GREEN VOLT

Chapter 11

Marine Mammal Ecology

Offshore EIA Report: Volume 1

Revision history

Revision	Date	Description	Prepared	Checked	Approved
1	21/10/2022	First draft	GS (Royal HaskoningDHV)	PP (Royal HaskoningDHV)	VC (Flotation Energy)
2	16/11/2022	Second draft	AS (Royal HaskoningDHV)	JM (Royal HaskoningDHV)	VC (Flotation Energy)
3	09/01/2023	Final for submission	JL (Royal HaskoningDHV)	CM (Royal HaskoningDHV)	VC (Flotation Energy)

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Acronyms

Acronym	Description
µV/m	Micro volts per metre
2D	Two Dimensional
AA	Appropriate Assessment
AC	Alternating Current
ADD	Acoustic Deterrent Devices
AIS	Automatic Identification System
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
BSI	British Standards Institution
CCS	Carbon Capture Storage
Cefas	Centre for the Environment and Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
CES	Coastal East Scotland
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CITES	Convention on International Trade in Endangered Species
cm	centimetre
CMS	Convention on Migratory Species
CPOD	Cetacean Porpoise Detector
CPT	Cone Penetration Test

CSIP	Cetacean Strandings Investigation Programme
CV	Coefficient of Variation
dB	decibel
DECC	Department of Energy and Climate Change (now BEIS)
Defra	Department for Environment, Food and Rural Affairs
DP	Dynamic Positioning
EaS	East Scotland
EC	European Commission
EcIA	Ecological Impact Assessment
ECOMMAS	East Coast Marine Mammal Acoustic Study
EDR	Effective Deterrent Radius
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIA Report	Environmental Impact Assessment Report
ELF	Extremely Low Frequency
EMF	Electromagnetic Field
EPS	European Protected Species
ES	Environmental Statement
FAD	Fish Aggregation Device
FCS	Favourable Conservation Status
FORTUNE	Floating Offshore Wind Turbine Noise
FPSO	Floating Production, Storage and Offloading
GES	Good Environmental Status
GNS	Greater North Sea
GPS	Global Positioning System
GSD	Ground Sample Distance

HE	High Explosive
HF	High Frequency
hr	hour
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HWT	Hebridean Whale and Dolphin Trust
Hz	Hertz
IAMMWG	Inter-Agency Marine Mammal Working Group
IEC	International Electrotechnical Commission
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
kg	kilogram
kHz	kilohertz
kJ	kilojoule
km	kilometre
km^2	kilometre squared
kV	kilovolt
LF	Low Frequency
LSA	Land Service Ammunition
m	metre
m/s	metres per second
max	maximum
MBES	Multi-Beam Echo Sounder
MF	Medium Frequency
ML	Marine Licence
mm	millimetre

mm^2	millimetre squared
MMMP	Marine Mammal Mitigation Protocol
MMObs	Marine Mammal Observers
MoF	Moray Firth
MPA	Marine Protected Area
MPA	Nature Conservation Marine Protected Area
MRE	Marine Renewable Energy
MS	Marine Scotland
MS-LOT	Marine Scotland - Licensing Operations Team
MSS	Marine Scotland Science
MU	Management Unit
N/A	Not Applicable
NAMCO	North Atlantic Marine Mammal Commission
NAS	Noise Abatement Systems
NEQ	Net Explosive Quantity
nm	nautical mile
NMFS	National Marine and Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPL	National Physical Laboratory
NS	North Sea
O&M	Operation and Maintenance
ORE	Offshore Renewable Energy
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantis
OWF	Offshore Wind Farm
OWL	Offshore Windfarm Ltd

PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PEMP	Project Environmental Monitoring Plan
PMF	Priority Marine Feature
PTS	Permanent Threshold Shift
RA	Risk Assessment
RMS	Root Mean Square
RoC	Review of Consents
RoI	Republic of Ireland
ROV	Remotely Operated Vehicles
SAC	Special Area of Conservation
SBES	Single Beam Echo Sounder
SBP	Sub-Bottom Profilers
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SEL_{cum}	Cumulative SEL
SEL_{ss}	SEL for single strike
SMASS	Scottish Marine Animal Stranding Scheme
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage (now NatureScot)
SNS	Southern North Sea
SPL	Sound Pressure Level
SPL_{peak}	peak SPL
SPP	Scotland's Planning Policy

SSC	Suspended Sediment Concentration
SSS	Side Scan Sonar
TLP	Tension Leg Platform
TNT	Trinitrotoluene
TTS	Temporary Threshold Shift
UHR	Ultra High Resolution
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
USBL	Ultra-Short Baseline
UXO	Unexploded Ordnance
VHF	Very High Frequency
WTG	Wind Turbine Generator
µPa	micro pascal
µT	microtesla

Glossary

Term	Description
Applicant	Green Volt Offshore Windfarm Ltd.
Buzzard	Buzzard Platform Complex.
Buzzard Export Cable Corridor	The area in which the export cables will be laid, from the perimeter of the Windfarm Site to Buzzard Platform Complex.
Green Volt Offshore Windfarm	Offshore windfarm including associated onshore and offshore infrastructure development (Combined On and Offshore Green Volt Projects).
Horizontal Directional Drilling	Mechanism for installation of export cable at landfall.
Inter-array cables	Cables which link the wind turbines to each other and the offshore substation platform.
Landfall Export Cable Corridor	The area in which the export cables will be laid, from the perimeter of the Windfarm Site to landfall.
Mean High Water Springs	At its highest and 'Neaps' or 'Neap tides' when the tidal range is at its lowest. The height of Mean High Water Springs (MHWS) 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 (Spring tides).
Moorings	Mechanism by which wind turbine generators are fixed to the seabed.
NorthConnect Parallel Export Cable Corridor Option	Landfall Export Cable Corridor between NorthConnect Parallel Landfall and point of separation from St Fergus South Export Cable Corridor Option.
NorthConnect Parallel Landfall	Southern landfall option where the offshore export cables come ashore.
Offshore Development Area	Encompasses i) Windfarm Site, including offshore substation platform ii) Offshore Export Cable Corridor to Landfall, iii) Export Cable Corridor to Buzzard Platform Complex.
Offshore export cables	The cables which would bring electricity from the offshore substation platform to the Landfall or to the Buzzard Platform Complex.
Offshore infrastructure	All of the offshore infrastructure, including wind turbine generators, offshore substation platform and all inter-array and export cables.
Offshore substation platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from landfall to the onshore substation.
Project	Green Volt Offshore Windfarm project as a whole, including associated onshore and offshore infrastructure development.
Safety zones	An area around a structure or vessel which must be avoided.

