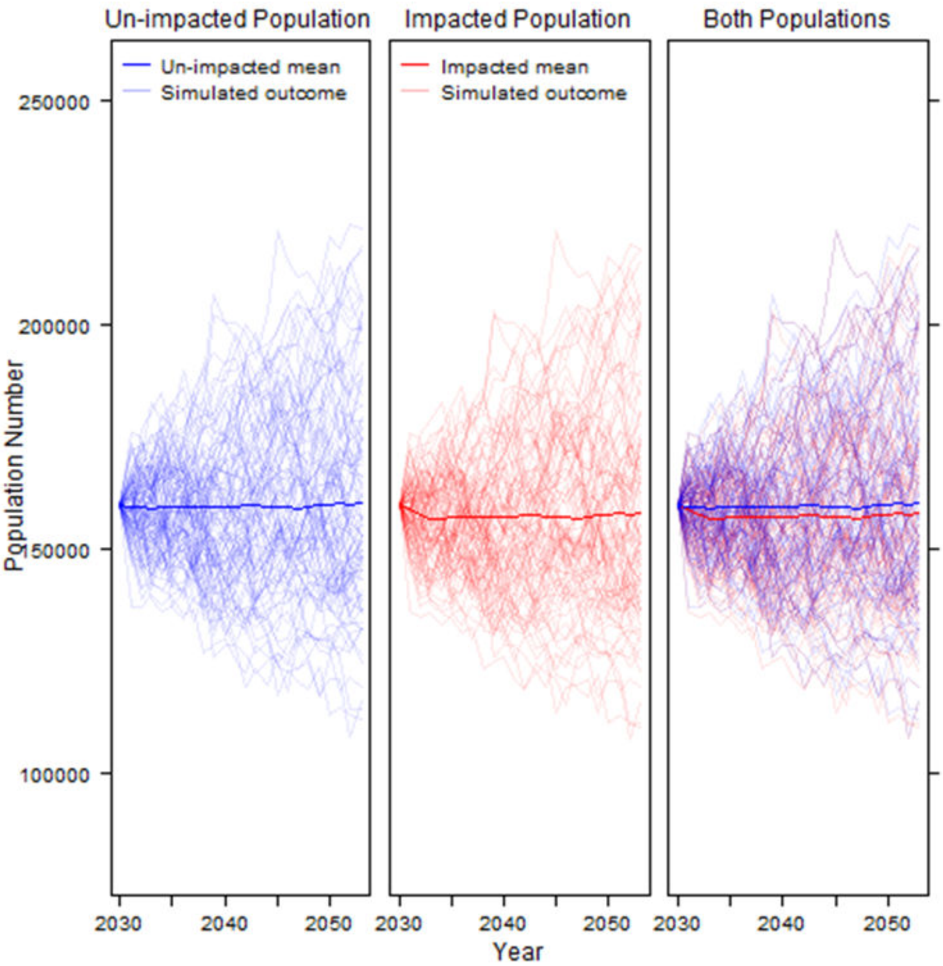

Figure 11-10 Population trajectory for impacted and unimpacted harbour porpoise populations with semi-submersible anchors piling and one day of disturbance

<u>Minke whale</u>

The results for minke whale show that the population during piling is stable, as presented in Figure 11-11; and the difference between unimpacted and impacted population abundance for the 25-year modelling duration differs by one individual (Table 11-33).

Table 11-33 Summary of the Minke whale iPCoD modelling results

SPECIES	SIMULATION YEAR	UN-IMPACTED MEAN POPULATION SIZE	IMPACTED MEAN POPULATION SIZE	IMPACTED AS % OF UN-IMPACTED POPULATION SIZE	MEDIAN RATIO IMPACTED UN-IMPACTED GROWTH RATE
Minke whale	Population after 1 year	10,309	10,308	99.99%	1.00
	Population after 6 years	10,289	10,287	99.98%	1.00
	Population after 12 years	10,249	10,248	99.99%	1.00
	Population after 25 years	10,255	10,254	99.99%	1.00

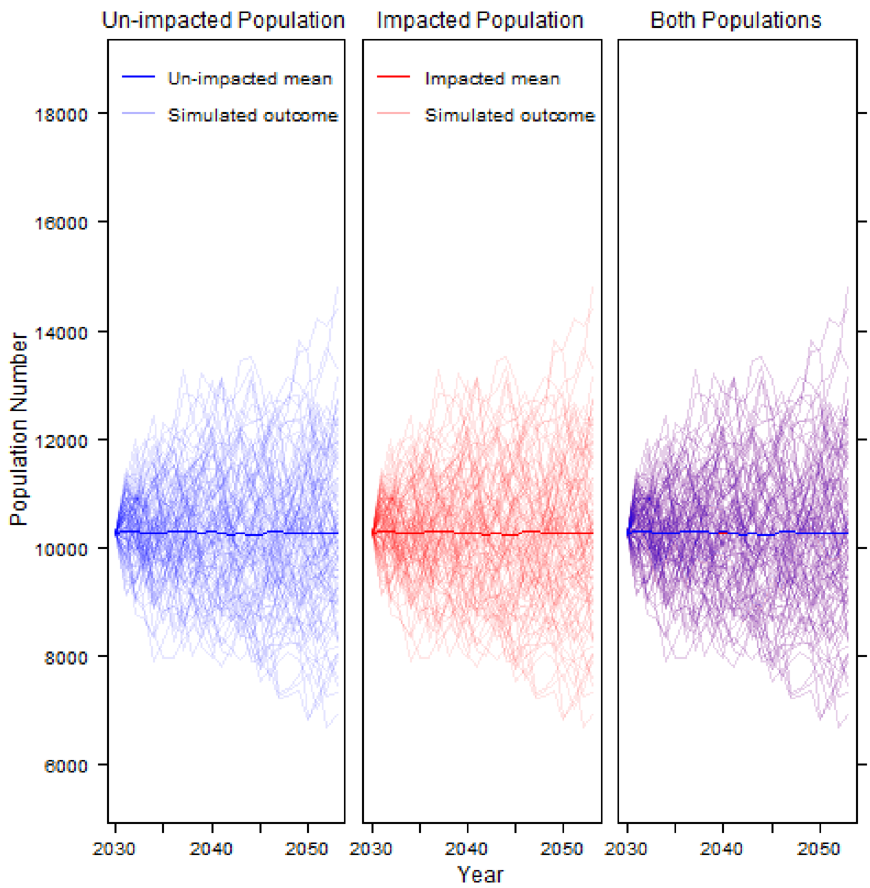

Figure 11-11 Population trajectory for impacted and unimpacted minke whale populations due to semi-submersible anchor piling

The UK population is predicted to be smaller by 1 individual after a 25-year modelled scenario. This difference equates to a predicted reduction of 0.01% from the predicted unimpacted population. Given these modelling results in relation to the UK proportion of the MU population, effects on minke whale population due to construction of Cenos FTUs is considered to be of negligible magnitude.

Grey seal

The iPCoD results for grey seal show that both the unimpacted and the impacted populations increase from around 2,742 to just under 3,500 after 25 years (Figure 11-12). Table 11-34 shows that the impacted population is 100% of the unimpacted population after the piling period, implying the grey seal population is not likely to be affected by piling and construction activities by semi-submersible anchor piling.

Table 11-34 Summary of the grey seal iPCoD modelling results

SPECIES	SIMULATION YEAR	UN-IMPACTED MEAN POPULATION SIZE	IMPACTED MEAN POPULATION SIZE	IMPACTED AS % OF UN-IMPACTED POPULATION SIZE	MEDIAN RATIO IMPACTED UN-IMPACTED GROWTH RATE
Grey seal	Population after 1 year	2,742	2,742	100.00%	1.000
	Population after 6 years	2,875	2,875	100.00%	1.000
	Population after 12 years)	3,054	3054	100.00%	1.000
	Population after 25 years	3,484	3,471	100.00%	1.000

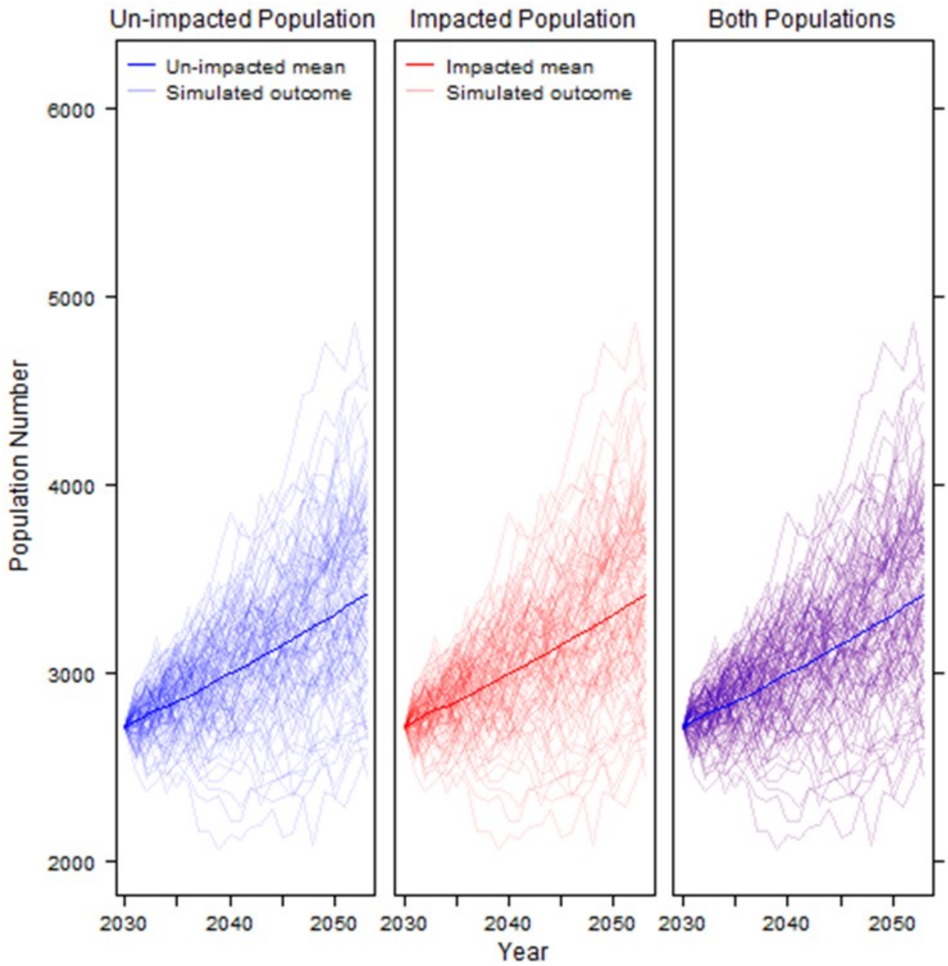

Figure 11-12 Population trajectory for impacted and unimpacted grey seal populations due to semi-submersible anchor piling

The results of the iPCoD modelling show that there is no effect of disturbance resulting from the Project on the size and trajectory of the grey seal population. Therefore, it is expected that the level of disturbance predicted is not sufficient to result in any changes at the population level since the impacted population is predicted to continue increasing at exactly the same rate as the un-impacted population. Therefore, effects on grey seal population due to construction of Cenos FTUs is considered to be of negligible magnitude.

White-beaked dolphin and bottlenose dolphin

In order to estimate disturbance to white-beaked dolphin and bottlenose dolphin, the harbour porpoise dose-response function has been used as a proxy for all dolphin species response in the absence of similar empirical data. However, as with minke whale, bottlenose dolphin and grey seal, these estimates make the assumption that the same relationship between SEL and probability of disturbance is observed in other marine mammal species as has been estimated for harbour porpoise by Graham *et al.* (2019). It is anticipated that this approach will be overly precautionary, as evidence suggests that dolphin species are less sensitive to disturbance than harbour porpoise.

A literature review of recent (post Southall *et al.*, (2007)) behavioural responses by harbour porpoises and bottlenose dolphins to sound was conducted by Moray Offshore Renewables Limited (2012). Several studies have reported a moderate to high level of behavioural response at a wide range of received SPLs (100 and 180 dB re 1µPa (micropascal)) (Lucke *et al.*, 2009; Tougaard *et al.*, 2009; Brandt *et al.*, 2011). Conversely, a study by Niu *et al.* (2020) reported moderate level responses to non-impulsive sound by bottlenose dolphins at received SPLs of 140 dB re 1µPa. Another HF cetacean, Risso's dolphin, reported no behavioural response to simulated mid-frequency active sonar at received SPLs of 135 dB re 1µPa (Southall *et al.*, 2012). Whilst both species showed a high degree of variability in responses and a general positive trend with higher responses at higher received levels, moderate level responses were observed above 80 dB re 1µPa in harbour porpoise and above 140 dB re 1µPa in bottlenose dolphins (Moray Offshore Renewables Limited, 2012), indicating that moderate level responses by bottlenose dolphins will be exhibited at a higher received SPL than anticipated in harbour porpoises and, therefore, are likely to exhibit a lesser response to disturbance.

The movement patterns of white-beaked dolphins in UK waters are poorly understood, and as such, it is not known the level of repeated disturbance an individual dolphin would be expected to receive over its lifetime. At one extreme, it could be assumed that there is no movement/turn-over of individuals in the area, and thus the same dolphins would be expected to be disturbed repeatedly on up to 285 piling days over the three-year piling activity period. However, this is highly conservative since the limited data available of white-beaked dolphin movement patterns suggests that white-beaked dolphins have a large ecological range and show low site fidelity (Bertulli *et al.*, 2015). It is more likely that animals transit through the area within their large home-range, and thus individuals are only present to be disturbed by piling at the Project over a limited number of days when present in the disturbance area. This might also be the case for oceanic population of bottlenose dolphins within the MU relevant to the Array Area. Modelling results based on dose-response curve presented in Table 11-30 indicate that up to 13.47% of the offshore bottlenose dolphin population might be disturbed due to semi-submersible pile driving. In comparison, only 2.633% of relevant MU for white-beaked dolphin might be subject to disturbance. Taking above into account and given the lack of data on white-beaked and bottlenose dolphin responses to pile driving, and the fact that iPCoD is not available for this species to determine whether or not this level of effect is likely to result in a population level effect, it is conservative to conclude a medium magnitude for white-beaked dolphins and high magnitude for bottlenose dolphin, since it is possible that impacts could result in a deviation from the baseline given the relatively small population estimate for the GNS MU.

Evaluation of significance

Taking the negligible to medium sensitivity and the negligible to high magnitude of the effect, the overall effect on marine mammals from disturbance caused by FTU and OSCPs pile driving during construction is considered to be minor or negligible and not significant in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
Harbour porpoise	Medium	Low	Minor
White-beaked dolphin	Low	Medium	Minor
Bottlenose dolphin	Low	High	Minor
Minke whale	Low	Negligible	Negligible
Grey seal	Negligible	Negligible	Negligible
Impact significance – NOT SIGNIFICANT			

Other species

As described in Section 11.4.4.2 other cetacean species could be present in the vicinity of the Array Area, however other species are likely to occur at lower densities than those described in more detail above.

These species include LF cetaceans (i.e. humpback whale) and HF cetaceans (killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, Risso's dolphin). There are very limited data on each of these species with respect to their sensitivity to behavioural disturbance due to sound emissions from impact piling. Nevertheless, as a precautionary assessment, it can be considered that these species share similar sensitivity to disturbance as the species described in more detail above. Therefore, humpback whale, killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, and Risso's dolphin are likely to be of low sensitivity to disturbance from piling sound. As these species are all considered to occur scarcely in the vicinity of the Array Area, at low densities the magnitude of any effects on the populations of these species is likely to be negligible.

The sensitivity of humpback whale, killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, and Risso's dolphin to disturbance from piling has been assessed as Low. The magnitude of disturbance has been assessed as Negligible. Therefore, the consequence of disturbance from piling to the populations of these other cetacean species is negligible, which is not significant in EIA terms.

Evaluation of significance

Considering medium sensitivity and the negligible magnitude of the effect due to FTU and OSCPs piling for all species, the overall effect on the populations of all marine mammals from disturbance caused by pile driving during construction is considered to be negligible and not significant in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
Humpback whale	Low	Negligible	Negligible
Killer whale	Low	Negligible	Negligible
Long-finned pilot whale	Low	Negligible	Negligible
Atlantic white-sided dolphin	Low	Negligible	Negligible
Short-beaked common dolphin	Low	Negligible	Negligible
Risso's dolphin	Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT			

11.6.1.1.2 Potential effects of underwater noise during UXO clearance

UXO clearance may be required during the pre-construction phase of the Project. The detonation of UXO will generate a broadband acoustic pulse at a very high peak pressure which has the potential to result in auditory injury or behavioural disturbance to marine mammal receptors.