St Fergus South Export Cable Corridor Option	Landfall Export Cable Corridor between St Fergus South Landfall and point of separation from NorthConnect Parallel Export Cable Corridor Option.
St Fergus South Landfall	Northern landfall option where the offshore export cables come ashore.
Windfarm Site	The area within which the wind turbine generators, offshore substation platform and inter-array cables will be present.

CHAPTER 11: MARINE MAMMAL ECOLOGY

11.1 Introduction

1. This chapter of the **Offshore Environmental Impact Assessment (EIA) Report** describes the marine mammal baseline information ('existing environment') in relation to the Project (in this instance the Project refers to the offshore elements of the Green Volt Offshore Windfarm only, up to Mean High Water Springs (MHWS)) and presents an assessment of potential effects associated with the construction, operation and maintenance (O&M) and decommissioning phases.

2. The objectives of this chapter are to:

- Define legislation, guidance, and policy documents relevant to marine mammals (**Section 11.2**)
- Provide an overview of consultation activities and present the responses relevant to marine mammals (**Section 11.3**)
- Present the methodology and significance criteria used in the assessments (**Section 11.4**)
- Define the scope of the Study Area (**Section 11.5**)
- Describe the baseline and existing environment for marine mammals (**Section 11.6**)
- Assess the potential effects that activities associated with any stage of the Project may have an effect on marine mammals from direct and indirect sources. Where required, mitigation measures have been outlined to prevent or reduce any significant effects and any residual effects determined (**Section 11.7**)
- Assess the potential cumulative effects for the Project with other plans, projects and activities (**Section 11.8**)
- Describe any potential transboundary effects, inter-relationships or interactions on marine mammals (**Sections 11.9, 11.10 and 11.11**).

3. This chapter has been written by Royal HaskoningDHV and incorporates site-specific survey results from HiDef Aerial Surveying Limited (**Appendix 12.1**; HiDef, 2022). Appropriately qualified and experienced marine technical specialists from Royal HaskoningDHV have completed the Ecological Impact Assessment (EcIA) for marine mammals with reference to the relevant legislation and guidance (**Section 11.2**).

4. In addition, impacts to designated sites for marine mammals are assessed in the **Offshore Report to Inform Appropriate Assessment**.

5. The effects assessed for marine mammals have been based on the relevant assessments in following offshore environment chapters:

- **Chapter 7: Marine Geology, Oceanography and Physical Processes**
- **Chapter 8: Marine Sediment and Water Quality**
- **Chapter 9: Benthic Ecology**
- **Chapter 10: Fish and Shellfish Ecology**
- **Chapter 14: Shipping and Navigation**

6. Additional information relevant to the marine mammal chapter is included in:

- **Appendix 12.1**: Digital video aerial surveys of seabirds and marine mammals at Green Volt: Two Year Report May 2020 to April 2022 (HiDef, 2022)
- **Appendix 9.1**: Green Volt Offshore Windfarm Underwater Noise Technical Report (Seiche Ltd., 2022)
- **Appendix 5.2,5.3 and 5.4**: Green Volt Offshore Windfarm Unexploded Ordnance Reports (6 Alpha Associates Ltd., 2022a, 2022b)
- **Appendix 9.2**: Green Volt Project Electromagnetic Field (EMF) assessment (National Grid, 2022)
- **Appendix 11.1**: Marine Mammal Cumulative Impact Assessment (CIA) screening.

7. Effects on designated European sites for marine mammals are assessed in the **Green Volt Offshore Windfarm Offshore Report to Inform Appropriate Assessment.**

11.2 Legislation, Guidance and Policy

11.2.1 Legislation

8. Marine mammal species in the waters surrounding the Project are protected by national and international legislation. All relevant legislation, policies and plans that have been taken into consideration when undertaking this EIA are outlined in **Chapter 3: Policy and Legislative Context**. **Table 11.1** details the legislation and policy relevant to marine mammals for the Project.

Table 11.1 International and National Legislation Relevant to Marine Mammals

Legislation	Level of protection	Species included	Details
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973.	International	All cetaceans	Prohibits the international trade in species listed in Appendix 1 (including sperm whale, northern right whale, and baleen whales) and allows for the controlled trade of all other cetacean species.
The Berne Convention 1979	International	All cetaceans, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*	The Convention conveys special protection to those species that are vulnerable or endangered. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981.
The Bonn Convention 1979	International	All cetacean species	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction.
Oslo and Paris Convention for the Protection of the Marine Environment (OSPAR Convention) 1992	International	Various whale species and harbour porpoise	OSPAR Convention has established a list of threatened and/or declining species in the north-east Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the European Commission (EC) Habitats and Birds Directives and measures under the Berne Convention and the Bonn Convention.
Convention on Biological Diversity 1993	International	All marine mammal species	Requires signatories to identify processes and activities that are likely to have impacts on the conservation and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.
Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, 2008 (ASCOBANS)	International	All cetaceans	ASCOBANS entered into force in 1994 under the auspices of the Convention on Migratory Species (CMS or Bonn Convention), with additional areas (the north-east Atlantic and Irish Sea) included into the convention in 2008. The aim of the convention is to promote cooperation between parties with a view to maintaining the Favourable Conservation Status (FCS) of small cetaceans throughout the agreement area.
Conservation of Seals Act 1970.	National	Grey and harbour seal	The Marine (Scotland) Act 2010 replaces the Conservation of Seals Act 1970 in Scottish waters. See below for further information.
The Wildlife and Countryside Act 1981 (as amended)	National	All cetaceans	Schedule 5: all cetaceans are fully protected within UK territorial waters. This includes disturbance or harassment of a wild animal (either intentionally or recklessly).
Nature Conservation (Scotland) Act 2004	National	All cetaceans, grey and harbour seal	The Nature Conservation (Scotland) Act 2004 sets out a series of measure designed to conserve biodiversity, and to protect and enhance the biological and geological natural heritage. This Act also provides

Legislation	Level of protection	Species included	Details
			amendments to the Wildlife and Countryside Act 1981 specifically for Scottish waters, adding that it is an offence to disturb cetacean species (either recklessly or intentionally). This Act also enacts requirements under the Bern Convention 1979.
Marine (Scotland) Act 2010	National	Grey and harbour seal	This Act provides a framework for the sustainable management of Scotland's seas and one of its key aims is to streamline and simplify the licensing and consenting process for marine projects. Under the Marine (Scotland) Act, the Conservation of Seals Act 1970 have been re-enacted, providing designation of specific seal haul-out sites for protections from intentional or reckless harassment. Under Part 6 of the new act, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering or where a licence has been issued to do so by Marine Scotland.
The Conservation (Natural Habitats, &c.) Regulations 1994 And The Conservation of Offshore Marine Habitats and Species Regulations 2017	National	All cetaceans, grey and harbour seal	The Habitats Regulations place an obligation on 'competent authorities' to carry out an Appropriate Assessment (AA) of any proposal likely to have a significant effect on a European site, to seek advice from Statutory Nature Conservation Bodies (SNCBs) and to reject an application that would have an adverse effect on the integrity of a European site except under very tightly constrained conditions. The **Offshore Report to Inform Appropriate Assessment** includes the information to support Appropriate Assessment of the Project against the requirements imposed by the regulations. Under the Habitats Regulations, all cetacean species are defined as European Protected Species (EPS). All seals are listed under Schedule 3 (animals which may not be captured or killed in certain ways). The 1994 Regulations apply onshore and within the territorial seas; and Offshore Marine Regulations 2017 apply to marine areas beyond 12 nautical miles (nm). These are referred to collectively as 'the Habitats Regulations'.

11.2.1.1 Species Protection

9. All species of cetacean (whale, dolphin and porpoise) occurring in UK waters are listed in Annex IV of the Habitats Directive as European Protected Species (EPS), and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. They are also considered species of community interest in need of strict protection, as directed by Article 12 of the Directive. Within the UK, The Habitats Directive is enacted through The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017.

10. The Habitats Regulations 1994 (as amended in Scotland) provide the protection given to EPS[1]. This protection is afforded in Scottish territorial waters (out to 12 nm) under Regulation 39(1) which make it an offence to:

    a. Deliberately or recklessly capture, injure or kill a wild animal of an EPS;
    b. Deliberately or recklessly:
        i. Harass a wild animal or group of wild animals of an EPS;
        ii. Disturb such an animal while it is occupying a structure or place which it uses for shelteror protection;
        iii. Disturb such an animal while it is rearing or otherwise caring for its young;

[1] *https://www.nature.scot/professional-advice/protected-areas-and-species/protected-species/legal-framework/habitats-directive-and-habitats-regulations/european-protected*

iv. Obstruct access to a breeding site or resting place of such an animal, or otherwise to denythe animal use of the breeding site or resting place;

v. Disturb such an animal in a manner that is, or in circumstances which are, likely tosignificantly affect the local distribution or abundance of the species to which it belongs;

vi. Disturb such an animal in a manner that is, or in circumstances which are, likely to impairits ability to survive, breed, or reproduce, or rear or otherwise care for its young or; or

vii. Disturb such an animal while it is migrating or hibernating.

11. Further protection is afforded through an additional disturbance offence given under Regulation 39(2) which states that "*it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean)*".

12. Marine Scotland (MS) is the regulator responsible for determining marine licence applications on behalf of the Scottish ministers. The EPS licence assessment will be carried out by Marine Scotland – Licensing Operations Team (MS-LOT) using the information provided by Green Volt Offshore Windfarm Limited (the Applicant) and advice from Marine Scotland Science (MSS) and NatureScot (Marine Scotland, 2020).

13. For activities taking place in Scottish waters beyond 12 nm (the Offshore Marine Area), EPS are protected under The Conservation of Offshore Marine Habitats and Species Regulations 2017. Marine Scotland (on behalf of the Scottish Ministers) is the licensing authority for all activities relevant to the renewable energy developments. Outside of 12 nm, the extent of legislative protection against injury is the same as within 12 nm. However, the definition of disturbance outside of 12 nm does not extend to individual animals. Therefore, whilst disturbance of a single animal within 12 nm may be considered an offence and thus require an EPS licence, for an EPS licence to be required outside of 12 nm there must be disturbance of a significant group of animals (Joint Nature Conservation Committee (JNCC) et al., 2010).

14. Harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, harbour seal and grey seal have protection under Annex II as species of Community Interest whose conservation requires the designation of Special Areas of Conservation (SACs). There are several SACs for marine mammals in Scottish waters. In addition, there are Marine Protected Areas (MPAs) in Scottish waters for cetacean species: one for Risso's dolphin *Grampus griseus*, and two for minke whale *Balaenoptera acutorostrata*, which are designated under the Marine (Scotland) Act 2010.

15. Grey and harbour seal are protected under the Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017, as well as Conservation of Seals Act. Under Section 117 of the Marine (Scotland) Act 2010, the Scottish Government identified and designated 194 haul-out sites for harbour and grey seals, where seals come ashore to rest, moult or breed. The designated haul-out sites were chosen with a focus on implementing legislation to protect seals from harassment at those sites. It is an offence to intentionally or recklessly harass a seal at a haul-out site.

16. Scottish Priority Marine Features (PMFs) (Scottish Natural Heritage (SNH, 2014) now NatureScot) are habitats and species considered to be marine nature conservation priorities in Scottish waters. The list includes 13 species of cetacean and both seals species, listed for either offshore waters only, or in both inshore and offshore waters.

11.2.2 Relevant Guidance

17. The principal guidance documents used to inform the assessment of potential impacts on marine mammals include, but are not limited to:

- The protection of Marine European Protected species from injury and disturbance – guidance of Scottish Inshore Waters (Marine Scotland, 2020)

- The protection of marine European Protected Species from injury and disturbance - guidance for the marine area in England and Wales and the UK offshore marine area (JNCC *et al*., 2010)
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (Chartered Institute of Ecology and Environmental Management (CIEEM), 2019)
- A review of noise abatement systems for offshore wind farm construction noise, and the potential for their application in Scottish Waters (Verfuss *et al.,* 2019)
- Reducing Underwater Noise (NIRAS, Sea Mammal Research Unit (SMRU) Consulting, and The Crown Estate, 2019)
- Scottish Government (2018) Marine Scotland Consenting and Licensing Guidance for Offshore Wind, Wave and Tidal Energy Applications
- Environmental Impact Assessment for offshore renewable energy projects – guide (British Standards Institution (BSI), 2015)
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report ((SMRU Ltd) on behalf of The Crown Estate, 2010)
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Centre for the Environment and Fisheries and Aquaculture Science (Cefas), 2011)
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010a)
- Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC, 2010b).
- National Policy Statement for renewable Energy Infrastructure (EN-3) (Department of Energy and Climate Change (DECC), 2011).
- Natural England and Joint Nature Conservation Committee (JNCC) advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas (Natural England and JNCC, 2019).
- Cable Burial Risk Assessment Guidance and Application Guide (Carbon Trust, 2015).