As detailed within EIAR Vol. 2, Chapter 5: Project Description, the risk associated with UXO has been independently assessed as being 'low' within the Array Area and 'medium' towards the western end of the EICC (EIAR Vol. 4, Appendix 5: UXO Threat and Risk Assessment). Given the degree of flexibility afforded by the design of both the Array Area and the width of the EICC, it is anticipated that it will be possible to avoid UXO through micro-siting / micro-routeing. However, where UXO are identified within the Project Area which cannot be avoided or which pose a genuine threat to the safe completion of construction works, clearance will be undertaken as necessary. The maximum worst-case scenario assumes the clearance of 51 UXOs within the Project Area, with 50 cleared by Low Order Deflagration (LOD) with a donor charge of 0.08 kg and one High-Order Detonation (HOD), with a charge weight of 227 kg and 5 kg donor charge, in accordance with predicted charge weights in the UXO risk assessment presented within EIAR Vol. 4, Appendix 5: UXO Threat and Risk Assessment. It is expected that, where possible, all UXO clearance will be undertaken using low-noise clearance methods, such as deflagration, and all efforts will be made to avoid HOD where possible. However, the potential effect associated with one HOD is given here to provide a worst-case assessment.

The potential for PTS-onset and TTS-onset (as a proxy for disturbance) from UXO clearance has been assessed for several scenarios:

- HOD: this method aims to completely detonate of all explosive material in the UXO. The worst-case HOD of a large 227 kg UXO has been assessed plus a 5 kg donor charge which is used to initiate the detonation. This is considered to be the worst-case method of UXO clearance; and
- LOD: clearance of any size of UXO using a small specialist donor charge (up to 0.08 kg) which causes a very high temperature rapid burning event to vaporise the explosive material in the UXO without an explosion (called deflagration). Sound levels are proportional to the donor charge only and is typically 85% less than HOD. The acoustic effects of LOD (i.e. risk of auditory injury and disturbance) are considerably smaller than HOD because of the lower sound source levels.

It should be noted that when attempting to employ a clearance, including deflagration, there is a residual low risk that a HOD will be initiated. However, recent evidence from *in situ* UXO disposal at Moray West OWF demonstrated that LOD was successful in every instance (Abad Oliva *et al.*, 2024) and thus the probability of unintentional HOD is low.

11.6.1.1.2.1 Risk of auditory injury from UXO clearance

Relatively LF sound is produced by controlled explosions, with most of the energy below a few hundred Hz, (von Benda-Beckmann *et al*., 2015; Salomons *et al*., 2021), which is below the range of greatest sensitivity for the majority of marine mammal species considered in the assessment, with the exception of baleen whales which belong to the LF hearing group (Southall *et al*., 2019). Therefore, a PTS at these low frequencies is expected to result in a minor reduction in hearing sensitivity outside of the range of peak sensitivity, and thus have little effect on vital rates for other species. Therefore, dolphin, porpoise and seal receptors, including Atlantic white-sided dolphin, Risso's dolphin and killer whale, are assessed to be of **low sensitivity** to PTS from HOD UXO clearance.

Due to their sensitivity to lower frequencies, and recent studies suggesting there is more acoustic energy concentrated at lower frequencies (<100 Hz) during HOD UXO clearance (Robinson *et al*., 2022), it is more precautionary to assess minke whale and humpback whale as having **medium sensitivity** to PTS from HOD UXO clearance.

Table 11-35, below, summarises the underwater noise propagation modelling results and impact assessment for the HOD of a large 227 kg UXO as the worst-case. PTS ranges reported below consider the worst-case impact ranges, calculated either for weighted or unweighted threshold values.

Table 11-35 A summary of the number of animals predicted to experience injury (PTS-onset; in the absence of any mitigation measures) and summary of the impact assessment for HOD (227 kg + donor) UXO clearance and for LOD (0.08 kg charge)

SPECIES	METRIC	LOD (0.08 KG DONOR) RESULT	HOD (227 + 5 KG DONOR) RESULT	SENSITIVITY	MAGNITUDE OF EFFECT	CONSEQUENCE
Harbour porpoise	Range (km)	0.685	9.685	Low	Negligible	Negligible
	No. of animals	2	306			
	% UK MU	0.0012	0.1917			
Bottlenose dolphin*	Range (km)	0.04	0.56	Low	Negligible	Negligible
	No. of animals	<1	<1			
	% UK MU	0.444	0.444			
White – beaked dolphin	Range (km)	0.040	0.56	Low	Negligible	Negligible
	No of animals	<1	<1			
	% UK MU	0.003	0.003			
Minke whale	Range (km)	0.120	2.220	Medium	Negligible	Negligible
	No. of animals	<1	<1			
	% UK MU	0.0097	0.0097			
Harbour seal	Range (km)	0.135	1.900	Low	Low	Negligible
	No. of animals	<1	3			
	% MU	0.3817	1.145			

SPECIES	METRIC	LOD (0.08 KG DONOR) RESULT	HOD (227 + 5 KG DONOR) RESULT	SENSITIVITY	MAGNITUDE OF EFFECT	CONSEQUENCE
Grey seal	Range (km)	0.135	1.900	Low	Low	Negligible
	No. of animals	<1	34			
	% MU	0.0368	1.253			

* Coastal MU number of animals considered for calculations as a most conservative estimate of number of animals and % of MU affected

For the worst-case HOD UXO clearance (227 kg UXO plus a 5 kg donor charge), the underwater noise modelling PTS ranges reported below consider the worst-case impact ranges, calculated for both weighted and unweighted threshold values (as presented in Table 11-20), indicated that the greatest impact range would occur for harbour porpoise and minke whale (9.685 and 2.220 km respectively). The potential for PTS-onset is possible for up to 306 harbour porpoises, equalling to 0.1917% of relevant UK proportion of MU for this species; and only one minke whale, due to very low expected densities for this species in the area. Up to three harbour and 34 grey seals might experience PTS, which constitutes less than 1.3% for both relevant MU's for these species. The estimates for seals should be treated as very conservative, as calculations assume all animals are below the water during sound exposure. For all other species, injury was predicted to affect less than one individual. For LOD, auditory injury was predicted to affect up to two harbour porpoises and less than one individual for remaining assessed species.

White-sided dolphins, short-beaked common dolphins, long finned pilot whales, Risso's dolphins and killer whales are expected to have similar impact ranges to the HF hearing group species (Southall *et al.*, 2019), such as bottlenose and white-sided dolphins. Humpback whales are expected to have similar impact ranges as minke whales, as both species are within the LF hearing group (Southall *et al.*, 2019). These species are expected to occur in lower densities and therefore it would be less likely that they would be in the vicinity of the Project Area in significant numbers during UXO clearance. Effects to these species and subsequent assessment of magnitude are therefore expected to be analogous with, or less than, that assessed for dolphin species and minke whales.

Whilst injury from UXO clearance is a permanent change in the hearing threshold and affected animals will not recover, a very low number of animals are predicted to be affected, which will be further reduced using embedded mitigation measures listed in the MMMP (EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol), including the use of ADDs and MMOs during UXO clearance and applying LOD as the primary disposal method.

Additionally, the effect is expected to occur intermittently over a short duration (maximum 51 days) in the year prior to piling activities. Therefore, considering the embedded mitigation measures, injury resulting from UXO clearance is defined as being of low magnitude for all marine mammal species.

Evaluation of significance

Taking the low to medium sensitivity and the negligible magnitude of the effect, the overall effect on marine mammals from injury caused by UXO clearance during pre-construction is considered to be minor for minke whale and humpback whale, negligible for all other marine mammal receptors and not significant in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
• Minke whale • Humpback whale	Medium	Low	Minor
All other marine mammal receptors	Low	Low	Negligible

Impact significance – NOT SIGNIFICANT

11.6.1.1.2.2 Disturbance from UXO clearance

Due to the lack of empirical studies, there is limited understanding of the effect of disturbance from UXO detonation on marine mammals, meaning that assessments can only provide an indication of the number of animals at risk, based on limited evidence.

Any disturbance from UXO clearance would be highly short-term, and intermittent. As per the JNCC guidance (2020), *"…a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement…"*. Therefore, it is not expected that disturbance from a single UXO detonation would result in any significant impacts or result in any changes to the vital rates of individuals. Therefore, all marine mammals are assessed to be of negligible sensitivity.

UXO clearance may commence with the use of an ADD to deter marine mammals from the zone of potential auditory injury. This is a form of intentional disturbance. However, as the source SPL of commonly used ADDs (e.g. Lofitech Seal Scarer) is significantly lower than the source SPL of UXO clearance (see EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol), the additional short-duration effect of disturbance is inconsequential when ADDs are used alongside UXO clearance. Behavioural responses are widely recognised as being highly variable and context specific (Southall *et al.*, 2007; 2019; 2021). Assessing the severity of such potential effects and development of probability-based response functions continues to be an area of ongoing scientific research interest (Graham *et al.*, 2019; Southall *et al.*, 2021). There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals. As sound due to UXO clearance is likely to elicit an instantaneous startle response, and not a long-duration disturbance event like the installation of a pile over the course of several hours, the TTS-onset threshold has been used as a proxy for disturbance.

Table 11-36 summarises the underwater noise modelling results and impact assessment for the HOD of a large 227 kg UXO and a 5 kg donor charge as the worst-case, and the LOD methods, with full details provided in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report. TTS ranges reported below consider the worst-case impact ranges, calculated either for weighted or unweighted threshold values.

Table 11-36 A summary of the number of animals predicted to experience disturbance and summary of the impact assessment for LOD (0.08 donor only) and high-order (227 kg + 5 kg donor) UXO clearance (EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report)

SPECIES	METRIC	LOD (0.08 KG DONOR) RESULT	HOD (227 + 5 KG DONOR) RESULT	SENSITIVITY	MAGNITUDE OF EFFECT	CONSEQUENCE
Harbour porpoise	Range (km)	1.495	17.850	Negligible	Negligible	Negligible
	No. of animals	8	1,041			
	% UK MU	0.005	0.652			
Bottlenose dolphin*	Range (km)	0.075	1.030	Negligible	Low	Negligible
	No. of animals	<1	3			
	% UK MU	0.444	1.33			
White – beaked dolphin	Range (km)	0.075	1.030	Negligible	Negligible	Negligible
	No of animals	<1	<1			
	% UK MU	0.003	0.003			
Minke whale	Range (km)	0.66	21.660	Negligible	Negligible	Negligible
	No. of animals	<1	62			
	% UK MU	0.0097	0.603			
Harbour seal	Range (km)	0.25	4.105	Negligible	Medium	Negligible
	No. of animals	<1	11			
	% MU	0.3817	4.2			
Grey seal	Range (km)	0.25	4.105	Negligible	High	Negligible
	No. of animals	<1	159			
	% MU	0.0368	5.86			

* Coastal MU number of animals considered for calculations as a most conservative estimate of number of animals and % of MU affected

For the worst-case HOD UXO clearance (227 kg UXO plus a 5 kg donor charge), the underwater noise modelling predicted that harbour porpoise (1,041 individuals) and minke whale (62 individuals) would be subject to the greatest disturbance effect from UXO clearance, which is equivalent to 0.652% and 0.603% of the MU population for those species, respectively. Three bottlenose dolphins might be impacted, while taking into account coastal population units, as a worst–case estimate scenario. Up to 159 grey seals and 11 harbour seals may experience disturbance, which constitutes to 5.86% and 4.2% respectively of relevant SMU. These numbers should be treated as very conservative, as calculations assume all animals in the population are at sea with their heads below the water during sound exposure.

The impact range and the number of animals predicted to be disturbed by low-order clearance, which is the preferred method of UXO disposal, is very low for all species (maximum of eight animals, and less than 0.45% of relevant MU for each species).

White-sided dolphins, short-beaked common dolphins, long finned pilot whales, Risso's dolphins and killer whales are expected to have similar impact ranges to the HF hearing group species (Southall *et al.*, 2019), such as bottlenose and white-sided dolphins. Humpback whales are expected to have similar impact ranges as minke whales, as both species are within the LF hearing group (Southall et al., 2019). These species are expected to occur in lower densities and therefore it would be less likely that they would be in the vicinity of the Project Area in significant numbers during UXO clearance. Effects to these species and subsequent assessment of magnitude are therefore expected to be analogous with, or less than, that assessed for dolphin species and minke whales.

Overall, whilst there may be some short-term, temporary and reversible disturbance to marine mammals, as a small proportion of the reference population of each species is expected to be disturbed by UXO clearance and so there is not likely to be significant shift away from baseline conditions.

Additionally, the effect is expected to occur intermittently for a short duration (maximum 51 days) in the year prior to piling activities. Therefore, after applying mitigation measures (i.e. use of ADDs and MMOs during UXO clearance and applying LOD as the primary disposal method.), disturbance resulting from UXO clearance is reduced to negligible magnitude for all marine mammal species.

Evaluation of significance

Taking the negligible sensitivity and the negligible magnitude of the effect, the overall effect on marine mammals from disturbance caused by UXO clearance during pre-construction is considered to be negligible and not significant in EIA terms.

Receptor	Sensitivity	Magnitude of effect	Consequence
All marine mammal receptors	Negligible	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

11.6.1.1.3 Potential effects of underwater noise during geophysical and geotechnical surveys

As detailed in EIA Vol. 2, Chapter 5: Project Description it is assumed that up to two geophysical surveys campaigns (maximum 60 days per campaign) will be conducted prior to any installation activities, with survey methods/equipment including MBES, SSS, SBP, 2D and 3D seismic surveys. Ultra-short baseline (USBL) has also been considered below.

The SPL produced by some geophysical survey equipment has the potential to result in injury and/or disturbance to marine mammals. The sound characteristics of activities associated with geophysical surveys proposed for the Project have been determined by a significant body of publicly available data and information (as presented within Table 11-37). Where a range of sound source levels were identified for an activity, a realistic worst-case level has been adopted for the assessment.

Table 11-37 Characteristics of underwater noise sources generated by geophysical activities

UNDERWATER NOISE GENERATING ACTIVITY	FREQUENCY RANGE (KHZ)	INDICATIVE SPL (SEL_{CUM} dB re 1 μPa^2s)	SCOPED IN FOR ASSESSMENT?
MBES	400-700	180-240	X
SSS	300-900	213-225	X
SBP	8-12, 100	247	✓
2D and 3D seismic surveys	0.5-4	226	✓
USBL	19-34	200	X

At this stage, a number of underwater noise sources from geophysical survey activities have been removed from further consideration as part of this assessment based on the nature of the sound and the likelihood that they will be masked by background ambient sound levels. A justification for scoping out these activities is provided below:

- MBES: when operating in shallow waters (< 200 m), MBES is typically operated at high frequencies (>200 kHz) that will fall outwith the known hearing range of marine mammal species likely to be present within the Project Area. Furthermore, due to the HF of sounds produced by MBES, emitted sound will attenuate rapidly through the water column and with increasing distance from the source. It is therefore considered that there is no potential for a significant impact to marine mammal receptors as a result of MBES activities;
- SSS: similar to MBES, SSS operates at HF outwith the known hearing range of marine mammal species likely to be present within the Project Area (typically > 300 kHz). It is therefore considered that there is no potential for a significant impact to marine mammal receptors as a result of SSS activities during geophysical surveys; and
- USBL: Because the use of USBL underwater positioning technology generates sounds of a relatively low amplitude (ca. 200 dB) and will always be operated in proximity to a survey vessel (itself generating notable sound emissions) the risk of injury is highly implausible and any disturbance effect due to the use of this equipment is considered to be incidental and not likely to generate any effect greater than the disturbance effect of the survey vessel itself. For this reason, USBL has not been considered further within this assessment.

One or more geotechnical survey campaigns will be undertaken within the Array Area and the ECC to support detailed design and engineering. Survey methods including drilling of boreholes, use of Cone Penetration Tests (CPTs), and vibrocores/piston cores.

Sound source data for the proposed CPTs were reported by Erbe and McPherson (2017). The sound signature was generally broadband in nature with levels measured 20 dB above the baseline sound levels, with expected source level of 189 dB re 1μPa^2s SEL, the sound generated due to the use of CPT is classified as impulsive due to its acoustic characteristics.

Measurements of a vibro-core test reported broadband sound source pressure levels of approximately 187 dB re 1 μPa re 1 m (rms) and SEL of 223 dB re 1 μPa^2s re 1 m calculated over 1 hour time window, which is the typical maximum time period required for a sample (Reiser *et al.*, 2011). Source levels for borehole drilling was reported in Erbe and McPherson (2017), with sound having broadband characteristics and source levels of 142 dB to 145 dB re 1 μPa re 1 m (rms). Both, vibro-core activity and borehole drilling fit into non-impulsive sounds category due to their acoustic properties.

The only survey activities that have the potential to result in injury or disturbance to marine mammal receptors are these associated with the use of SBP, CPT, 2D and 3D seismic surveys, vibrocores and borehole drilling.

11.6.1.1.3.1.1 Injury from geophysical and geotechnical surveys

Without the implementation of appropriate mitigation measures, there is the potential for SBP and 2D and 3D seismic surveys equipment to result in injury to marine mammals. It should be noted that sonar-like survey sources, such as SBP, are classed as non-impulsive sound because they generally comprise a single (or multiple discrete) frequency (e.g. a sine wave or swept sine wave) repeated pulse, as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times. Although vibrocoring, CPT and borehole drilling sound emissions are of lower intensity than SBP, there is a potential for these activities to result in injury to marine mammals at a very close range to the source. The 2D and 3D seismic surveys source produces a broadband impulsive sound.

To assess potential injury ranges for marine mammals due to the use of equipment mentioned above, underwater noise modelling was conducted, with full details provided in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report. In order to calculate impact ranges for PTS onset for marine mammals due to the use of SBP, 2D and 3D seismic surveys, vibrocoring and borehole drilling non-impulsive SEL criteria were applied, while for CPT impulsive SEL threshold values were used based on Southall *et al.* (2019). The outputs are presented in Table 11-38 below.

Table 11-38 Sound modelling results for injury impacts from geophysical and geotechnical equipment, based on SEL_{cum}

UNDERWATER NOISE GENERATING ACTIVITY	POTENTIAL PTS RANGES (M)			
	LF	HF	VHF	PCW
SBP*	100	110	400	105
2D and 3D seismic surveys*	5	N/A	10	N/A
Borehole drilling*	5	65	100	5
CPT**	10	100	100	25
Vibro-coring*	100	100	310	100

*Non-impulsive SEL threshold from Southall et al., 2019 used
**Impulsive SEL threshold from Southall et al., 2019 used[3]

Across all modelled sound sources, SBP injury (PTS) ranges resulting from cumulative sound exposure were the highest, followed by vibro-coring. The highest PTS ranges were obtained for VHF cetaceans (i.e., harbour porpoise),

[3] *Sounds impulsive at the source have broadband sound characteristics and consist of high peak sound pressure with rapid rise time and rapid decay, while continuous sounds typically do not have a high peak sound pressure with rapid rise/decay time ((ANSI, 1986 and 2005; NIOSH, 1998).*

with PTS potentially occurring within 400 m from the sound source for SBP and 310 for vibro-coring. All other PTS impact ranges for all marine mammal species considered in the assessment were lower than 110 m.

For the geophysical survey sources (SBP and 2D and 3D seismic surveys), many of the injury ranges are limited to circa 100 m as this is the approximate water depth in the area. Geophysical survey systems such as SBP typically have very strong directionality, which effectively means that there is only potential for injury when a marine mammal is directly underneath the sound source. Once the animal moves outside of the main beam, there is significantly reduced potential for injury. Additionally, marine mammals are highly mobile within the marine environment, as such it is considered that the majority of injury ranges will be slightly reduced as a result of an animal swimming away from the sound source. The 2D and 3D seismic surveys source is a sparker, which produces a broadband impulsive sound. Sparkers emit an omnidirectional broadband acoustic pulse into the water column by first creating an electrical pulse between electrodes located on the tip of the device, and a grounding point located on the body. The resulting acoustic pulse penetrates into the seabed and is dispersed by the sediment. Dispersion varies with the thickness of sediment layers, grain size and position, and the energy reflected back to the sparker system hydrophones creates a profile of the seabed (Ruppel *et al.*, 2022).

As detailed in Section 11.6.1.1, each marine mammal species has a unique hearing frequency range within which it has the ability to adapt to perceived sounds. When these hearing ranges are exceeded, the potential for injury arises. SBP system transmit a series of sound pulses into the water column which echo off sediment and rock layers up to 50 m below the seabed. While SBP systems transmit sound in a highly directional manner (therefore limiting the potential for horizontal propagation), the high source level of the sound (ca. 247 dB re 1 µPa @ 1 m) has the potential to result in auditory injury to animals within the LF, HF and VHF cetacean hearing groups as well as seals which will likely manifest as a small change in hearing sensitivity at certain frequencies which will be permanent, although it is not likely to cause effects to individual animals vital rates.

Therefore, all marine mammal species present within the Study Area as assessed as having medium sensitivity to injury from SBP, 2D and 3D seismic surveys, CPT, borehole drilling and vibro-coring.

Based on the nature of survey works proposed for the Project, and the limited spatial scale of survey activities within the marine environment, it is anticipated that only animals in very close proximity to SBP, 2D and 3D seismic surveys, vibro-coring and borehole drilling operations have the potential to experience acoustic injury. The greatest injury range for all marine mammal species likely to be present within the Project Area relates to harbour porpoise, with a maximum injury range of 400 m from the source. As vibro-coring modelling results were based on the worst-case scenario, of sampling lasting one hour, the modelled PTS ranges are very conservative and most probably exaggerated. SEL levels for geotechnical surveys with the use of CPT and borehole drilling are significantly lower, the possibility to induce PTS in marine mammals due to these activities is limited to very close distance to the sound source. As all these sound-emitting activities take place in close proximity to a survey vessel, which itself generates sound emissions, it is likely that marine mammals will move away (or flee) from the vessel prior to exposure to sound from the survey equipment, thereby reducing the potential risk of injury.

Given the potential for auditory injury to arise to marine mammals within the Project Area as a result of SBP activities is the highest, a series of embedded mitigation measures will be applied to certain pre-construction survey activities to reduce the potential risk of injury to marine mammals. JNCC guidance on minimising the potential for auditory injury to marine mammals requires that, prior to the commencement of any SBP activities, a period of observation over a pre-defined mitigation zone (i.e., a minimum of 400 m to consider the maximum injury range of harbour porpoise) should be undertaken by qualified MMOs. During hours or darkness or in poor weather conditions, observation of marine mammals within the mitigation zone should be undertaken using a PAM system by a qualified PAMO. Further details of these mitigation measure will be provided within the MMMP (EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol) submitted for the Project post-consent. Through the implementation of these mitigation measures it is considered that the potential risk of injury to all marine mammal species as a result of SBP operations will be greatly reduced.

Taking above into account, potential effect from pre-construction geophysical and geotechnical surveys is assessed as being of negligible magnitude.

Evaluation of significance

Taking the medium sensitivity and the negligible magnitude of the effect, the overall effect of injury to marine mammals from geophysical and geotechnical surveys is considered to be negligible and not significant in EIA terms.

Equipment	Sensitivity	Magnitude of effect	Consequence
SBP, 2D and 3D seismic surveys, vibro-coring, CPT and borehole drilling	Medium	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

11.6.1.1.3.1.2 Disturbance from geophysical and geotechnical surveys

In addition to the potential for physiological effects from geophysical and geotechnical surveys, activities have the potential to induce behavioural effects in marine mammal species (i.e., disturbance). Behavioural responses in marine mammals are highly species specific and can include increased alertness within an animal, altered vocal behaviour, alteration in movement, swimming speed or diving behaviour or the temporary or permanent abandonment of a habitat.

Although there is a growing body of existing research into the potential effects of underwater noise on marine mammals, there is no existing evidence on the effect of SBP and geotechnical survey operations. Two recent studies undertaken by Kates Varghese *et al* (2020; 2021) concluded that, in response to a 12 kHz multi-beam echosounder survey off the coast of California, Cuvier's beaked whale *Ziphius cavirostris* (HF cetaceans) exhibited no clear change in distribution or foraging behaviour in response to the sound. Similarly, a study undertaken in the North Sea concluded that, following the short-term displacement of harbour porpoises following exposure to and underwater noise, animals returned to affected sites within a few hours of the cessation of the activity (Thompson *et al*., 2013). Therefore, all cetacean species present within the Study Area as assessed as having negligible sensitivity to disturbance from geophysical and geotechnical surveys.

To assess potential behavioural response for marine mammals due to the use of geophysical and geotechnical equipment, underwater noise modelling was conducted, with full details provided in EIAR Vol. 4, Appendix 15:

Underwater Noise Modelling Report. Behavioural impact thresholds applied were 120 dB re 1μPa (rms) for non-impulsive sound sources and 140 dB re 1μPa (rms) and 160 dB re 1μPa (rms) for mild and strong behavioural response due to impulsive sounds (NMFS, 2005). The outputs are presented in Table 11-39 below.

Table 11-39 Sound modelling results for behavioural impacts from geophysical and geotechnical equipment

UNDERWATER NOISE GENERATING ACTIVITY	POTENTIAL IMPACT RANGES (M)			
	LF	HF	VHF	PCW
SBP*	1,275	1,275	1,275	1,275
2D and 3D seismic surveys*	530	530	530	530
Borehole drilling*	375	375	375	375
CPT**	1,330 (mild) 140 (strong)	1,330 (mild) 140 (strong)	1,330 (mild) 140 (strong)	1,330 (mild) 140 (strong)
Vibrocoring*	1,340	1,340	1,340	1,340

*Non-impulsive SEL threshold from Southall et al., 2019 used
**Impulsive SEL threshold from Southall et al., 2019 used[4]

The highest impact ranges for all marine mammal species included in the assessment were obtained for SBP (1,275 m) and vibro-coring activities (1,340 m). A mild behavioural response is also expected up to 1,330 m during CPT activities. It has to be noted here, that these impact ranges are based on conservative threshold values and are limited to no more than 1.4 km away from the sound source. Effects associated with geophysical and geotechnical surveys will be highly localised in scale, short-term and transient in nature (as the survey vessel moves across the Project Area). Taking above into account, the potential effect is therefore assessed as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity and the low magnitude of the effect, the overall effect of disturbance to marine mammals from geophysical surveys is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Negligible	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

[4] *Sounds impulsive at the source have broadband sound characteristics and consist of high peak sound pressure with rapid rise time and rapid decay, while continuous sounds typically do not have a high peak sound pressure with rapid rise/decay time ((ANSI, 1986 and 2005; NIOSH, 1998).*

11.6.1.1.4 Potential effects of underwater noise from construction vessels

Underwater noise generated by Project construction vessels within the marine environment have the potential to result in behavioural changes in marine mammal receptors. The magnitude of effects associated with underwater noise from Project vessels will increase with both the size of the vessel and the number of vessels that are operating within the marine environment at any given time.

As detailed within EIAR Vol. 3, Chapter 15: Shipping and Navigation, the Project Area is located within a moderate to high area of shipping activity within territorial waters (between the Export/Import Cable landfall and the 12 NM limit), with vessel activities primarily associated with Peterhead and Aberdeen harbours. With increasing distance offshore along the EICC and within the Array Area, the vessel density decreases, with activity primarily associated with offshore oil and gas installations (EMODnet, 2024). The majority of vessel traffic around the shipping and navigation study area of the Array Area is comprised of oil and gas vessels (82%), followed by fishing vessels (7%), tugs (4%), cargo vessels (3%), tankers (2%), and recreational vessels (1%). An average of four to five vessels per day were recorded within the Array Area across the 21-day summer survey. The higher vessel activity across the Project Area is around the EICC and was associated largely with oil and gas vessels (34%), fishing vessels (32%), and cargo vessels (16%), with vessel length most commonly between 50 – 100 m. An average of 74 vessels per day were recorded during the summer period in the EICC shipping and navigation study area and an average of 64 to 65 per day during the winter period.

During the construction and pre-construction phase, vessel activities will primarily be associated with Project-specific surveys and site investigations, site preparation activities and construction activities. As detailed within EIAR Vol. 2, Chapter 5: Project Description, up to 22 vessels will be required to simultaneously operate for construction works, with a maximum of 319 vessel transits a year throughout the up to six-year construction period. Construction works will typically be undertaken 24 hours a day, seven days a week offshore (dependent on weather conditions). It is anticipated that a maximum of 22 vessels will be operating consecutively within the Project Area at any one time. It is anticipated that a large portion of construction vessels will be stationary or slow-moving for significant periods during the construction phase.

The susceptibility of marine mammals to potential effects of underwater noise from construction vessels varies from species to species, with a number of variables (including location, water depth, time of year etc.) influencing an animals' ability to tolerate underwater noise from construction vessels (Pirotta *et al.*, 2015; Marley *et al.*, 2017). There is evidence to suggest that cetacean species have the ability to compensate for any immediate behavioural effects from vessel disturbance (Christiansen *et al.*, 2015; Christiansen and Lusseau, 2015), therefore reducing the immediate biological effect of vessel disturbance at both an individual and population level. The underwater SPL associated with survey and construction vessels will primarily be non-impulsive, continuous and LF (i.e., below 1 kHz). Sound emissions from vessels associated with the Project will exceed the threshold for behavioural effects from continuous sound (120 dB_{rms} re 1 µPa), with evidence suggesting that vessels specific to windfarm construction will result in short-term displacement effects to harbour porpoises (Brandt *et al.*, 2018; Benhemma-Le Gall *et al.*, 2021). However, this behaviour exhibited by harbour porpoises is consistent with underwater noise emissions from other vessels within the marine environment (Dyndo *et al.*, 2015; Oakley *et al.*, 2017; Wisniewska *et al.*, 2018), with HF sound considered to be the most disruptive to harbour porpoise behaviour and activity. All cetacean species present within the Marine Mammals Study Area are assessed as having low sensitivity to potential effects of underwater noise from construction vessels.

For seals present within the Marine Mammals Study Area, the potential effects of underwater noise are only applicable to animals that are at sea during vessel activities. Potential effects to seals include avoidance of vessel activities and TTS. Both grey seals and harbour seals are classified as having a low sensitivity to potential effects of underwater noise from construction vessels.

Underwater noise modelling was conducted in order to assess the potential of injury and disturbance to marine mammals due to the presence of different construction vessels. The results are presented in Table 11-40.

Table 11-40 Estimated Potential PTS and disturbance ranges from different construction vessels for marine mammals

SOURCE VESSEL	RANGE (M)				
	LF	HF	VHF	PCW	ALL
	PTS	PTS	PTS	PTS	Disturbance
Sandwave clearance	N/E	12	94	N/E	2,648
Boulder clearance, offshore construction vessel, excavator, backhoe dredger	N/E	N/E	N/E	N/E	433
Main Installation Vessels (Barge/DP vessel)	N/E	12	94	N/E	2,648
Jack up rig/jack up vessel	N/E	N/E	N/E	N/E	N/E
Tug/Anchor Handlers	N/E	N/E	N/E	N/E	2,742
Cable Laying, Installation Vessels	N/E	12	94	N/E	2,648
Rock Placement Vessels	N/E	12	94	N/E	2,648
Guard Vessels, workboats	N/E	N/E	N/E	N/E	2,742

Results show that PTS range due to vessel activity is the highest for harbour porpoise, reaching 94 m. However, it is very unlikely that an animal will approach the vessel and enter the PTS zone, due to known avoidance behaviour. Modelled disturbance ranges reach 2,742 m. As detailed in Table 11-15, a number of embedded mitigations have been adopted to reduce the potential for physiological and behavioural effects to marine mammals as a result of underwater noise from construction vessels. An EMP (EIAR Vol. 4, Appendix 32: Outline Environmental Management Plan) will be implemented and adhered to, in line with the protocols outlined in the Scottish Marine Wildlife Watching Code and Guide to Best Practice for Watching Marine Wildlife. All construction vessels will maintain a steady speed and direction while passing marine mammals in order to reduce the severity and magnitude of disturbance to marine mammals. The Project-specific VMP will outline indicative transit routes for Project vessels within the marine environment. These transit routes have been selected in consideration of the receiving environment and baseline environmental conditions to reduce the area through which Project vessels will be transiting. However, construction vessels are expected to work on site for a prolonged period of time, and the duration of the effect has to be taken into consideration while assessing the magnitude of the effect.

Taking above into account potential physiological or behavioural effects to marine mammals as a result of potential effects of underwater noise from construction vessels are considered to be temporary in nature, with a very small likelihood of significant impacts on marine mammal populations. The potential effect is therefore assessed as being of low magnitude.

Evaluation of significance

Taking the low sensitivity and the low magnitude of the effect, the overall effect on marine mammals of underwater noise from construction vessels is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Negligible

Impact significance – NOT SIGNIFICANT

11.6.1.2 Changes to prey distribution

During the pre-construction surveys and construction phase of the Project, there is the potential for indirect effects to marine mammals to arise as a result of changes to their prey distribution. These effects may arise as a result of works which will directly interact with the seabed (including seabed preparation works, cable lying and FTU and OSCPs foundation installation) and through the introduction of anthropogenic underwater noise, which may result in physiological or behavioural effects to prey species. The assessment of potential effects to fish and shellfish species, which are considered prey to marine mammals, have been assessed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology. This fish and shellfish ecology assessment considers the following pathways for potential effects during the construction phase:

- Temporary effects to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
- Underwater noise and vibration; and
- Potential changes to SSC.