11.2.3 Relevant Policy

11.2.3.1 Scotland's National Marine Plan: A Single Framework for Managing Our Seas

18. This plan covers the management of Scottish waters both inshore (less than 12 nm) and offshore (between 12 and 200 nm) (Scottish Government, 2015). Within Scotland's National Marine Plan are a set of Good Environmental Status (GES) indicators that must be met. Within these, of relevance to this Project and marine mammal species are:

- *"Biological diversity is maintained and recovered where appropriate. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions (GES 1);*
- *All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity (GES 4);*
- *Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment (GES 11)".*

11.2.3.2 Scottish Planning Policy

19. Scotland's Planning Policy (SPP) (Scottish Government, 2014) contains the following Policy Principles with regards to Valuing the Natural Environment and these have been taken into consideration when undertaking the EIA for the proposed scheme:

20. The planning system should:

- *Conserve and enhance protected sites and species, taking account of the need to maintain healthy ecosystems and work with the natural processes which provide important services to communities;*
- *Seek benefits for biodiversity from new development where possible, including the restoration of degraded habitats and the avoidance of further fragmentation or isolation of habitats; and*
- *Support opportunities for enjoying and learning about the natural environment.*
- *The planning system should support an integrated approach to coastal planning to ensure that development plans and regional marine plans are complementary.*

11.3 Consultation

21. The Applicant has sought opinion from key stakeholders through scoping and consultation regarding the Project and the **Offshore Scoping Report** (Royal HaskoningDHV, 2021) (**Appendix 1.2**). The responses received from stakeholders relevant to marine mammals are provided in **Table 11.2**, with reference to the section of the **Offshore EIA Report** where the comment is addressed.

Table 11.2 Consultation Responses

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
Marine Scotland - Licensing Operations Team (MS-LOT)	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.1] Marine Mammal Ecology:** With regards to the list of species to be included in the assessment, in addition to those identified in Section 6.3.2 of the Scoping Report, the Scottish Ministers advise that the Developer must take a precautionary approach and include Atlantic white-sided dolphin and humpback whale in the EIA Report. In relation to bottlenose dolphin, both the NatureScot representation and MSS advice note that the figure for the East Scotland Management Unit is incorrect and NatureScot recommends using 224 for the total bottlenose dolphin population. In relation to seals, the Scottish Ministers are content with the Developer's proposed use of Carter *et al*. (2021) maps, but draw attention to the MSS advice regarding these and advise that the points it raises must be addressed fully.	Atlantic white-sided dolphin, Risso's dolphin and humpback whale have been included in the **Offshore EIA Report** (**Section 11.6**). The bottlenose dolphin East Scotland MU has been updated to 224 for the total bottlenose dolphin population (**Section 11.6.2**). The Carter *et al*. (2020) maps and latest Special Committee on Seals (SCOS) data currently available at time of writing have been used to determine the seal densities (**Section 11.6.3**).
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.2] Marine Mammal Ecology:** The Scottish Ministers broadly agree with the impact assessment methodologies proposed, however the NatureScot representation in regards to use of appropriate guidance in relation to impacts on EPS within 12 nm must be fully addressed in the EIA Report.	The JNCC *et al*. (2010) and Marine Scotland (2020) guidance for the protection of Marine EPS from injury and disturbance has been used to determine the requirement for an EPS licence and taken into account in defining levels of magnitude for marine mammals (**Section 11.4.1.3**).
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.3] Marine Mammal Ecology:** The Scottish Ministers are broadly content with the data sources listed in Table 6.11 of the Scoping Report, however advise the Developer to additionally consider any recent data from the ECOMMAS project, a view supported by the NatureScot representation. The Scottish Ministers draw further attention to the NatureScot representation with regards to aerial survey data and advise that this is must not be used to generate marine mammal density estimates for the Proposed Development Area and advise that it is used instead to supplement the data sources listed in Table 6.11. In Section 6.3.3.5 of the Scoping Report, the Developer states that there are no data gaps for any marine mammals. However, the Scottish Ministers highlight the point raised by NatureScot regarding the existence of seasonal gaps and which	Recent data from East Coast Marine Mammal Acoustic Study (ECOMMAS) and other projects have been considered in **Section 11.6**. As a precautionary approach density estimates for each marine mammal species used in the assessments are based on the highest for the area, see **Section 11.6.6**. Assumptions and limitations, including data gaps, are considered in **Section 11.5.4**.

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
		suggests aerial survey work may help fill these, depending on coverage.	
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.4] Marine Mammal Ecology:** In Table 6.17 of the Scoping Report the Developer summarises the potential impacts to marine mammals identified during the different phases of the Proposed Development. The Scottish Ministers broadly agree with the potential impacts scoped in to and out of further assessment in the EIA Report, with the exception of the following potential impacts with must be scoped in to the EIA Report; EMF effects during the operation and maintenance phase of the Proposed Development; underwater noise arising from geophysical surveys during the construction phase of the Proposed Development and cumulative barrier effects from underwater noise and other windfarms in the vicinity. This is a view supported by both the NatureScot representation and the MSS advice and these must both be fully addressed by the Developer.	Electromagnetic field (EMF) effects during the operation and maintenance phase of the Project; underwater noise arising from geophysical surveys during the construction phase of the Project and cumulative barrier effects from underwater noise and other windfarms in the vicinity have been assessed further in the **Offshore EIA Report** (**Sections 11.7** and 11.8).
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.5] Marine Mammal Ecology:** In regards to the impacts from vessel interactions, the Scottish Ministers highlight the NatureScot representation and advise that information on the number and type of vessel movements must be included in the EIA Report along with any potential impacts from the activity on marine mammals. The NatureScot representation in this regard must be addressed fully in the EIA Report.	As outlined above, the assessment of the potential effects on marine mammals from vessel interactions includes information on the number and type of vessel movements (**Section 11.7.5.6**).
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.6] Marine Mammal Ecology:** In addition, should Acoustic Deterrent Devices (ADDs) be used to mitigate the impacts of noise disturbance during piling, the impacts of ADDs must be scoped in to the EIA Report for further assessment during the construction phase of the Proposed Development.	An assessment of the potential effects of using ADD as mitigation for piling is provided in **Section 11.7.5.3**.
MS-LOT	April 2022 Offshore Scoping Opinion	**[Ref: 5.12.7] Marine Mammal Ecology:** With regards to cabling routes and cable burial, the Scottish Ministers direct the Developer to the NatureScot representation which states that in addition to mooring lines of the floating turbines, the Developer should consider the potential impacts of entanglement to cetacean species from the dynamic cabling including inter-array cables, anchor cables etc. The Scottish Ministers advise that the Developer must address this point in full in the EIA Report.	The potential effects of entanglement to cetacean species from the mooring lines of the floating turbines and the dynamic cabling including inter-array cables, anchor cables etc., has been assessed in **Section 11.7.6.5**.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.12.8] Marine Mammal Ecology:** The Scottish Ministers agree with MSS that appropriate underwater noise modelling techniques should be used for the assessment in the Environmental Appraisal and conducted in a way so that the information can be used for both the EPS and HRA processes. The Scottish Ministers advise the Developer to engage further with MSS via MS-LOT on this point.	Underwater noise modelling (**Appendix 9.1**) has been conducted and summarised in **Section 11.7.4**.