Marine mammals predate on a wide range of fish and shellfish species including clupeids (e.g., herring and sprat), gadoids (e.g., cod and whiting), sandeels and flatfish (Pierce *et al.*, 2004; Canning *et al.*, 2008; Tetley *et al.*, 2008; Jansen *et al.*, 2010; Evans and Hintner, 2013; Leopold *et al.*, 2018). Some species (e.g. cod and sandeel) are likely to be present along the length of the EICC and within the Array Area, whereas some species (e.g. whiting) are present within isolated areas of the Project Area (further details are available in EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology).

As marine mammals are highly mobile in nature and wide-ranging in their distribution, the availability of prey within the marine environment, and their ability to travel for foraging, extends outwith the direct spatial footprint of the Project. Marine mammals will be able to forage in alternative areas if required during the construction phase of the Project, even if displaced from preferred foraging locations due to changes to prey distribution.

Cetaceans are typically generalist feeders, utilising opportunistic predation methods for fish and shellfish species that are available at the time, which, combined with their highly mobile nature, makes them resilient to spatial changes in prey availability. Notable exceptions to this are Risso's dolphins and bottlenose dolphin.

The diet of Risso's dolphin in Scotland is dominated by cephalopods such as the octopus *Eledone cirrhosa* (MacLeod *et al.*, 2014). Cephalopod species are typically highly mobile and widely distributed, not tied to unique habitat types, and not sensitive to underwater noise, and therefore unlikely to be affected by construction activities. The coastal population of bottlenose dolphin specialises on salmon around the coast (e.g. at river mouths such as the Dee; Palmer *et al*., 2019; Quick *et al*., 2014; Cheney *et al*., 2013; Hastie *et al*., 2004). However, as described in EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, salmon are only likely to move through the Project Area during their pelagic migrations. Therefore, they are not tied to specific habitats and will continue to be able to move throughout the wider region in spite of any construction activities occurring. Any effects in the inshore environment, overlapping with the habitat of the CES MU population will be extremely spatially limited, of a short duration and typically reversible once the activity ceases. Therefore, there are no likely cumulative effects on salmon or cephalopods and, as a result, there is no anticipated change to this prey source for these cetaceans with more specialist dietary preferences.

Grey seals and harbour seals, on the other hand, forage close to their haul-out sites, particularly at certain times of year e.g. harbour seals during the breeding season, but range further outside of these spatially constrained periods. As an example, grey seals are known to travel >100 km from their breeding sites (Carter *et al.*, 2022). However, both seal species have general dietary preferences and are known to eat many species of fish and shellfish (Hammond and Wilson, 2016a, Hammond and Wilson, 2016b). The relative low importance of the Project Area to both grey and harbour seal species indicates that any disruption to prey resources due to the pre-construction and construction phase of the Project would have minimal consequences to their foraging ecology.

As detailed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, owing to the highly localised, short-term and temporary nature of works associated with the pre-construction and construction phase of the Project, it is considered that there is no potential for significant effects to fish and shellfish species which are considered to be prey for marine mammals. Therefore, given the adaptability of marine mammal species and the non-significant effect of pre-construction and construction works for fish and shellfish species, marine mammals are assessed as having low sensitivity to changes in prey resources during the construction phase of the Project.

For any potential effects to fish and shellfish species during the construction phase of the Project (i.e., as a result of underwater noise or an increase in SSC), effects will occur during a temporally constrained period over a highly localised scale and will be transient in nature. As detailed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, works associated with the construction phase of the Project will be subject to a series of embedded mitigation measures that will reduce the potential for effects to fish and shellfish receptors (including through the implementation of Project-specific management plans and the micro-siting of Project infrastructure to avoid areas of rare or important habitats (where possible)). Therefore, any potential effects to fish and shellfish species, which are considered prey to marine mammals are of a local spatial extent and reversible, even when considering the more constrained feeding tactics of seals at certain times of the year. The potential effect is therefore assessed as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity and the negligible magnitude of the effect, the overall effect to marine mammals due to changes in prey distribution linked with the construction activities is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

11.6.2 Potential effects during operation and maintenance

11.6.2.1 Injury and disturbance from underwater noise-generating activities

11.6.2.1.1 Potential effects of underwater noise from geophysical and geotechnical surveys

During the operation and maintenance phase, the windfarm will operate with minimum day-to-day intervention, however both scheduled and unscheduled monitoring and maintenance of the Export/Import Cable, the IACs and the FTUs will be required. Acoustic effects associated with monitoring surveys are anticipated to be less than those assessed during the construction phase (Section 11.6.1.1.3). Owing to the highly localised, short-term and transient nature of maintenance survey activities all marine mammal species likely to be present within the Project Area are considered to have a low sensitivity. Additionally, the localised and short-term effects of sound emissions during the operation and maintenance phase will only have the potential to affect marine mammals at an extremely localised scale. The potential effect is therefore assessed as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity and the low magnitude of the effect, the overall effect on marine mammals of underwater sound from geophysical and geotechnical surveys is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

11.6.2.1.2 Potential effects of operational underwater noise

During the operation and maintenance phase of the Project, the potential effects of operational sound emissions from the FTUs on marine mammal receptors are anticipated to be less than those anticipated during the construction phase of the Project. Operational sound associated with floating FTUs is primarily associated with turbine generated sound and short, transient signals ('pinging') due to the movement of mooring lines, due to the sudden change in tension in a mooring cable following a period of slackness during periods of significant water motion.

Burns *et al.* (2022) conducted a series of underwater noise measurements at floating OWFs (and control sites) at Hywind, Scotland. SPLs recorded correlated clearly with wind speed; the lowest derived broadband source level (5th percentile) of 156.7 dB re 1 μPa²m² occurred in 10 kt wind speed. The highest (95th percentile) was 172.0 dB re 1 μPa²m² at 25 kt wind speed. The dominant turbine-related tonal sound was measured at 24 Hz and 71 Hz, likely due to mechanical sound originating from the nacelle. This was then used to define a sound field across the array to determine the potential effect on marine mammals. It was found that a VHF cetacean such as harbour porpoise would need to stay within 50 m of a turbine throughout a full 24-hour period to accumulate sufficient energy for the onset of TTS, assuming 15 kt winds. This was the maximum TTS range calculated for all marine mammal groups (more details presented in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report). It is therefore concluded that auditory injury (i.e. PTS) is highly unlikely to occur. Operational sound generated by floating OWF structures at Kincardine and Hywind Scotland was measured and reported by Risch *et al.* (2022). At wind speeds of 15 m/s, operational sound levels equalled were reported to be higher at Kincardine than at Hywind: 148.8 dB re 1 μPa at Kincardine and 145.4 dB re 1 μPa at Hywind Scotland location. It was also noted that the predicted sound fields for unweighted SPLs were above the median ambient sound levels in the North Sea for a maximum of 3.5 km – 4.0 km from the centre of the Kincardine site and 3.0 km – 3.7 km from the centre of Hywind Scotland, noting that both sites are comprised of five turbines.

Transient mooring line sounds were analysed at Hywind in Norway and reported by Martin *et al.* (2011). This study concluded that received SPL_{peak} at a distance of 150 m was above 160 dB re 1 μPa. The frequency content of the transient sound events extended throughout the recorded frequency range of 0 Hz to 20 kHz. Between 0 – 23 of these transient sound events occurred per day throughout the survey and were thought to be related to tension releases in the mooring system. These data were further analysed as part of the Hywind Scotland EIA underwater noise assessment and found to be lacking in detail to determine a SEL from the measured SPL_{peak} values (Xodus Group, 2015). Through extrapolation of the data, the assessment presented a SPL_{rms} at 150 m of around 145 dB re 1 μPa (rms) and the SEL per "snap" was estimated to be 135 dB re 1 μPa^{2}s. The 23 events at one turbine were then extrapolated to a theoretical array and it was found that with up to 115 of these snapping events per day, the resultant potential cumulative SEL over a 24-hour period was 156 dB re 1 μPa^{2}s at 150 m from the turbines. This was a level below the onset criteria for impulsive sounds for injury to marine mammals based on the Southall et al. (2007) thresholds. These thresholds have since been updated and later studies have shown that the sounds generated by mooring systems were not strictly impulsive. Therefore, although the study provides a useful background, the applicability of these data to future projects is limited. Further measurements undertaken at both the Kincardine and Hywind Scotland sites report that transients were seen during periods of higher wind speeds and "significant wave height", although did not report what constituted as 'significant'. The energy of these transients was often seen to be distributed across the whole analysis bandwidth (10 Hz – 48 kHz) and were of short duration (one second or less) (Risch *et al.*, 2023). In terms of the number of events occurring, considerably more were observed at Kincardine than at Hywind Scotland although both sites showed great variability, with hundreds of transient events recorder per day. The kurtosis value at Hywind Scotland was shown to be similar between the two measurement locations, which indicates that the soundscape was comparable in terms of impulsiveness to that of vessel sound.

At present, evidence of disturbance to marine mammals as a result of mooring line pinging is limited. Southall *et al.* (2007) concluded that an underwater impulsive sound profile of 140 dB re 1 μPa (rms) would result in a mild behavioural response in marine mammals. However, taking into account recent evidence of non-impulsiveness of this type of underwater noise, continuous sound threshold of 120 dB re 1 μPa (rms) (NMFS, 2023) is more appropriate for the purposes of this assessment.

Due to the very limited range of underwater noise emitted by operational floating turbines studies to date, and low probability of marine mammals to experience injury or disturbance as a result of operational noise, all marine mammal species are considered to have a low sensitivity to potential effects of operational underwater noise during the operation and maintenance phase.

With consideration given to the highly localised spatial scale of potential effects (i.e., within the immediate vicinity of the Array Area), the potential for injury and disturbance from operational underwater noise to marine mammals is assessed as being of negligible magnitude.

Evaluation of significance

Taking the negligible sensitivity and the negligible magnitude of the effect, the overall effect on marine mammals of operational underwater noise is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

11.6.2.1.3 Potential effects of underwater noise from maintenance vessels

During the operation and maintenance phase, there will be a marginal, localised increase in the vessel presence and activity compared to baseline levels, with a maximum of 10 vessels on site at any given time during operation and maintenance works. Underwater noise generated by vessels associated with the operation and maintenance of the Project have the potential to result in an increase in disturbance to marine mammals through avoidance and displacement from the Project.

Reported broadband underwater noise levels for the CNS vary, depending on the frequency band, from median value of 98 dB re 1 µPa (frequency band 2 kHz – 16 kHz) to 107 dB re 1 µPa (frequency bands 20 – 160 Hz, 0.2 kHz – 1.6 kHz), which is moderate in comparison to other monitored areas of the North Sea (Basan *et al.*, 2024). Reported sound levels at low frequencies were positively correlated with AIS shipping activity (Basan *et al.*, 2024), which is most likely due to relatively high activity of cargo, fishing and oil and gas service vessels in the region. As presented within Section 11.6.1.1.4, vessel activity across the Project Area is moderate to high (detailed further within EIAR Vol. 3, Chapter 15: Shipping and Navigation). Therefore, the underwater noise emissions from a small number of daily movements of Project operation and maintenance vessels are not considered to result a significant increase in underwater noise when compared to existing baseline.

The operational life of the Project is 35 years. As detailed in EIAR Vol. 2, Chapter 5: Project Description, maintenance and inspection activities will be carried out on site using a number of different vessels (service operations vessel (SOV), CSV, anchor handler, construction vessel, CIV, and survey vessel). It is estimated that there will be a maximum of 10 vessels present at any time within the Project Area.

Given the number of Project maintenance vessels within the Project Area, the mobile, transient and temporary nature of any potential disturbance effect to marine mammals as a result of generated underwater noise is considered to be equal to or less than that expected as part of the construction and pre-construction phase (as presented within Section 11.6.1.1.4). Therefore, the assessment of sensitivity for each marine mammal species presented within Section 11.6.1.1.4 also applies to the assessment of potential effects during the operation and maintenance phase. All marine mammal species are therefore considered to have a low sensitivity to the transient disturbance from underwater noise generated by vessels related to operation and maintenance.

The Project undertook underwater noise modelling to assess effects of underwater noise due operational vessels sound emissions (EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report). Modelling results show that the potential of PTS exists only to harbour porpoise present within 59 m from the sound source and disturbance might be expected to occur for all marine mammals up to 3,337 m from the vessel. In addition to implementing the embedded mitigation measures outlined in Table 11-15, all operation and maintenance works and personnel will adhere to the best practice guidance and protocols outlined in Section 11.5.4. Due to the nature of works associated with the operation and maintenance phase, any underwater noise generated by Project maintenance vessels will be highly localised, short-term, and temporary in nature, and will not constitute a significant departure from baseline levels of shipping. Furthermore, it is considered that there is no potential for underwater noise emitted by maintenance vessels to result in a significant effect to marine mammal vital rates throughout both the Project and Regional Marine Mammals Study Area. Therefore, the risk of disturbance to marine mammals as a result of underwater noise generated by operation and maintenance vessels are assessed as being negligible magnitude.

Evaluation of significance

Taking the low sensitivity of marine mammals and the low magnitude of effect, the overall effect of underwater noise generated by operation and maintenance vessels is considered to be negligible and therefore not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible

Impact significance - NOT SIGNIFICANT

11.6.2.2 Long-term changes to prey resources

During the operation and maintenance phase of the Project, there is the potential for indirect effects to marine mammals through changes to prey resources. The assessment of potential effects to fish and shellfish species which are considered prey to marine mammals have been assessed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology. This fish and shellfish ecology assessment considers the following pathways for potential effects during the operation and maintenance phase:

- Long-term effects to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
- Underwater noise and vibration;
- Potential effects from EMF and heat generated by cables;

- Operational windfarms may act as a Fish Aggregation Device (FAD); and
- Secondary entanglement.

Key prey species for marine mammals considered within this assessment include clupeids (e.g., herring and sprat), gadoids (e.g., cod and whiting), sandeels and flatfish (Pierce *et al.*, 2004; Canning *et al.*, 2008; Tetley *et al.*, 2008; Jansen *et al.*, 2010; Evans and Hintner, 2013; Leopold *et al.*, 2018). Herring and whiting made up the majority of marine finfish within the fish and shellfish study area. The presence of nursery and/or spawning grounds of sprat, herring, cod, whiting, lemon sole, plaice, and sandeel were recorded within the fish and shellfish study area, although site-specific surveys determined that while the Project Area was considered mostly 'unsuitable' for herring and sandeel spawning. There is also potential for diadromous fish species to migrate through the Project Area, which could potentially be prey species for the coastal population of bottlenose dolphin (see EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology).

Fish and shellfish species, including prey species of marine mammals, were assessed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology as having a range of sensitivities (negligible to high) to the impact pathways listed above. Species reliant on the seabed, including sandeel, are considered to have a high sensitivity to habitat disturbance and loss, however the Project Area does not overlap with important sandeel or herring grounds, therefore the impact is defined as being not significant. Like marine mammals, there is potential for disturbance, injury, and mortality to fish as a result of underwater noise, and the assessment concluded an overall minor significance of effect. Potential effects as a result of EMF and heat generated by cables, and secondary entanglement, were assessed as negligible and not significant for all fish and shellfish species.

Floating structures and associated moorings have the potential to act as artificial reefs and FADs, which attract fish from other areas and group individuals together into a smaller area. The introduction of hard structures in the marine environment will likely become inhabited by marine organisms, creating new habitats and demonstrating an artificial reef effect. The installation of OWF foundations is generally followed by rapid colonization of a variety of fouling organisms that attract fish that feed on fouling biota or use the structures for shelter. The potential effect of the operational windfarm acting as an FAD was assessed as a minor effect which could have positive, negative, or neutral consequences and was not significant.

As detailed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, a series of primary (designed in) mitigation measures have been adopted for the Project in order to reduce the potential for effects to fish and shellfish receptors including through the micro-siting of Project infrastructure to avoid areas of rate or important habitats (where possible) and through reducing the spatial footprint of the Project on the seafloor as far as practicable (i.e., through the burial of the EICC and therefore reduced requirement for additional cable protection). Potential effects to fish and shellfish species are considered to occur over a highly localised spatial extent and of a negligible to low magnitude, and are considered not significant for all species.

With the exception of Risso's dolphin (cephalopod specialists; MacLeod *et al.*, 2014), marine mammals are considered to be generalist feeders. They use opportunistic predation methods for fish and shellfish species that are available at the time and are able to supplement their diet with other species should one prey be unavailable, making them resilient to changes in prey availability. As detailed in Section 11.6.1.2, marine mammals are highly mobile in nature and wide-ranging in their distribution, and therefore would be able to forage in alternative locations and find alternative prey within the marine environment outwith the direct spatial footprint of the Project. While Risso's dolphin are more specialist feeders, cephalopod species are typically highly mobile and not tied to unique habitat types, therefore likely to be found outside of the Project Area. Considering elements of marine mammal biology that make them resilient to these localised effects on prey populations, all marine mammal species are therefore considered to have a low sensitivity to changes to prey resources during the operation and maintenance phase.

Marine mammals may target marine infrastructure for foraging as these have the potential to act as artificial reefs and FADs, therefore increasing foraging opportunities in the area for marine mammals, as observed in the case of harbour seals making targeted trips to OWF areas (Russell *et al.*, 2014). In this sense, the resultant effect of the infrastructure could be beneficial to marine mammals. As there was no potential for a significant effect on fish and shellfish species (as detailed within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology), there is not expected to be an effect on marine mammals. Considering the high mobility of marine mammals in comparison to the localised nature of the effect and the potential benefit of FADs as a result of the presence of marine infrastructure, the potential effect of changes to prey resources for all marine mammals is assessed as being of low magnitude.

Evaluation of significance

Taking the low sensitivity of marine mammals and the low magnitude of effect, the overall effect of long-term changes to prey resources related to operation and maintenance is considered to be a minor, effect which could be positive, neutral or adverse, which is not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor

Impact significance - NOT SIGNIFICANT

11.6.2.3 Secondary entanglement

The potential for secondary entanglement to marine mammal species may arise as a result of animal entanglement within fishing gears and other marine debris which has fouled (snagged) on mooring lines and/or cables utilised by offshore infrastructure within the water column. Abandoned, Lost or Discarded Fishing Gear (ALDFG) is a recognised global issue, with fishing equipment entanglement on marine infrastructure presenting a potential pathway for injury and/or mortality of a range of marine species, including marine mammals. While commercial fisheries have a legal obligation to retrieve lost gear under the UK Fisheries Bill, it is acknowledged that it is not possible to retrieve all lost gear in every situation.

The potential for secondary entanglement only exists within the footprint of the Array Area where mooring lines and cables are present. As detailed within EIAR Vol. 2, Chapter 5: Project Description several types of mooring system are under consideration for the FTU semi-submersible floating substructure. It is anticipated that a maximum of nine mooring lines will be required per FTU of either semi-taut or tension design.

The potential effect of secondary entanglement could have severe consequences for marine mammal species (i.e. mortality). The risk of entanglement varies between species and depends on the nature of the material interacting with the animal, and the body size, movement and behaviour of the species in question. Key behavioural factors which influence the species-specific risk of entanglement include the ability to detect and avoid material within the water column (by vision or echolocation) and behaviours relating to the species' foraging ecology (e.g. consideration given to the depths and methods of foraging). Additionally, fish and other small animals which become entangled within debris have the potential to attract predators such as marine mammals, bringing them closer to the debris and increasing the risk of secondary entanglement. There is the potential for secondary entanglement to result in injury and/or mortality to small numbers of individual marine mammals, and the consequences of entanglement at the level of the individual could be fatal or injurious. Therefore, all marine mammals are considered to have a high sensitivity to secondary entanglement during the operation and maintenance phase.

To date, there have been no recorded instances of secondary entanglement of marine mammals associated with the mooring systems of offshore floating infrastructure (including marine renewable infrastructure and any anchored Floating Production Storage and Offloading (FPSO) or Floating Storage and Offloading (FSO) utilised by the oil and gas industry) (Benjamins *et al.*, 2014; OES, 2024). Moreover, fishing activity, within the ICES rectangle in which the Array Area sits (43F1), occurs at low levels and is dominated by demersal trawling for Nephrops. Low levels of demersal seine netting and pelagic trawling also take place. There is no reported gill or trammel netting within the ICES rectangles adjacent to the Array Area and lost nets from these fisheries are typically recovered in the location in which they were lost (Oliveira *et al.*, 2015). The risk of demersal trawl and seine nets being lost or fouled within the Array Area is exceptionally low due to the fact that these are weighted nets which are dragged along the seabed and would remain on the seabed, should they come loose or ensnare on something. Pelagic trawl nets are unweighted, but the scale and material used in these nets still makes them remarkably heavy and it is not anticipated that they would remain within the water column long enough to be carried by currents into the Array Area. Studies indicate that buoyant plastic fishing gear is a type of marine debris that poses a high risk of secondary entanglement and tends to remain near the surface Gilman *et al.*, 2021). The risk of secondary entanglement may therefore be highest in the first few meters of the water column close to floating platforms; however this type of fishing gear (set and fixed gillnets and trammel nets, drift gillnets) is not common within the waters surrounding Project Area, and these nets are not used near the Array Area. Additionally, safety zones around project infrastructure will prohibit fishing vessels from occupying areas where interactions with the array infrastructure could occur to generate ALDFG or marine debris.

The magnitude of the effect of secondary entanglement is dependent upon both the type of gear or debris which has fouled on Project infrastructure (including the thickness, length, and number of loops of the debris) and the behaviour of the individual animal which encounters the debris. However, entangling material on Project infrastructure is not anticipated to occur at a level that would be likely to impact the conservation status of any marine mammal species (i.e., impacts on a population level are not anticipated). As detailed within EIAR Vol. 2, Chapter 5: Project Description, to manage weight / drag-induced fatigue as a result of marine growth, Project infrastructure will be subject to routine inspection, maintenance and servicing of components in line with a pre-defined maintenance schedule. This will facilitate the detection and removal of any ALDFG. Taking above into account, the potential effect of secondary entanglement for all marine mammals is assessed as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity of marine mammals and the negligible magnitude of effect, the overall effect of secondary entanglement related to operation and maintenance is considered to be minor and therefore not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
High	Negligible	Minor

Impact significance - NOT SIGNIFICANT

11.6.3 Potential effects during decommissioning

Effects on Marine Mammal Ecology receptors associated with decommissioning are anticipated to result from the full removal of the Project components. Decommissioning activities will be subject to consultations and further assessments closer to the time of decommissioning to understand technical feasibility, safety and risk, and environmental considerations in detail. These details will be included in a Decommissioning Programme which will be developed post-consent and updated over the life of the Project.

The decommissioning of the Project intends to complete the full removal of offshore infrastructure to below the mudline (where safe/practicable to do so), in line with the OSPAR Convention and forthcoming guidance from OSPAR's North-East Atlantic Environmental Strategy 2030. The majority of decommissioning works are likely to be undertaken in reverse to the sequence of construction works and involve similar or lesser levels of effects to construction.

A Decommissioning Programme will be prepared prior to construction, in line with the requirements of Section 105 of the Energy Act 2004 (as amended) and any applicable guidance available at the time. Currently it is assumed that:

- FTU substructure and WTG components will be removed and towed to port;
- Mooring lines will be removed, and where possible piles will be removed or cut to a suitable distance below the mudline such that the upper portion is removed;
- Cables no longer required will be removed where safe to do so; where they cross live third-party assets, they may be cut and left in situ to prevent damage to third-party operations; and
- The OSCPs will be decommissioned and the jacket and topside(s) will be towed to shore. The piles will be cut a suitable distance below the mudline.

The sensitivities and effect magnitudes for decommissioning are considered to be comparable to those identified for the construction phase. Therefore, in the absence of detailed information regarding decommissioning works, the effects during the decommissioning of the Project are considered analogous with, or likely less than, those of the construction phase.

11.6.4 Summary of potential effects

A summary of the outcomes of the assessment of potential effects from the construction, operation and maintenance and decommissioning of the Project is provided in Table 11-41.

No significant effects on marine mammal receptors were identified. Therefore, mitigation measures in addition to the embedded mitigation measures listed in Section 11.5.4 are not considered necessary.

Table 11-41 Summary of potential effects

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Construction							
Injury and disturbance from underwater noise generating activities	Injury due to FTU pile driving	Harbour porpoise	Low	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		White-beaked dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
		Bottlenose dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Minke whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Grey seal	Low	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
		Humpback whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Killer whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Long-finned pilot whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
		Atlantic white-sided dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Short-beaked common dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Risso's dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	Disturbance due to pile driving (FTUs and OSCPs)	Harbour porpoise	Medium	Low	Minor	None required above existing embedded mitigation measures.	N/A
		White-beaked dolphin	Low	Medium	Minor	None required above existing embedded mitigation measures.	N/A
		Bottlenose dolphin	Low	High	Minor	None required above existing embedded mitigation measures.	N/A
		Minke whale	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
		Grey seal	Negligible	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
		Humpback whale	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
		Killer whale	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
		Long-finned pilot whale	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
		Atlantic white-sided dolphin	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
		Short-beaked common dolphin	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
		Risso's dolphin	Low	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
	Injury due to OSCPs pile driving	Harbour porpoise	Low	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		White-beaked dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Bottlenose dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
						JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	
		Minke whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Grey seal	Low	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Humpback whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
						JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	
		Killer whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Long-finned pilot whale	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Atlantic white-sided dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
						JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	
		Short-beaked common dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
		Risso's dolphin	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC piling guidelines will be followed to mitigate risk of injury to individuals.	N/A
	Injury due to UXO clearance	Minke whale Humpback whale	Medium	Low	Minor	None required above existing embedded mitigation measures.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
						JNCC UXO guidelines will be followed to mitigate risk of injury to individuals.	
		All other marine mammal receptors	Low	Low	Negligible	None required above existing embedded mitigation measures. JNCC UXO guidelines will be followed to mitigate risk of injury to individuals.	N/A
	Disturbance due to UXO clearance	All marine mammal receptors	Negligible	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
	Injury from geophysical and geotechnical surveys: SBP, 2D and 3D seismic surveys,	All marine mammal receptors	Medium	Negligible	Negligible	None required above existing embedded mitigation measures. JNCC geophysical survey guidelines will be adhered to for SBP to mitigate risk of injury to individuals.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	CPT and borehole drilling						
	Disturbance from geophysical and geotechnical surveys	All marine mammal receptors	Negligible	Negligible	Negligible	None required above existing embedded mitigation measures.	N/A
	Construction vessels	All marine mammal receptors	Low	Low	Negligible	None required above existing embedded mitigation.	N/A
Changes to prey distribution due to construction activities		All marine mammal receptors	Low	Negligible	Negligible	None required above existing embedded mitigation.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Operation and maintenance							
Injury and disturbance rom underwater noise-generating activities	Geophysical and geotechnical surveys	All marine mammal receptors	Low	Negligible	Negligible	None required above existing embedded mitigation. JNCC geophysical survey guidelines will be adhered to for SBP to mitigate risk of injury to individuals.	N/A
	Operational underwater noise	All marine mammal receptors	Low	Negligible	Negligible	None required above existing embedded mitigation.	N/A
	Maintenance vessel operations	All marine mammal receptors	Low	Negligible	Negligible	None required above existing embedded mitigation.	N/A
Long-term changes to prey resources		All marine mammal receptors	Low	Low	Low	None required above existing embedded mitigation.	N/A

POTENTIAL EFFECT	SOURCE OF EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Secondary entanglement		All marine mammal receptors	High	Negligible	Minor	None required above existing embedded mitigation.	N/A
Decommissioning							
The sensitivity of receptors and the magnitude of effects to marine mammal receptors concluded as part of the assessment of potential effects during the construction phase (Section 11.6.1) are also applicable to the decommissioning phase.							

11.7 Assessment of cumulative effects

11.7.1 Introduction

Potential impacts from the Project have the potential to interact with those from other projects (developments), plans and activities, resulting in cumulative effects on Marine Mammal Ecology receptors. The general approach to the cumulative effects assessment is described in EIAR Vol. 2, Chapter 7: EIA Methodology and in EIAR Vol. 4, Appendix 31: Cumulative Effects Assessment Methodology. Further detail relevant to the assessment of marine mammals is provided in EIAR Vol. 4, Appendix 17: Marine Mammals Cumulative Effects Assessment Screening. A quantitative assessment of cumulative underwater noise effects are presented in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report, which contains full detail of the assessments and has been summarised here. Outputs from the sound propagation modelling were used to estimate numbers of animals injured and disturbed by underwater noise emissions, and those numbers were used in marine mammal population modelling using the iPCoD framework. Full details of the iPCoD results can be found in EIAR Vol. 4, Appendix 18: Interim Population Consequences of Disturbance (iPCoD) Modelling Report.

Relevant projects (developments) selected for inclusion in cumulative assessment were initially screened based on distance from the Project, and anticipated timescales for construction. To define the zone of influence (ZoI), projects within 200 km (two times the maximum TTS range of 100 km for LF cetaceans, as derived from underwater noise propagation modelling; EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report and EIAR Vol. 3, Chapter 11: Marine Mammal Ecology) were selected and screened on the basis of the likelihood of cumulative effects. This process is described in more detail in EIAR Vol. 4, Appendix 17: Marine Mammal Cumulative Effects Assessment Screening. Of those windfarms within 200 km of the array area, only those with piling anticipated to occur within ± 1 year of piling at the Project were taken forward for the assessment (i.e. piling in the years 2030 – 2034), plus two cables projects (developments) at the early stages of planning. The relevant projects (developments) for inclusion within the cumulative effects in relation to the Project are presented in Table 11-42, and are shown in Figure 11-13.

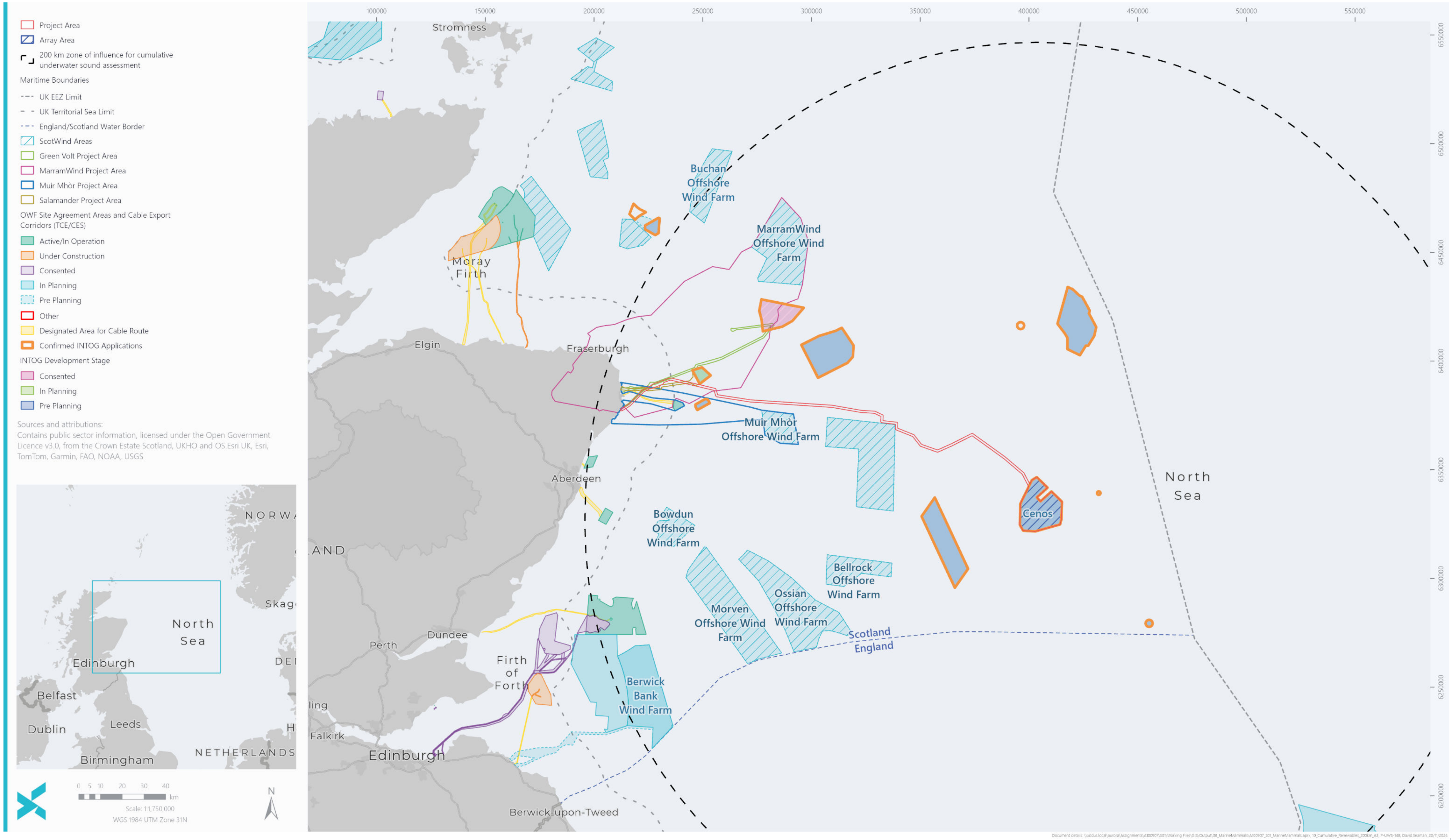

Figure 11-13 Map showing Cenos in relation to other OWF projects. Projects included in the cumulative assessment are labelled with their name and also listed in Table 11-42.