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 2.5.8] Description of the Proposed Development:** The EIA Report must also include consideration of the options which will be assessed in relation to UXO clearance, the differences amongst them and an assessment of the environmental effects of these options. In this regard, the Scottish Ministers advise that the EIA Report must include a worst case of high order detonation in terms of impact and mitigation, unless there is robust supporting evidence that can be presented to show consistent performance of the preferred low order or deflagration method.	
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	Site-specific monthly aerial surveys are being conducted for both marine mammals and seabirds, with the initial monthly survey undertaken in May 2020. Aerial surveys alone will not provide all of the required information due to the limited availability of animals being at the sea surface. We caution against using this data to generate marine mammal density estimates for the Project Area, however the data will provide a useful update to the existing information detailed in Table 6.11.	A range of data and information has been used to describe the existing environment for marine mammals, as outlined in **Sections 11.5.3** and **Section 11.6**. As a precautionary approach density estimates for each marine mammal species used in the assessments are based on the highest for the area, see **Section 11.6.6**.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	In addition, we have not had sight of this monthly aerial survey plan so cannot comment whether it adequately covers the site and export cable corridor. We also suggest that any recent data from the ECOMMAS project is considered as this may help inform usage by cetaceans (porpoise and dolphins) in the near shore area.	An overview of the site-specific aerial surveys (**Appendix 12.1**) is provided in **Section 11.6.1**. Recent data from the ECOMMAS and other projects have been considered in **Section 11.6.2**.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	"*Section 6.3.2.5 suggests that there are no data gaps for any marine mammals. However, the majority of the surveys have only been carried out in summer months meaning that there are seasonal gaps. The aerial surveys may help to fill these seasonal gaps depending on coverage*."	A review of all relevant and currently available data sources and information, has been undertaken to inform the existing environment for marine mammals, as outlined in **Sections 11.5.3** and **11.6**. Assumptions and limitations, including data gaps, are considered in **Section 11.5.4**.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	We agree with the list of cetacean species given in Section 6.3.2. However, we recommend that humpback whale is included in the regularly seen list. There has been an increase in sightings of humpback whales in the North Sea from the Forth north to Shetland over the last few years.	Since scoping a further review of available data and information has been conducted, resulting in Risso's dolphin and humpback whale included in the list of cetaceans (**Section 11.6.2**).
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	Section 6.3.2.3 regarding reference populations mainly refers to the IAMMWG (2021) updated paper on Management Unit (MU). However, the figure given for the East Scotland bottlenose dolphin MU is incorrect. NatureScot recommends the use of 224 for the total bottlenose dolphin population in the East Scotland management unit.	The MU reference populations, including the East Scotland MU for bottlenose dolphin, have been updated based on Inter-Agency Marine Mammal Working Group (IAMMWG) (2022) (**Section 11.6.2**).
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	In Section 6.3.2.6, four cetacean species are listed as key species being taken forward for assessment – harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale. We suggest this list should only be finalised once the aerial surveys and any other baseline data investigation has been completed. We recommend that Atlantic white-sided dolphin is taken forward for assessment due the prevalence of	Since scoping a further review of available data and information has been conducted, including site-specific aerial survey data. Atlantic white-sided dolphin, Risso's dolphin and humpback whale have been included, where relevant, in the assessments (**Section 11.7**). Where there is little information

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
		this species forming mixed groups with white-beaked dolphin.	on density estimates, qualitative assessments have been included.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	We agree that all the suggested potential impacts during construction for marine mammals, as detailed in Section 6.3.3.1, are scoped in at this time.	Noted
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	For underwater noise, some of the construction activities (particularly within 12nm) may require an EPS licence.	Effects on EPS have been assessed and requirements for EPS licence determined.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	We agree with the suggested potential impacts for the operation and maintenance phase, as detailed in Section 6.3.3.2.	Noted
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	We note that this Section states “The potential for impacts from both EMF and change to water quality during operation have been scoped out. This is consistent with other recent OWF projects”. We advise that EMF is an issue that can’t yet be scoped out especially if cables are not able to be buried."	The potential effects of EMF during operation have been scoped in and further assessed in **Section 11.7.6.6**.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	Section 6.3.3.1.2 regarding vessel interaction mentions that marine mammals in the area will “be used to” the type of vessels expected to be used in the construction phase. Marine mammals do not stay resident in one area and may travel throughout the North Sea and beyond; and the scoping report gives no indication of the number of vessel movements expected- this will be required in the EIA Report. More information on the number and type of vessel movements will be required in the EIA Report and any potential impacts from this activity detailed in the marine mammal section.	The assessment of the potential effects on marine mammals from vessel interactions includes information on the number and type of vessel movements (**Section 11.7.5.6**).
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	As this is a floating wind proposal with dynamic cabling, consideration should be given to what will be done to review whether the inter-array cabling, anchor cables etc. will not post a risk of entanglement to cetacean species. We commissioned research in this area and would advise reference to our report: *Understanding the potential for marine megafauna entanglements from renewables marine energy development*.	The potential effects of entanglement to cetacean species from the mooring lines of the floating turbines and the dynamic cabling including inter-array cables, anchor cables etc., has been assessed in **Section 11.7.6.5**, with reference to the NatureScot commissioned report by Benjamins *et al*. (2014).
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore	In Section 6.3.4.2 regarding impact assessment methodology for marine mammals, the JNCC guidance on EPS is referred to. This guidance only applies outwith 12 nm. Within Scottish territorial waters different legislation and guidance needs to be adhered to. This may have implications for Table 6.18	The JNCC *et al*. (2010) and Marine Scotland (2020) guidance for the protection of Marine EPS from injury and disturbance has been taken into account in defining levels of magnitude for marine mammals (**Section 11.4.1.3**).