Table 11-42 List of developments considered for the marine mammal cumulative effect assessment

LOCATION	PROJECT TYPE	PROJECT NAME	DISTACE TO ARRAY AREA (km)	DISTACE TO EICC (km)	STATUS	CONFIDENCE[5]
United Kingdom	Offshore Wind	Berwick Bank Wind Farm	173.92	105.09	Application	Low
United Kingdom	Offshore Wind	Ossian Offshore Wind Farm	89.03	66.12	Application	Low
United Kingdom	Offshore Wind	Bowdun Offshore Wind Farm	145.13	47.49	Pre-Application (Scoping)	Low
United Kingdom	Offshore Wind	MarramWind	132.45	0	Pre-Application (Scoping)	Low
United Kingdom	Offshore Wind	Buchan Offshore Wind Farm	186.34	70.89	Pre-Application (Scoping)	Low
United Kingdom	Offshore Wind	Muir Mhòr Offshore Wind Farm	102.71	0	Application	Low
United Kingdom	Offshore Wind	Morven Offshore Wind Farm	120.82	67.10	Pre-Application (Scoping)	Low
United Kingdom	Offshore Wind	Bellrock Offshore Wind Farm	59.64	53.46	Pre-Application (Scoping)	Low
United Kingdom	Cable	Eastern Green Link 3	163.47	0	Pre-Application (Scoping)	Low

[5] Confidence ratings have been applied to each cumulative development where: 'Low' = pre-application or application, 'Medium' = consented and 'High' = under construction or operational.

The following effects have been taken forward for the cumulative effects assessment:

- Construction and decommissioning:
  - Underwater noise (auditory injury and disturbance); and
  - Changes to prey distribution.
- Operation and maintenance:
  - Injury and disturbance from underwater noise-generating activities;
  - Long-term changes to prey resources; and
  - Secondary entanglement.

11.7.2 Cumulative construction effects

11.7.2.1 Auditory injury to marine mammals

Although marine mammals are potentially sensitive to auditory injury affecting various ecological functions (e.g. feeding, communicating with conspecifics, predator awareness), the sensitivity of marine mammals found in the Study Area has been assessed as low or medium (depending on the specific species; Section 11.6.1.1.1).

Mitigation measures are required to be implemented during activities that generate high amplitude underwater noise, including geophysical survey (JNCC, 2017), UXO clearance (JNCC, 2023) and impact piling (JNCC, 2010), and therefore these measures can be considered to be embedded into project design through the implementation of and adherence to MMMP (EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol). As a result of strict adherence to the measures within the JNCC guidelines, which will be in place for all developments screened into the cumulative assessment (Table 11-42), auditory injury effects on marine mammal species will be reduced to as low as reasonably practicable. Therefore, the magnitude of the cumulative effect on all marine mammal species will be negligible. The embedded mitigation which will be employed by the Project and all other developments within the ZoI, will essentially eliminate the risk of injury to marine mammals. Considering this, the overall cumulative effect of auditory injury to marine mammals is negligible and not significant in EIA terms.

11.7.2.2 Disturbance to marine mammals

iPCoD modelling was carried out to assess disturbance to marine mammals due to cumulative piling activities (EIAR Vol. 4, Appendix 18: Interim Population Consequences of Disturbance (iPCoD) Modelling Report). The worst-case scenario from the Project-alone assessment was the basis for the iPCoD piling scenario, i.e., the predicted effects from OSCPs piling plus semi-submersible anchor piling for the FTUs. For the three species carried through the iPCoD model (harbour porpoise, minke whale and grey seal), one day of residual disturbance was selected, to allow optimal comparability with other OWF assessments. This provides a suitably precautionary approach that demonstrates a reasonable worst-case for predicted effects from windfarm construction at the Project and a range of other developments in the ZoI, following the approach agreed with NatureScot at the Marine Mammal Consultation Meeting on 2nd October 2024 (Section 11.3).

Four effects of underwater noise were excluded from the iPCoD modelling:

- Auditory injury due to piling was not included as an additional impact pathway in the modelled cumulative assessment of disturbance (see Section 11.7.2.1). This is because of the embedded mitigation in the Project design which result in a very small (<1 individual) risk of auditory injury (PTS) from impact piling. As these embedded measures (implemented through strict adherence to an approved MMMP (EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol)) will be in place for all projects screened in to the cumulative assessment, auditory injury effects on marine mammal species will be reduced to as low as reasonably practicable.
- Auditory injury or disturbance from UXO clearance was not included as an additional impact pathway in the modelled cumulative assessment of disturbance. This is because there is a presumption that all UXO clearance operations will employ mitigation (avoidance) and low-noise methods of clearance to minimise sound emissions, in line with the joint position statement on UXO clearance (UK Government, 2022), and thus reducing likelihood of auditory injury as low as reasonably practicable (see Section 11.7.2.1). Additionally, in line with the justification presented in Section 11.6.1.1.2.2, significant behavioural disturbance resulting from isolated pulses of sound as generated during UXO clearance is not likely.
- Auditory injury or disturbance from geophysical surveys was not included as an additional pathway in the modelled cumulative assessment of disturbance. This is because the embedded mitigation would reduce auditory injury effects on marine mammals to negligible levels (Section 11.6.1.1.3.1.1), and as described in Section 11.6.1.1.3.1.2, any disturbance effects associated with geophysical and geotechnical surveys will be highly localised in scale, short-term and transient in nature, therefore significant behavioural disturbance is very unlikely.
- Auditory injury or disturbance from vessels was not included as an additional pathway to the modelled cumulative assessment of disturbance. In line with the justification presented in Section 11.6.1.1.4, potential effects of underwater noise from construction vessels are considered to be temporary in nature, with no potential for significant impact on marine mammals population levels. Considering the embedded mitigation and adherence to an MMMP (EIAR Vol. 4, Appendix 33: Outline Marine Mammal Mitigation Protocol), disturbance from vessels will be reduced to as low as reasonably practicable.

Therefore, the only activity which was included in the cumulative iPCoD scenarios was disturbance to marine mammals from impact piling. This captured OSCPs and FTU anchor piling at the Project, and FTU monopile/pin pile/anchor pile installation at the other OWF projects listed in Table 11-42.

The piling season for all projects considered cumulatively was assumed to be the same as for Project-alone modelling (1st April to 30th September in each year of piling), and piling was assumed to be performed on a 75% duty cycle (i.e. on 23 days per month) to account for operational delays, again in alignment with the piling parameters for the project-alone scenario. Other iPCoD parameters were kept consistent with the Project-alone assessment, as described in detail in EIAR Vol. 4, Appendix 18: Interim Population Consequences of Disturbance (iPCoD) Modelling Report.

Where available, the data for the iPCoD modelling for projects included in the cumulative assessment were obtained from publicly available project-specific data sources, (e.g. the Berwick Bank Wind Farm EIA; SSE Renewables, 2022). However, for the majority of projects included in the cumulative assessment for piling sound, detailed data were not available, and so EDRs as presented in (JNCC, 2020a) were used to estimate the number of individuals that would be disturbed by piling operations. Expert judgment and knowledge of project parameters from scoping reports was used to define an appropriately realistic worst-case scenario, e.g. number of days of piling, whether monopiles (26 km EDR) or pin/anchor piles (15 km EDR). The area of disturbance (based on EDR) was multiplied by the species-specific density as presented in individual EIARs or taken from SCANS IV (Gilles *et al.*, 2023) or seal densities from Carter *et al.* (2022) to estimate the number of individuals that would be disturbed per day. The numbers of individuals disturbed, that were used in iPCoD modelling, are shown in Table 11-43.

Table 11-43 Details of piling used for assessment in cumulative modelling. NA indicates project-specific values available for number of animals disturbed per day, otherwise, EDR was used to calculate number deterred.

Project	Animal density			Number animals disturbed per day			Max number of turbines	Number of days piling per turbine	Total number of piling days
	HP	MW	GS	HP	MW	GS			
Berwick Bank Wind Farm [a]	NA	NA	NA	2815	132	1940	307	2	614
Bowdun OWF	1.0398	0.0419	0.012	2209	89	26	67	1	67
Buchan OWF	1.0398	0.0419	0.012	735	30	9	70	2	140
MarramWind OWF	1.0398	0.0419	0.012	2209	89	26	225	1	225
Muir Mhòr OWF	1.0398	0.0419	0.012	735	30	9	67	2	134
Ossian OWF	0.651	0.028	0.18	461	20	128	270	2	540
Bellrock OWF	1.0398	0.0419	0.012	2209	89	26	80	1	80
Morven OWF	1.0398	0.0419	0.012	2209	89	26	191	1	191

[a] Numbers of animals disturbed during piling operations at Berwick Bank Wind Farm were taken directly from the EIA (SSE Renewables, 2022), and were not calculated using the EDR approach used for other projects.

11.7.2.2.1 Harbour porpoise

The iPCoD modelling results for disturbance to harbour porpoise from cumulative pile driving are summarised in Table 11-44.

Table 11-44 Summary of the cumulative results of iPCoD modelling for harbour porpoise

SPECIES	SIMULATION YEAR	UN-IMPACTED MEAN POPULATION SIZE	IMPACTED MEAN POPULATION SIZE	IMPACTED AS % OF UN-IMPACTED POPULATION SIZE	MEDIAN RATIO IMPACTED UN-IMPACTED GROWTH RATE
Harbour porpoise	Population after 1 year	159,381	158,749	99.60%	0.997
	Population after 6 years	160,034	156,628	97.87%	0.981
	Population after 12 years)	160,247	156,910	97.92%	0.980
	Population after 25 years	161,018	157,669	97.92%	0.983

Results indicate, that after an initial decline during the years of piling at the Project cumulative with other OWF projects, the harbour porpoise population size is predicted to remain fairly constant throughout the simulation, with the impacted population estimated to remain at a slightly lower size than the unimpacted population but following a similar trend (Figure 11-14). The results in Table 11-44 show that after 25 years, the impacted population is 97.92% of the unimpacted population. This equates to approximately 161,000 animals and 158,000 animals for the unimpacted and impacted populations, respectively. As can be observed in the results in Table 11-44, both unimpacted and impacted populations are predicted to increase slightly after the initial piling impacts. As can be seen in Figure 11-14, the magnitude of stochastic variability around the unimpacted and impacted population means is far greater than the magnitude of population change resulting from the cumulative impacts of piling.

The results of the iPCoD modelling show a change of -2.1%, it is not anticipated that this level of disturbance would have a major effect on the conservation status of the harbour porpoise population of the NS MU. Taking into account above, the magnitude of effect on the harbour porpoise population due to cumulative scenario is considered to be of low.

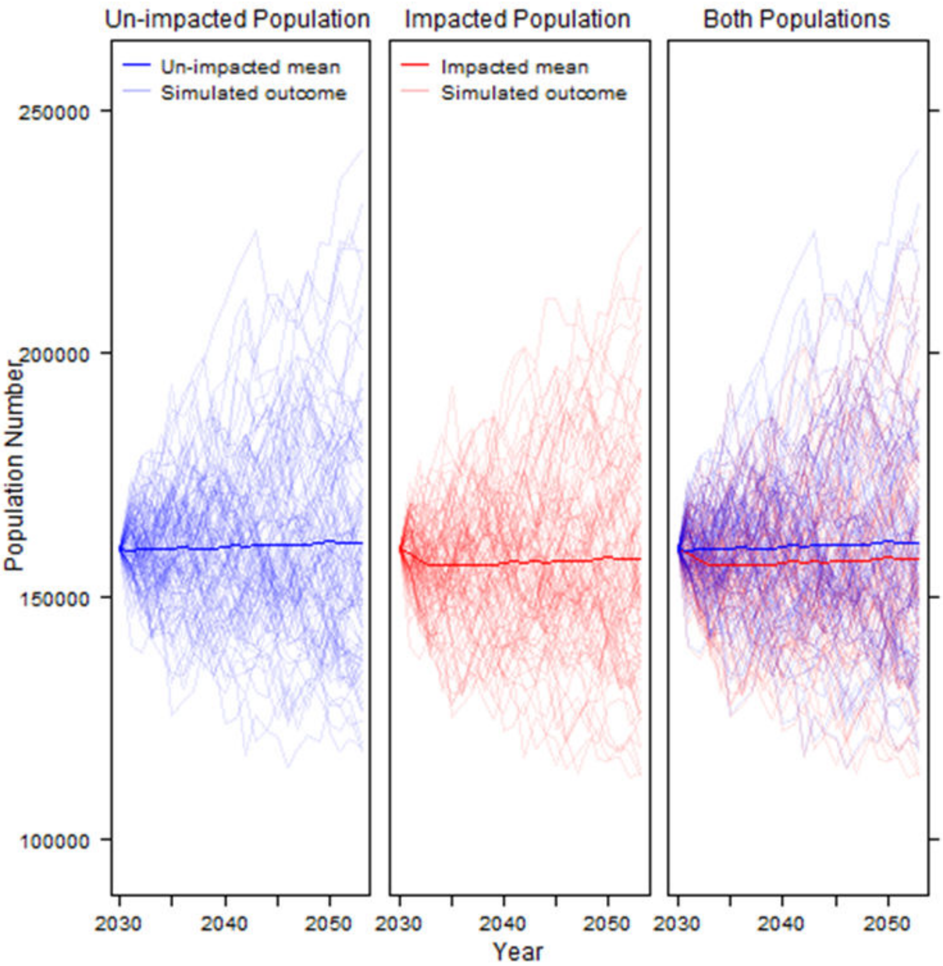

Figure 11-14 Population trajectory for impacted and unimpacted harbour porpoise populations resulting from the cumulative piling scenario with one day of residual disturbance

11.7.2.2.2 Minke whale

The results for minke whale show that the population during piling is stable as presented in Figure 11-15. After 25 years, it is predicted the impacted population will be around 99.99% of the unimpacted population size (Table 11-45).

Table 11-45 Summary of the cumulative iPCoD modelling results for minke whale

SPECIES	SIMULATION YEAR	UN-IMPACTED MEAN POPULATION SIZE	IMPACTED MEAN POPULATION SIZE	IMPACTED AS % OF UN-IMPACTED POPULATION SIZE	MEDIAN RATIO IMPACTED UN-IMPACTED GROWTH RATE
Minke whale	Population after 1 year	10,301	10,301	100%	1.000
	Population after 6 years	10,309	10,306	99.97%	1.000
	Population after 12 years	10,301	10,300	99.99%	1.000
	Population after 25 years	10,318	10,317	99.99%	1.000

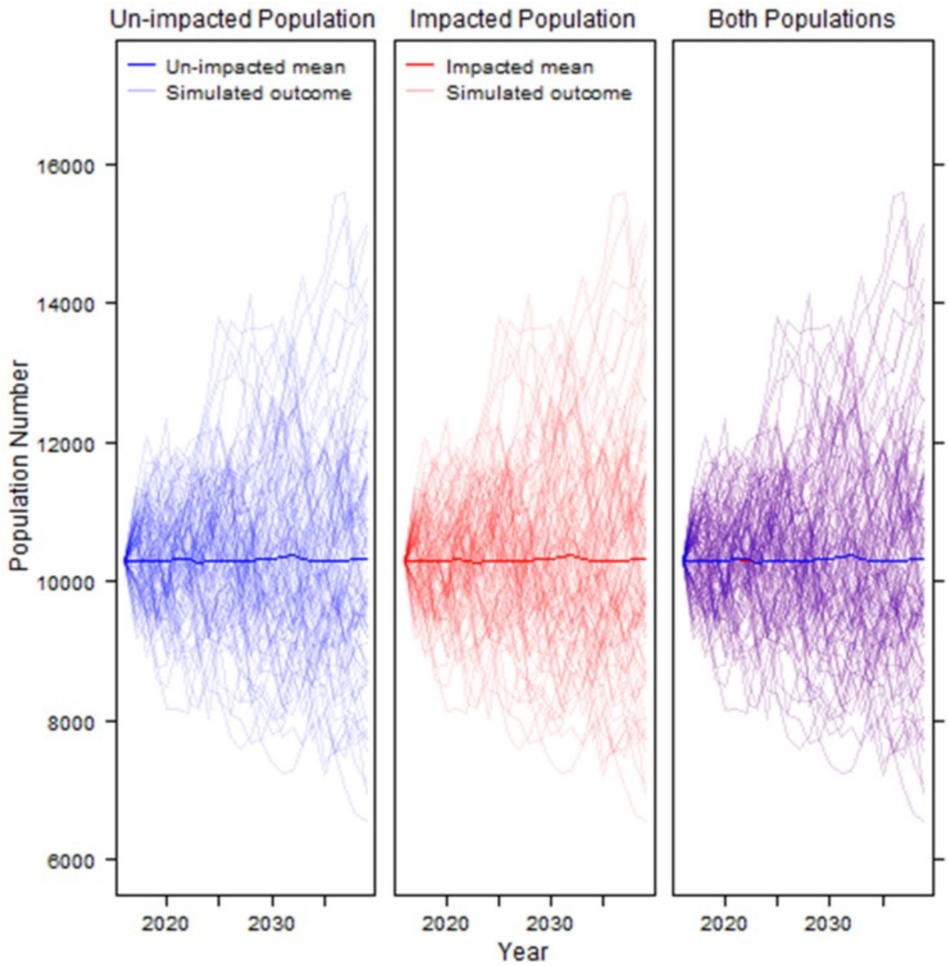

Figure 11-15 Population trajectory for impacted and unimpacted minke whale populations due to cumulative piling and one day of disturbance

The UK population is predicted to be one individual smaller after a 25-year modelled scenario. This difference equates to a predicted reduction of <0.01% from the predicted unimpacted population. Given these modelling results in relation to the UK proportion of the MU population, the magnitude of effects on the minke whale population due to cumulative scenario is considered to be negligible.