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
	Scoping Opinion	which shows the definitions of levels of magnitude for marine mammals.	
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	Section 6.3.2.4.1 states that the supporting features of the minke whale are protected under the Conservation Objectives of the Southern Trench MPA. This has implications for the export cable. As mentioned in Appendix B – Benthic Interests, it's advised in the Conservation and Management document for the Southern Trench MPA regarding cable and pipeline activities that in order to reduce or limit pressures, early discussion of siting, design and construction is recommended to reduce the risks of disturbance. This is also recommended to reduce potential impact on the habitat of sandeels	Conservation Objectives of the Southern Trench MPA for minke whale are summarised in **Section 11.6.4.1**. Implications for the potential effects of the Landfall Export Cable Corridor have been taken into account. Pre-application surveys, siting and installation techniques will be implemented – as outlined in **Chapter 9: Benthic Ecology**, to reduce or limit pressures, minimise the footprint of new cables within areas of burrowed mud habitat for sandeels.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	The nearest designated seal haul-out to the proposed landfall sites is the Ythan River Mouth, designated for grey seals, approximately 21 km away. We agree that this can be scoped out of further assessment given the distance away from the expected export cable landfall.	Noted
NatureScot	Stakeholder engagement meeting, 14th February 2022	UKs position statement on the UKs approach to UXO - there is an expectation you wouldn't go to high order	Noted. High order has been assessed as worst case. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with stakeholders.
NorthConnect Limited	April 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	We would suggest that the potential use of Acoustic Deterrent Devices (ADD) as mitigation if piling is carried out, as mentioned in Section 2.4 Construction notes, needs careful consideration. It should be clear why this mitigation is required, taking account of the potential for ADDs to potential cause harm in their own right.	An assessment of the potential effects of using ADD as mitigation for piling is provided in **Section 11.7.5.3**.
Marine Scotland Science (MSS)	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	With respect to marine mammals, MSS broadly agree with the list of impact pathways to be scoped in / out of the EIA (as summarised in section 6.3.3.9), with the exception of the following points	Noted
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	MSS recommend that if barrier effects from both underwater noise and physical presence of windfarms are to be included in the EIAR (for their respective stages), they should also be considered cumulatively together with other developments in the project region	Cumulative barrier effects from underwater noise and physical presence of other windfarms in the vicinity have been considered in **Sections 11.7.5.7, 11.7.6.3, 11.7.6.7** and **11.8.**.
MSS	4th February 2022 Representation to MS-	MSS recommend that should any further geophysical survey work be required during construction, then the effects of underwater noise arising from this activity should be scoped into the assessment.	As a precautionary approach and to cover any further requirements for geophysical survey work the

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
	LOT during consultation on Offshore Scoping Opinion		assessment has been included in **Section 11.7.5.1**.
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	We note NatureScot's advice that EMF cannot be scoped out due to the cables suspended in the water column. MSS advise that there is no evidence of impact of EMF from dynamic electrical cables on marine mammals, but we support a qualitative assessment of potential electromagnetic effects from these cables.	A qualitative assessment of potential EMF impacts from cables suspended in the water column has been included in **Section 11.7.6.6**.
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	As noted by the applicant, some of the activities proposed (e.g. foundation installation, geophysical surveys, potential UXO clearance) may require an EPS licence because of the potential to disturb or injure cetaceans. Although a separate application will need to be made for this licensing, we recommend that appropriate underwater noise modelling techniques are used for the assessment in the Environmental Appraisal, and that is done so in a way that the information can also be used for the EPS and Habitat Regulations Appraisal (HRA process. Guidance on EPS licensing process is available on the Marine Scotland website (Marine European protected species: protection from injury and disturbance - gov.scot (www.gov.scot)).	The JNCC *et al*. (2010) and Marine Scotland (2020) guidance the protection of Marine EPS from injury and disturbance has been used to determine the requirement for an EPS licence.
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	MSS agree with the list of marine mammal species expected to be taken forward for the Environmental Impact Assessment (as listed in section 6.3.2.6), whilst acknowledging that the additional species identified in this section may also be included, following the results of the baseline characterisation surveys and assessment. We also note NatureScot's advice to include Atlantic white sided dolphin. We advise that this species has rarely been observed in the Scottish North Sea (e.g. SCANS III surveys) and that any assessment will likely be qualitative, at best.	Since scoping a further review of available data and information has been conducted, including site-specific aerial survey data. Atlantic white-sided dolphin, Risso's dolphin and humpback whale have been included, where relevant, in the assessments (**Section 11.6.6**). Where there is little information on density estimates, qualitative assessments have been included.
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	MSS are broadly content with the management units and reference population sizes identified in the scoping report in section 6.3.2.3, however we note that the bottlenose dolphin Coastal East Scotland MU abundance published in IAMWWG (2021) is incorrect and the version provided on the NatureScot website should be used instead (https://www.nature.scot/doc/east-coast-scotland-bottlenosedolphins-estimate-population-size-2015-2019).	The Management Unit (MU) reference populations, including the East Scotland MU for bottlenose dolphin, have been updated based on IAMMWG (2022) (**Section 11.6.2**).
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	For seals, while we recommend using the Carter *et al.* (2021) maps as suggested, we note that these maps do not provide absolute densities. The correction factor for these, to convert from relative to absolute density will be provided in the upcoming SCOS (2022) report. In the interim, MSS will be able to provide this method on request.	The Carter *et al*. (2020) maps and latest SCOS (2021) data currently available at time of writing have been used to determine the seal densities (**Section 11.6.3**). MSS were contacted and the method provided used to convert from relative to absolute density.
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore	"The most appropriate at-sea abundance and distribution estimates for informing licencing and planning decisions are those derived from habitat preference modelling (Carter et al. 2020). These are more up to date, in terms of both telemetry and haulout count data, than previous maps (Russell et al. 2017) and do not rely on null usage (decaying use with distance from haul out sites) for areas which lack	The Carter *et al*. (2020) maps and latest SCOS (2021) data currently available at time of writing have been used to determine the seal densities (**Section 11.6.3**). MSS were contacted and the method provided used to convert from relative to absolute density.

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
	Scoping Opinion	sufficient telemetry data. However, the limitations associated with the respective methods (discussed in Russell and Carter 2020) should be considered during interpretation. Critically, for both the usage maps (Russell et al. 2017) and the habitat preference maps (Carter et al. 2020), the confidence intervals are calculated on a cell-by-cell (5 x 5 km cell) basis and thus should not be summed over multiple cells to generate lower or upper confidence intervals for a wider area (e.g. a wind farm footprint). The habitat preference maps present at-sea seal density values as relative abundance (i.e. percentage of the at-sea population of the study area estimated to be in a cell at any one time), rather than absolute abundance (i.e. number of animals per cell). This is because the conversion process from relative to absolute abundance involves certain assumptions and caveats (discussed below). Thus, relative density maps (rather than absolute) should be used whenever possible. Nevertheless, absolute abundance estimates are required for certain applications. The process for estimating absolute density is detailed below. The at-sea abundance estimates used the most recent available haulout count data up to 2018, but can be updated in the future with more up-to-date counts. Currently, uncertainty around the size of the at-sea population (at individual haulout sites or overall) cannot be incorporated into the maps; the lower and upper confidence intervals for absolute density maps only represent uncertainty in the habitat preference relationships, and therefore relate to uncertainty in the spatial distribution of a fixed number of seals emanating from each haulout area. The predicted at-sea abundances are derived from combining the haulout counts which were used to generate the relative densities, the estimated proportion of the population hauled out and thus available to count during surveys, and the estimated proportion of the total population at sea during the main foraging season (i.e. excluding breeding and moulting). The latest at-sea maps of seal distribution (Carter et al. 2020) provide a relative index of density (the percentage of the total at-sea abundance, i.e. the mean maps will sum to 100% across all grid cells). Separate maps of 95% upper and lower confidence intervals associated with these mean relative density values are also provided. These confidence intervals encompass only the uncertainty in the habitat preference relationships (i.e. the latest haulout count was considered for each 5 x 5 km cell; no uncertainty in the relative weighting of haulout counts was incorporated). The density estimates (percentage of total at-sea population) presented in these maps were based on weighting the predicted at-sea distribution emanating from each 5 x 5 km haulout grid cell by its most recent August count. To convert these relative estimates to absolute estimates, the first step is to convert the total from the above-mentioned August haulout counts (36,982 and 46,763 for harbour and grey seals, respectively) into a population estimate, accounting for the seals that were at sea during the surveys. This was done using the mean estimated proportion of the population hauled out during the survey window, and thus available to count, from telemetry data: 0.72 for harbour seals (Lonergan et al. 2013) and 0.2515 for grey seals (SCOS-BP 21/02).	