11.7.2.2.3 Grey seal

iPCoD modelling suggests that after 25 years, unimpacted grey seal populations will increase from around 2,700 animals to over 3,400 animals (Table 11-46). The modelling estimates that cumulative effects will cause the impacted population to increase at a slower rate, initially, than the unimpacted population (Figure 11-16) due to the cumulative effects of disturbance due to piling. The impacted population is estimated to be 98.7% of the unimpacted population after 25 years (Table 11-46).

Table 11-46 Summary of the cumulative iPCoD modelling results for grey seal

SPECIES	SIMULATION YEAR	UN-IMPACTED MEAN POPULATION SIZE	IMPACTED MEAN POPULATION SIZE	IMPACTED AS % OF UN-IMPACTED POPULATION SIZE	MEDIAN RATIO IMPACTED UN-IMPACTED GROWTH RATE
Grey seal	Population after 1 year	2,734	2,726	99.71%	0.997
	Population after 6 years	2,880	2,841	98.65%	0.985
	Population after 12 years)	3,054	3,014	98.69%	0.989
	Population after 25 years	3,469	3,424	98.70%	0.989

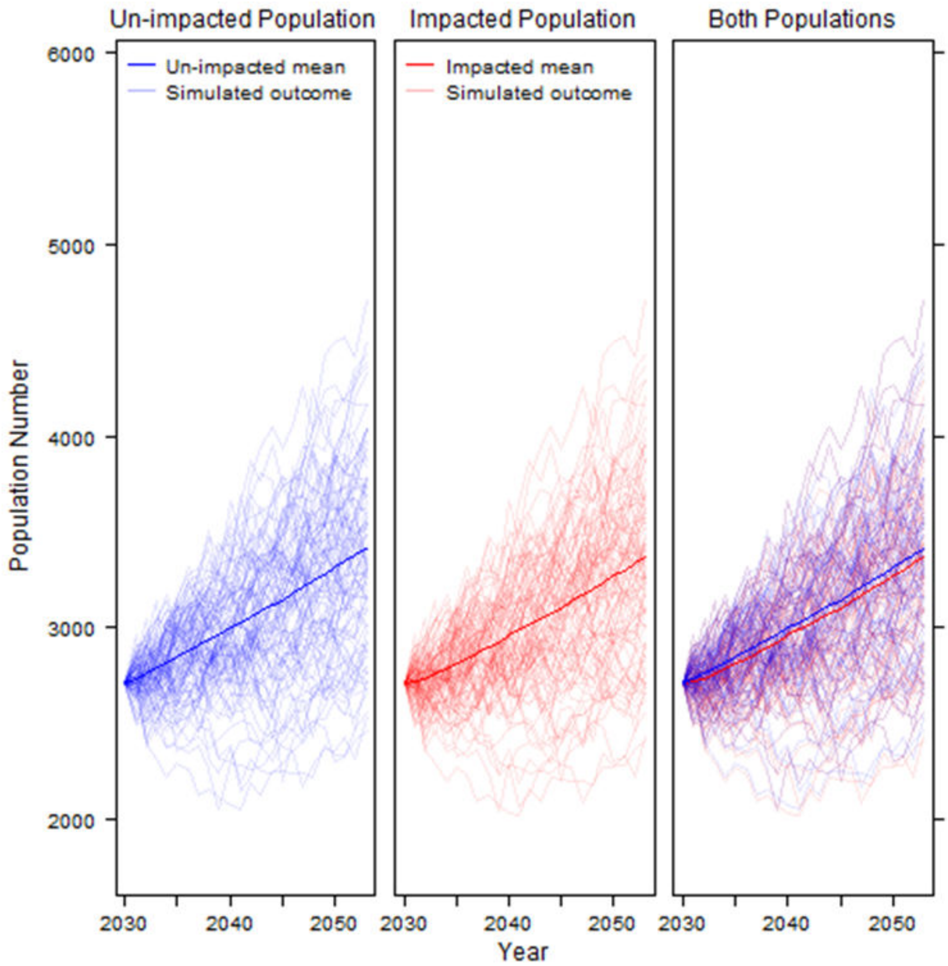

Figure 11-16 Population trajectory for impacted and unimpacted grey seal populations due to cumulative piling and one day of disturbance

The results of the iPCoD modelling show that there is no effect of disturbance resulting from the cumulative scenario on the trajectory of the grey seal population. Although a change of -2.28% on a population level will occur it is not anticipated that this level of disturbance would have a major effect on the conservation status of grey seals. Therefore, the magnitude of the effect on the grey seals population due to construction of Cenos FTUs is considered to be low.

It should also be noted that this magnitude of effect is based applying an EDR defined for harbour porpoise to the grey seal density (Carter *et al.*, 2022), to obtain a number of grey seals likely to be disturbed. Grey seals are not considered to be as aversive, and not likely to experience significant disturbance at the same distance from piling activity as the harbour porpoise EDRs, especially when the incentive to be in a certain location is strong (Aarts *et al.*, 2017). This is therefore considered a very precautionary approach, and the magnitude of this effect on the grey seal population is likely, in reality, to be much lower.

11.7.2.2.4 Harbour seal

Harbour seal was not assessed using iPCoD with respect to disturbance from sound emissions from piling, due to the distance of the piling operations from the typical coastal distribution of harbour seals (Carter et al., 2022), the range over which sound levels had the potential to disturb marine mammals, and the very low predicted density of harbour seals within this offshore area with the potential for a significant disturbance effect (Carter *et al.*, 2022). The magnitude of effect on harbour seal has therefore been assessed as negligible.

11.7.2.2.5 White-beaked dolphin and bottlenose dolphin

Due to the absence of data, cumulative iPCoD modelling could not be carried out for white-beaked dolphin. Applying the same precautionary approach to magnitude scoring as for the Project-alone disturbance assessment, it can be assumed that the effects of the cumulative scenario is of medium magnitude for white-beaked dolphin.

Although the iPCoD documentation does contain parameters for bottlenose dolphin, these have been derived for the coastal population which occupies the CES MU, and not the offshore population of the GNS MU where the Project is located and where effects will be experienced, so the model was not used to assess the effects on this population. Because the population size of the GNS MU is relatively small, and the potential disturbance per day of piling in the cumulative scenario could be several hundred individuals per day, the magnitude of this effect on the bottlenose dolphin population is considered to be high.

11.7.2.2.6 Other species

As described in Section 11.4.4.2 several other cetacean species could be present in the vicinity of the Array Area, however these other species are likely to occur at lower densities than those described in more detail above.

These species include LF cetaceans (i.e. humpback whale) and HF cetaceans (killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, Risso's dolphin). There are very limited data on each of these species with respect to their sensitivity to behavioural disturbance due to sound emissions from impact piling, and there are no parameters with which to assess population consequences of disturbance due to sound emissions from piling using the iPCoD framework. Nevertheless, as a precautionary assessment, it can be considered that these species share similar sensitivity to disturbance as the species described in more detail above. Therefore, humpback whale, killer whale, long-finned pilot whale, Atlantic white-sided dolphin, short-beaked common dolphin, and Risso's dolphin are likely to be of low sensitivity to disturbance from piling sound. As these species are all considered to occur scarcely in the vicinity of the Array Area, and at such low densities, while noting the scale of their respective MU (where applicable), the magnitude of cumulative effect on the populations of these species is considered to be negligible.

Taking the negligible to medium sensitivity and the negligible to high magnitude of the effect due to FTU and OSCPs piling for all species, the overall effect on marine mammals from disturbance caused by cumulative piling scenario during construction is considered to be minor or negligible and not significant in EIA terms.

11.7.2.3 Changes to prey distribution

The cumulative ZoI attributed to marine mammals has been selected as 200 km, based on the outcome of the sound propagation modelling results. However, with regards to prey distribution, this cumulative effects assessment and the assessment for the Project alone (in Section 11.6.1.2), are largely based on the outcomes of the assessment within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology. As any changes to marine mammal prey distribution will be dependent on potential effects to fish and shellfish distributions, developments considered cumulatively herein are within 60 km of the Project (i.e. the cumulative ZoI used within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology).

On this basis, the following developments from Table 11-42 are considered cumulatively within this impact pathway: Bowdun OWF; MarramWind (array and cable); Muir Mhòr Wind Farm, Bellrock; and Eastern Green Link (EGL) 3.

Ultimately, the assessment within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology found that all effects were, at most, minor (not significant). This suggests that the Project activities alone would not have a significant impact on the distributions, presence, and availability of habitat for any of the fish and shellfish species known to occur within the Project Area. In cumulative terms, the effects on fish and shellfish were also all negligible or minor (not significant). This is largely on account of the localised effects of disturbance to all fish and shellfish receptors which have extensive available habitat throughout the marine environment of the central and NNS. Despite overlapping timelines of construction between the Project and the other developments listed above, the effects associated with construction will be temporally limited and therefore recovery of habitats is expected such that changes to prey (i.e. fish and shellfish) distributions are minimal. Consequently, this effect is judged to be of negligible magnitude.

With respect to marine mammals which prey on fish and shellfish species, as described in Section 11.6.1.2, they are highly mobile in nature and wide-ranging in their distribution. The availability of prey within the marine environment, and marine mammals' ability to move to exploit foraging opportunities across wide ranges (especially when compared against the scale of their MUs) will not be impeded by the construction of the Project and any other developments being undertaken concurrently. Nor are there likely to be any long-term changes to the habitats of prey species due to the presence of infrastructure (see Section 11.6.2.2). Marine mammals are typically generalist species and exhibit flexibility in their diets, therefore will be able to exploit alternative areas as required over the course of any construction activity.

Notable exceptions to this are Risso's dolphin (which are cephalopod specialists, MacLeod *et al.*, 2014) and bottlenose dolphin. With regards to cephalopods, these species are typically highly mobile, not tied to any unique habitat types, not sensitive to underwater noise and therefore unlikely to be affected by construction activities. The coastal population of bottlenose dolphin specialises on salmon around the coast (e.g. at river mouths such as the Dee; Palmer *et al.*, 2019; Quick *et al.*, 2014; Cheney *et al.*, 2013; Hastie *et al.*, 2004). However, as described in EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, salmon are only likely to move through the Project Area during pelagic migrations. Therefore, they are not tied to specific habitats and will continue to be able to move throughout the wider region in spite of any construction activities occurring. Any effects in the inshore environment, overlapping with the habitat of the CES MU population will be extremely spatially limited, of a short duration and typically reversible once the activity ceases. Therefore, there are no likely cumulative effects on salmon or cephalopods and, as a result, there is no anticipated change to this prey source for these cetaceans with more specialist dietary preferences.

Seals do exhibit general dietary preferences but are known to eat many species of fish and shellfish (Hammond and Wilson, 2016a, Hammond and Wilson, 2016b). Overall, the Study Area is considered to be of relatively low importance to both grey and harbour seal species, particularly compared to other regions such as the North Coast and Orkney (grey seal) and the Western Isles (harbour seal). This can be extrapolated further to suggest that the other cumulative developments (within 60 km of the Project) are also not located in areas of considerable importance to either species. Therefore, any temporary disruption to prey resources due to the construction phase of the Project acting cumulative with other developments would have minimal consequences to their foraging ecology.

Owing to the relative flexibility of marine mammal diets, this receptor group as a whole is considered to be of low sensitivity to changes in prey distribution.

Overall, the effects associated with the other developments will be intermittent, temporary and are not likely to enhance or increase the effect of the Project alone. Therefore, the cumulative effect remains consistent with the assessment for the Project in isolation. Changes to prey distribution are assessed to be negligible and not significant in EIA terms.

11.7.3 Cumulative operation and maintenance effects

11.7.3.1 Injury and disturbance from underwater noise-generating activities

Over the course of the operational phase of the Project, and that of the other developments listed within Table 11-42, underwater noise may be generated as a result of geophysical and geotechnical surveys, the operation of the FTUs, and the presence of monitoring and maintenance vessels. All, or some, of these activities will be common to the other developments within Table 11-42. Therefore, all of the developments listed in Table 11-42 are considered within the scope of this cumulative assessment pathway.

During the operational phase of the Project and other developments, windfarms are intended to operate with minimal day-to-day intervention. Therefore, monitoring and maintenance activities will be relatively infrequent and limited in duration. Any sound emissions during the operation and maintenance phase will only have the potential to affect marine mammals at an extremely localised scale. The assessment for the Project alone concluded that, due to the highly localised, short-term and transient nature of maintenance survey activities the potential effect was assessed as being of negligible magnitude.

While the schedule of any geophysical and / geotechnical survey activity for any of the other developments in Table 11-42 is not known, it is assumed that there will be a requirement for such activities as part of some, if not all, of these developments. However, like for the Project alone, these activities are expected to be short-term and transient. Therefore, it is not expected that there will be any material increase in underwater noise to marine mammals as a result of these activities should they occur concurrently across all the developments.

With regards to sound generated by operational FTUs, Section 11.6.2.1.2 determined that a VHF cetacean (e.g. harbour porpoise) would need to be within 50 m of a turbine over a 24-hour period in order for the TTS threshold to be exceeded (per the findings of EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report). Given the mobility of marine mammals, it is highly unlikely that they would remain within such close proximity of an operational turbine to the extent that any effects would be felt by the individuals. The magnitude of the effect of this sound was considered to be negligible for the Project alone. In cumulative terms, the other developments listed in Table 11-42 which have array areas (and therefore turbines) are sufficiently far from the Project such there is no potential for overlap in the sound generated between developments (given how highly localised the sound emissions will be). Therefore, the opportunity for potential cumulative disturbance effects of underwater noise as generated by operational infrastructure is negligible, and any risk of auditory injury is scoped out.

Lastly, as described in Section 11.6.2.1.3 and in EIAR Vol. 3, Chapter 15: Shipping and Navigation, the predicted vessel presence over the operational life of the Project is anticipated to represent an insignificant change from baseline shipping levels. Therefore, the number of vessels is expected to be similar to baseline vessel presence. The magnitude of effect associated with underwater noise as generated by operational vessel presence for the Project alone is considered to be negligible, and any risk of auditory injury is scoped out.

Of the developments in Table 11-42, the other windfarm developments are of a similar or smaller scale. Given the limited number of Project maintenance vessels within the Project Area (maximum of 10 vessels simultaneously), and the equivalent vessels likely to be present in association with the other developments in the area, the potential disturbance effect to marine mammals as a result of generated underwater noise is considered to be minimal. Certainly, the underwater noise generated during the operational phase of developments will be equal to or less than that expected as part of the construction and pre-construction phase. Furthermore, the limited vessels will be infrequently present and are likely to be dispersed over a wide area. Over the operational life of the Project and that of the other developments, the presence of the maintenance vessels is unlikely to contribute significantly to background levels of shipping. Consequently, the effect on marine mammals will be indiscernible from background levels of sound.

Accounting for all of the above operational sources of sound (geophysical and geotechnical surveys, the operation of the FTUs, and the presence of maintenance vessels), the combined cumulative magnitude of effect is considered to be low magnitude. This is conservative in spite of these sound sources all being limited in spatial extent and temporary in duration. This also represents an increase in magnitude compared against the Project alone assessment.

Due to the very limited and transient range of underwater noise emitted by these sources, and the very low probability of marine mammals to experience injury or disturbance as a result of operational sound, all marine mammal species are considered to have a low sensitivity to potential effects of operational underwater noise during the operation and maintenance phase.

Evaluation of significance

Taking into account the low sensitivity of marine mammals to operational underwater noise and the medium magnitude of cumulative effect, the overall consequence to marine mammals is minor and therefore not significant.

11.7.3.2 Long-term changes to prey resources

As with changes to prey distribution during the construction period (Section 11.7.2.3), this effect closely corresponds to the assessment undertaken within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology. Therefore, as before, only developments within 60 km of the Project are considered cumulatively herein.