Consultee	Document / Date	Comment	Response / where addressed in the EIA Report
		The second step is to estimate the mean total at-sea abundance during the months over which the maps represent (i.e. excluding breeding and moulting) using the proportion of the population estimated to be at sea; estimated to be is 0.8236 for harbour seals (October to May; Russell et al. 2015) and 0.8616 for grey seals (May to August; Russell et al. 2015). This results in an estimated at-sea total of 42,303 harbour and 160,203 grey seals9. These values could be used to calculate mean predicted absolute abundance over any number of grid cells by multiplying the percentage value in each cell of by the estimated total at-sea abundance for the species and summing this value over all grid cells of interest. Note that the proportion of the population estimated to be at sea is averaged across days and years, and thus does not account for variation in the proportion of time spent at-sea with season and state of tide. Moreover, lower and upper confidence limits for absolute density maps do not capture uncertainty related to variation in the proportion of time spent at-sea throughout the year, thus relative density maps should be used where possible."	

11.4 Assessment Methodology

11.4.1 Impact Assessment Methodology

22. The approach to the assessment for marine mammals follows the methodology set out in **Chapter 6: EIA Methodology**. The following sections describe the methodology used to assess the potential impacts of the Project on marine mammals in more detail.

23. The approach to determining the significance of an effect follows a systematic process for all impacts. This involves identifying, qualifying and, where possible, quantifying the sensitivity, value and magnitude of all ecological receptors which have been scoped into this assessment. Using this information, a significance of each potential effect has been determined using a matrix approach.

24. The assessment of impacts for marine mammals following best practice, EIA guidance and the Marine Scotland (2020) and JNCC *et al*. (2010) guidance.

11.4.1.1 Sensitivity

25. The sensitivity of a marine mammal receptor is determined through its ability to accommodate change and on its ability to recover if it is negatively affected. The sensitivity level of marine mammals to each type of impact is justified within the impact assessment and is dependent on the following factors:

- Adaptability – The degree to which a receptor can avoid or adapt to an impact
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect
- Recoverability – The temporal scale over and extent to which a receptor will recover following an impact
- Value – A measure of the receptor's importance and rarity (as reflected in the species conservation status and legislative importance, see **Section 11.4.1.2**)

26. **Table 11.3** defines the levels of sensitivity and what they mean for the receptor. The sensitivity to potential impacts of lethality, physical injury, auditory injury or hearing impairment, as well as behavioural disturbance or auditory masking are considered for each species, using available evidence including published data sources.

Table 11.3: Definitions of Sensitivity Levels for marine mammals

Sensitivity	Definition
High	Individual receptor has very limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact.
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.

11.4.1.2 Value

27. In addition, the 'value' of the receptor forms an important element within the assessment, for instance, if the receptor is a protected species. It is important to understand that high value and high sensitivity are not necessarily linked. A receptor could be of high value (e.g. an Annex II species) but have a low or negligible physical / ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis.

28. Most species of marine mammals are protected by a number of national and international legislation All cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin, grey seal and harbour seal are Annex II species and also afforded international protection through the designation of European sites. As such, all species of marine mammal and basking shark can be considered to be of high value.

29. The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement. **Table 11.4** provides definitions for the value afforded to a receptor based on its legislative importance.

Table 11.4 Definitions of Value Levels for Marine Mammals

Value	Definition
High	Internationally or nationally important Internationally protected species that are listed as a qualifying interest feature of an internationally protected site (i.e. Annex II protected species designated feature of a European designated site) and protected species (including EPS) that are not qualifying features of a European designated site..
Medium	Regionally important or internationally rare Protected species that are not qualifying features of a European designated site, but are recognised as a Biodiversity Action Plan (BAP) priority species either alone or under a grouped action plan, and are listed on the local action plan relating to the marine mammal Study Area.
Low	Locally important or nationally rare Protected species that are not qualifying features of a European designated site and are occasionally recorded within the Study Area in low numbers compared to other regions.
Negligible	Not considered to be or particular important or rare Species that are not qualifying features of a European designated site and are never or infrequently recorded within the Study Area in very low numbers compared to other regions.

11.4.1.3 Conservation Status

30. When assessing potential impacts consideration is also given to the Conservation Status of a species. There are three parameters that determine when the Conservation Status of a species can be taken as Favourable:

- Population(s) of the species is maintained on a long-term basis
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future
- The habitat on which the species depends (for feeding, breeding, rearing etc.) is maintained in sufficient size to maintain the population(s) over a period of years/decades.

31. In the UK the Conservation Status of marine mammals is reported every six years by the JNCC. **Table 11.5** presents the Conservation Status of marine mammal species relevant for the Project based the most recent 2013-2018 reporting (JNCC, 2019).

Table 11.5: Conservation Status of Marine Mammal Species (JNCC, 2019) Relevant for the Project

Species	Conservation Status
Harbour porpoise Phocoena phocoena	Unknown
Bottlenose dolphin Tursiops truncatus	Unknown
White-beaked dolphin Lagenorhynchus albirostris	Unknown
Atlantic white-sided dolphin Lagenorhynchus actus	Unknown
Risso's dolphin Grampus griseus	Unknown
Minke whale Balaenoptera acutorostrata	Unknown
Humpback whale Megaptera novaeangliae	Not assessed
Grey seal Halichoerus grypus	Favourable
Harbour seal Phoca vitulina	Unfavourable – Inadequate

11.4.1.4 Magnitude

32. The significance of the potential effects is also based on the intensity or degree of impact to the baseline conditions and is categorised into four levels of magnitude: high; medium; low; or negligible, as defined in **Table 11.6**.