As stated in Section 11.6.2.2, floating structures and associated moorings have the potential to act as artificial reefs and FADs, which attract fish from other areas and group individuals together into a smaller area. The introduction of hard structures in the marine environment will likely become inhabited by marine organisms. In cumulative terms, any of the developments within 60 km of the Project and listed in Table 11-42 which involve installation of infrastructure are relevant to the assessment here.

There are, at present, limited details available on the physical footprints associated with other nearby developments (Bowdun Offshore Wind Farm, MarramWind Offshore Wind Farm and export cable, Muir Mhòr Offshore Wind Farm, Bellrock Offshore Wind Farm, and Eastern Green Link 3); however, as concluded in EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, the potential areas of artificial reef or fish aggregation will be localised to discreet areas around installed infrastructure and associated protection measures. Ultimately, the cumulative effect magnitude is deemed to be consistent with that of the Project alone assessment – the effect is of low magnitude.

Generally, further research is needed to better understand whether this fish aggregation effect represents a redistribution of existing biomass, or higher productivity in the vicinity of FTUs. While the artificial reef effect might increase foraging opportunities in the area for marine mammals, as evidenced by harbour seals making targeted trips to OWF areas in Scotland (Russel *et al.*, 2014), this is likely to have a very localised effect within the context of the wider CNS or at the scale of marine mammal MUs. Furthermore, there is the potential for this to be seen as a positive effect, rather than adverse. As discussed in more detail in Section 11.7.2.3, marine mammals are judged to be of low sensitivity to long-term changes to prey resources as a result of the operational Project in combination with other developments.

Overall, the effects associated with the other developments will occur at a highly localised scale, and are not likely to enhance or increase the effect of the Project alone. Therefore, the cumulative effect remains consistent with the assessment for the Project in isolation. Changes to prey distribution are assessed to be a minor (positive, neutral or adverse) effect and not significant in EIA terms.

11.7.3.3 Secondary entanglement

As discussed in Section 11.6.2.3, secondary entanglement could have severe consequences for marine mammal species (i.e. mortality). This risk exists in relation to all projects in the list described in Table 11-42.

Although the risk of secondary entanglement varies considerably between species, as a precautionary approach all marine mammal species are considered to have a high sensitivity to secondary entanglement at the level of the individual, during the operation and maintenance phase (see Section 11.6.2.3 for details).

To date, there have been no recorded instances of secondary entanglement of marine mammals associated with the mooring systems of OWFs or mooring systems from other industries (Benjamins *et al.*, 2014; OES, 2024). The risk of demersal trawl and seine nets (which are used in the ZoI) being lost or fouled within the Array Area is exceptionally low due to the fact that these are weighted nets which are dragged along the seabed and would remain on the seabed, should they come loose or ensnare on something. Pelagic trawl nets are unweighted, but the scale and material used in these nets still makes them remarkably heavy and it is not anticipated that they would remain within the water column long enough to be carried by currents to snag on other infrastructure. Studies indicate that buoyant plastic fishing gear is a type of marine debris that poses a high risk of secondary entanglement and tends to remain near the surface Gilman *et al.*, 2021). The risk of secondary entanglement may therefore be highest in the first few meters of the water column close to floating platforms; however, this type of fishing gear (set and fixed gillnets and trammel nets, drift gillnets) is not common within the waters surrounding Project Area and these nets are not used near the Array Area. Additionally, safety zones around Project infrastructure, and that of other OWF projects, will reduce the risk of fishing vessels from occupying areas where interactions (e.g. snagging of fishing gear) with infrastructure could occur.

The magnitude of the effect of secondary entanglement is dependent upon both the type of gear or debris which has fouled on Project infrastructure (including the thickness, length, and number of loops of the debris) and the behaviour of the individual animal which encounters the debris. As OWF projects have a responsibility and requirement to inspect, monitor and maintain their infrastructure (e.g. video surveys for marine growth on substructures) the presence of ALFDG would be observed on a regular basis. However, as stated above, the likelihood of this occurring is very low. Taking above into account, the potential magnitude of cumulative secondary entanglement for all marine mammals is assessed as being negligible. Considering the high sensitivity of marine mammals and the negligible magnitude of effect, the overall effect of secondary entanglement related to operation and maintenance is considered to be minor and therefore not significant in EIA terms.

11.7.4 Cumulative decommissioning effects

The decommissioning of the Project intends to complete the full removal of offshore infrastructure to below the mudline (where safe/practicable to do so). The majority of decommissioning works are likely to be undertaken in reverse to the sequence of construction works. However, there is limited information on the details around decommissioning of the Project and around the lifecycle of other developments. Considering this, it is assumed that decommissioning involves similar or lesser levels of effects to construction.

A Decommissioning Programme will be prepared prior to construction, in line with the requirements of Section 105 of the Energy Act 2004 (as amended) and any applicable guidance available at the time.

11.7.5 Summary of cumulative effects

A summary of the outcomes of the assessment of cumulative effects for the construction, operation and maintenance and decommissioning phases of the Project is provided in Table 11-47.

Table 11-47 Summary of assessment of cumulative effects

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Construction						
Auditory injury to marine mammals	Harbour porpoise	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	White-beaked dolphin	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Bottlenose dolphin	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Minke whale	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	Harbour seal	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Grey seal	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Disturbance to marine mammals	Harbour porpoise	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	White-beaked dolphin	Low	Medium	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Bottlenose dolphin	Low	High	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	Minke whale	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Grey seal	Negligible	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Harbour seal	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Humpback whale	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Killer whale	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	Long-finned pilot whale	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Atlantic white-sided dolphin	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Short-beaked common dolphin	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Risso's dolphin	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Changes to prey distribution	Marine mammals	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Operation and maintenance						
Injury and disturbance from underwater noise-generating activities	Marine mammals	Low	Medium	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Long-term changes to prey resources	Marine mammals	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Secondary entanglement	Marine mammals	High	Negligible	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

11.8 Inter-related effects

Inter-related effects are the potential effects of multiple impacts, effecting one receptor or a group of receptors. Inter-related effects include interactions between the impacts of the different phases of the Project (i.e. interaction of impacts across construction, operation and maintenance and decommissioning), as well as the interaction between impacts on a receptor within a Project phase. The potential inter-related effects for marine mammal receptors are described below.

11.8.1 Inter-related effects between Project phases

All phases of the Project have the potential to result in effects to marine mammals.

As described in Section 11.6.1.1, the greatest potential for injury and/or disturbance to marine mammals from underwater noise will arise as a result of pre-construction activities (UXO clearance, geophysical and geotechnical surveys) and impact piling. Underwater noise associated with operational FTUs and with vessels during all phases of the project will be highly localised (and, in the case of vessels, transient and temporary, and an insignificant change from the baseline) and the assessment of potential effects concluded that effects on marine mammal receptors were negligible and therefore not significant. With consideration given to the localised, intermittent and temporary nature of underwater noise associated with the construction (and pre-construction) phase, no long-term population level effects on marine mammal receptors are anticipated as a result of these activities. It is therefore concluded that there is limited potential for an interaction between activities producing underwater noise during the construction (and pre-construction), operation and maintenance and decommissioning phases of the Project to result in an effect which is greater than each phase when assessed in isolation.

No potential significant effects, both during the construction period and due to long-term habitat changes throughout the operational life of the Project, were identified for fish and shellfish species which are considered to be prey for marine mammals. The indirect effects of changes to prey distribution and long-term changes to prey resources were also assessed as of negligible or minor significance to marine mammals, owing to the adaptable ecological traits (including dietary preferences) of species that are likely to occur in the Study Area and the temporary nature of the changes in prey availability (see section 11.6.1.2 and 11.6.2.2). It is therefore concluded that there is limited potential for an interaction between effects on prey during the construction (and pre-construction) and decommissioning phases, and the longer-term effects on prey habitats during the operation and maintenance phase of the Project, therefore it is unlikely that there will be an effect which is greater than each phase when assessed in isolation.

11.8.2 Inter-related effects within a Project phase

There is the potential for works associated with the construction phase (including pre-construction) of the Project (i.e., UXO clearance, geophysical and geotechnical surveys, piling, and vessel noise) to result in inter-related injury and/or disturbance effects on marine mammals. All marine mammal receptors were concluded as having a low or negligible sensitivity to potential effects associated with UXO clearance and geophysical surveys, with the exception of minke whales and humpback whales which were concluded as having a medium sensitivity to UXO clearance. However, the magnitude of effect for all marine mammals was concluded as negligible for both UXO clearance and geophysical surveys, therefore the potential effect was concluded as negligible and therefore not significant for all marine mammals. Furthermore, as detailed within EIAR Vol. 2, Chapter 5: Project Description the assessment of UXO risk across the Project Area was concluded as 'low', with any UXO encountered within the Project Area anticipated to be avoided through micro-routeing. It is therefore concluded that, while there is the potential for inter-related effects to arise as a result of these activities, it is not anticipated that a significant adverse effect will arise as a result of these activities being undertaken in combination. Marine mammals were assessed to have low to medium sensitivity to impact piling, with magnitude ranging from negligible to high. The potential effect was concluded as negligible or minor and not significant to all marine mammals. However, there will not be any temporal overlap between pre-construction activities (i.e. UXO clearance and geophysical and geotechnical surveys), therefore the potential for a significant adverse inter-related effect between these activities is considered limited as the impacts are primarily evaluated independently.

During the operation and maintenance phase of the Project, the limited spatial extent of any potential effects associated with operational underwater noise, vessel disturbance and indirect effects associated with potential effects to prey species and secondary entanglement will be similar for all species and therefore inter-related effects may arise. However, given the highly localised nature of potential effects, it is concluded that the combined effect of these potential effect during the operation and maintenance phase is not anticipated to result in a greater effect than the assessment of these impacts in isolation (as presented in Section 11.6.2).

11.8.3 Inter-relationships

Inter-relationships are defined as the interaction between the impacts assessed within different topic assessment chapters on a receptor. The other chapters and impacts related to the assessment of potential effects on marine mammals are provided in Table 11-48.

Table 11-48 Marine mammal inter-relationships

CHAPTER	IMPACT	DESCRIPTION
EIAR Vol. 3, Chapter 9: Marine Water and Sediment Quality	Indirect impacts to marine mammals from the mobilisation of sediment bound contaminants resulting in changes to water quality which may affect prey species.	Any works associated with the Project that have the potential to impact habitat quality and water quality for fish and shellfish species which are considered prey for marine mammals. As presented within EIAR Vol. 3, Chapter 9: Marine Water and Sediment Quality, any potential impacts associated with the mobilisation of sediment bound contaminants across the EICC and within the Array Area are concluded as not significant.
EIAR Vol. 3, Chapter 10: Benthic Ecology	Indirect impacts to marine mammals through benthic habitat change, including the potential for changes to habitat quality.	There is the potential for short-term and long-term changes to benthic habitats which are important for fish and shellfish species which are considered prey for marine mammals. These impacts may arise as a result of the disturbance to or loss of benthic habitats upon which those fish and shellfish species rely. As presented within EIAR Vol. 3, Chapter 10: Benthic Ecology, all potential effects throughout the construction, operation and maintenance and decommissioning phases of the Project are concluded as not significant.
EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology	Indirect impacts to marine mammals through changes to abundance and distribution of fish and shellfish species which are considered prey to marine mammals.	Works associated with the Project have the potential to influence the abundance and distribution of fish and shellfish species which are considered prey for marine mammals. As presented within EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology, all potential effects throughout the construction, operation and maintenance and decommissioning phases of the Project are concluded as not significant.
EIAR Vol. 3, Chapter 14: Commercial Fisheries	Indirect impacts on marine mammals through secondary entanglement with discarded or lost fishing gears entangled on FTU mooring lines.	There is the potential for lost or derelict fishing gears to become entangled with FTU mooring lines within the Array Area, therefore introducing the risk of secondary entanglement to marine mammals. As presented in EIAR Vol. 3, Chapter 14: Commercial Fisheries, increased risk of loss or damage to fishing gear (snagging risk) throughout the construction, operation and maintenance and decommissioning phases of the Project are concluded as not significant.

11.9 Whole Project assessment

Please refer to EIAR Vol. 2, Chapter 7: EIA Methodology for the full description of the Whole Project assessment. Onshore aspects have not been assessed as part of the Project. Horizontal Direct Drilling (HDD) installation will be undertaken by rigs onshore, therefore the sound that will be produced is anticipated to be negligible (Hall and Francine, 1991; Nedwell *et al.*, 2012). The nearest seal haul-out site is 20 km away from the landfall; therefore it is not anticipated to be any impacts to marine mammal receptors. It is not anticipated that there will be any additional impacts from the onshore Project on Marine Mammal Ecology receptors as the onshore aspects are fully terrestrial.

11.10 Ecosystem assessment

Marine mammals occupy the upper levels of the food chain and are considered top predators in the UK marine environment (BEIS, 2022). A holistic approach has been adopted to identify impacts in order to consider any potential ecosystem-wide impacts, particularly across trophic levels (e.g. how impacts on prey species might affect their availability to predators). Variations in the availability or distribution of marine mammals could have cascading effects on other species within the ecosystem, indirectly influencing the prey species that they feed on if the level of foraging is affected (e.g. fish species). This has the potential to affect other predators (e.g. birds and piscivorous fish) through subsequent changes in prey availability. The monitoring being conducted as part of the PrePARED project aims to improve the understanding of the value of OWFs in terms of food availability and prey quality for marine predators. Only preliminary results are currently available based on the first two years of surveys.

Key prey species for marine mammals considered in this assessment include clupeids (e.g., herring and sprat), gadoids (e.g., cod and whiting), sandeels and flatfish. Marine mammals are considered to be generalist feeders, apart from Risso's dolphin which predominantly feeds on cephalopods. The effect of changes in prey distributions on marine mammals was assessed in Section 11.6.1.2 and 11.6.2.2 and concluded no significant effect. Marine mammals are considered to be highly mobile and wide ranging, as well as generalist feeders, and therefore are considered of low sensitivity to changes in prey availability. Changes in predator distribution and abundance can potentially impact fish and shellfish prey species, for example via predator aggregations around the subsea infrastructure at the Project Area. This was assessed in EIAR Vol. 3, Chapter 13: Fish and Shellfish Ecology as not significant, and subsequently the effect of changes on fish prey for offshore ornithology was assessed in EIAR Vol. 3, Chapter 12: Ornithology.

Ecosystem effects have been considered holistically throughout the ecological chapters of the EIAR. There is not considered to be a significant long-term change in the presence of marine mammal predators as a result of the Project which could result in an ecosystem-scale effect. No ecosystem effects have been concluded in relation to marine mammals either as direct impacts, or through indirect impacts to prey species.

11.11 Transboundary effects

Transboundary effects arise when impacts from a development within one European Economic Area (EEA) state's territory affects the environment of another EEA state(s).

There is no potential for transboundary impacts upon marine mammal receptors due to construction, operation and maintenance and decommissioning of the Project. The potential impacts are localised and are not expected to affect other EEA states. Therefore, transboundary effects for marine mammal receptors do not need to be considered further.

Marine mammals are highly mobile in nature, with all animals that may be present within the Project Area (as described in Section 11.4.4) and Study Area (as presented within Section 11.4.1) likely to also range widely throughout their relevant MUs, including into international waters. For example, those MUs which are defined for harbour porpoise, bottlenose dolphin, white-beaked dolphin, white-sided dolphin, Risso's dolphin and minke whale extend into Norwegian, Swedish, Danish, German, Dutch, Belgian and French international waters (IAMMWG, 2023). Additionally, given the proximity between the Project Area and the UK-Norway EEZ boundary(approximately 43 km), it is possible that underwater noise emissions during the construction phase could be perceived in transboundary waters. However, at this distance, it is not likely that underwater noise could result in a significant transboundary effect to marine mammals (either alone or in combination with other Projects).

Furthermore, is it considered that given the highly localised nature of works and the spatial influence of potential effects associated with the operation and maintenance and decommissioning phases of the Project, it is unlikely that there will be a likely significant effect on any marine mammal species which is a qualifying feature of any transboundary designated sites.

11.12 Summary of mitigation and monitoring

No secondary mitigation, over and above the embedded mitigation measures proposed in Section 11.5.4, is either required or proposed in relation to the potential effects of the Project on marine mammals as no adverse significant impacts are predicted.

However, some activities, such as those with the potential to generate high-amplitude underwater noise (geophysical survey, UXO clearance, impact piling), will employ mitigation measures to avoid and minimise the impact of this sound. These measures are embedded into the Project design through the implementation of and adherence to a MMMP (EIAR Vol.4, Appendix 33: Outline Marine Mammal Mitigation Protocol), which aligns with published mitigation guidelines.

Furthermore, Project infrastructure will be subject to annual inspection including removal of substantial marine growth, and maintenance and servicing of components in line with a pre-defined maintenance schedule. These maintenance procedures will facilitate the detection and removal of any ALDFG which could cause secondary entanglement.

No monitoring is currently proposed for marine mammal ecological receptors.

11.13 References

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