33. Determining the magnitude of an impact considers several factors, including:

- Type of activity: will the effects be permanent or temporary
- Duration and frequency of the activity
- Extent of the activity
- Timing and location of the activity

34. The thresholds defining each level of magnitude of impact for each impact have been determined based on current scientific understanding of marine mammal population biology, JNCC *et al*. (2010) draft guidance on disturbance to EPS species and the Marine Scotland (2020) Guidance for Scottish Inshore Water for the protection of Marine EPS from injury and disturbance.

35. The magnitude of each impact is calculated or described in a quantitative or qualitative way within the assessment. Where possible the number individuals of a species that could potentially be affected by the activity has been determined, and to what extent the relevant population could be affected.

36. There are currently no agreed thresholds to determine magnitude of impact for marine mammals. The JNCC *et al*. (2010) EPS draft guidance suggests definitions for a 'significant group' of individuals or proportion of the population for EPS species. As such this guidance has been considered in defining the thresholds for magnitude of impact.

37. The JNCC *et al*. (2010) draft guidance provides some indication on how many animals may be 'removed' from a population without causing detrimental effects to the population at FCS. The JNCC *et al*. (2010) draft guidance also provides limited consideration of temporary impacts, with guidance reflecting consideration of permanent displacement.

38. The number of animals that can be 'removed' from a population through injury or disturbance varies between species but is largely dependent on the growth rate of the population; populations with low growth rates can sustain the removal of a smaller proportion of the population than one with a larger growth rate.

39. Temporary impacts are considered to be of medium magnitude at greater than 5% of the reference population being affected within one year. JNCC *et al*. (2010) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth would be halted. In assigning 5% to a temporary impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

40. Permanent impacts to greater than 1% of the reference population being affected within a single year are considered to be high magnitude in this assessment. This is based on ASCOBANS and Department for Environment, Food and Rural Affairs (Defra) advice (Defra, 2003; ASCOBANS, 2015) relating to impacts from fisheries by-catch (i.e. a permanent effect) on harbour porpoise. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to ASCOBANS, with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra, 2003; ASCOBANS, 2015).

Table 11.6 Definitions of Magnitude Levels for Marine Mammals

Magnitude	Definition
High	Permanent irreversible change to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 1% of the reference population are anticipated to be exposed to the impact. OR Long-term impact for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that more than 5% of the reference population are anticipated to be exposed to the impact. OR Temporary impact (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 10% of the reference population are anticipated to be exposed to the impact.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.01% and 1% of the reference population anticipated to be exposed to impact. OR Long-term impact for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that between 1% and 5% of the reference population are anticipated to be exposed to the impact. OR Temporary impact (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 5% and 10% of the reference population anticipated to be exposed to impact.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.001% and 0.01% of the reference population anticipated to be exposed to impact. OR Long-term impact for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that between 0.01% and 1% of the reference population are anticipated to be exposed to the impact . OR Intermittent and temporary impact (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to impact.

Magnitude	Definition
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that less than 0.001% of the reference population anticipated to be exposed to impact. OR Long-term effect for 10 years or more (but not permanent, e.g. limited to lifetime of the projects). Assessment indicates that less than 0.01% of the reference population are anticipated to be exposed to the impact. OR Intermittent and temporary impact (limited to the construction phase of development or project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that less than 1% of the reference population anticipated to be exposed to impact.

11.4.1.5 Effect significance

41. The potential significance of an effect is a function of the sensitivity of the receptor and the magnitude of the effect (see **Chapter 6: EIA Methodology** for further details). The determination of significance is guided by the use of an effect significance matrix, as shown in **Table 11.7**. Definitions of each level of significance are provided in **Table 11.8**.

42. Potential effects identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations. Appropriate mitigation, including embedded mitigation, has been identified, where possible. The aim of mitigation measures is to avoid or reduce the overall impact in order to determine a residual impact upon a given receptor.

Table 11.7 Effect Significance Matrix

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 11.8: Effect Significance Definitions

Effect significance	Definition
Major	Very large or large change in receptor, either adverse or beneficial, which are important at a population (national or international) level because they contribute to achieving national or regional objectives, or, expected to result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate or large change in receptor, which may to be important considerations at national or regional population level. Potential to result in exceedance of statutory objectives and / or breaches of legislation.
Minor	Small change in receptor, which may be raised as local issues but are unlikely to be important at a regional population level.
Negligible	No discernible change in receptor condition.
No impact	No impact, therefore no change in receptor condition.

11.4.2 Cumulative Impact Assessment Methodology

43. The Cumulative Impact Assessment (CIA) considers other plans, projects and activities that may have cumulative impacts with the Project. As part of this process, the assessment considers which of the residual impacts assessed for the Project on their own have the potential to contribute to a cumulative impact, the data and information available to inform the cumulative assessment and the resulting confidence in any assessment that is undertaken. **Chapter 6: EIA Methodology** provides further details of the general framework and approach to the CIA.

44. The types of plans and projects taken into consideration (see **Appendix 11.1: Marine Mammal CIA Screening**) are:

- Other offshore wind farms (including construction, operation and decommissioning)
- Marine Renewable Energy (MRE) developments (wave and tidal)
- Aggregate extraction and dredging
- Licenced disposal sites
- Shipping and navigation
- Planned construction sub-sea cables and pipelines
- Carbon Capture Storage (CCS) activities
- Potential port/harbour development
- Oil and gas development, operation and decommissioning, including seismic surveys
- Unexploded ordnance (UXO) clearance
- Commercial fishing
- Geophysical surveys

45. For the marine mammal assessment, the different stages of project development, especially for other offshore wind farm projects have been taken into account within the CIA screening (**Appendix 11.1**):

   1. built and operational projects
   2. projects under construction
   3. projects that have been consented (but construction has not yet commenced)
   4. projects that have an application submitted to the appropriate regulatory body that have not yet been determined
   5. projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects)
   6. projects that have been identified in relevant strategic plans or programmes.

46. The plans and projects considered in the CIA are:

- Located in the relevant marine mammal Management Unit (MU) population reference area or the North Sea area for all marine mammal species; and
- Offshore projects and developments, if there is the potential for cumulative impacts during the construction, operational or decommissioning of the Project.

47. The CIA considers projects, plans and activities which have sufficient information available to undertake the assessment. Insufficient information will preclude a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances.

11.4.3 Transboundary Impact Assessment Methodology

48. The transboundary assessment considers the potential for transboundary effects to occur on marine mammal species. The highly mobile nature of marine mammals included within the assessments means that there is the potential for transboundary impacts since species might arise from areas outwith UK waters.

49. For marine mammals, the potential for transboundary impacts has been addressed by considering the reference populations (MUs) and potential linkages to other countries (for example, as identified through seal telemetry studies).

11.4.4 Inter-Relationships Methodology

50. This assessment considers the potential for there to be inter-relationships between impacts; whereby impacts may act together to affect a single receptor, or where an impact on one receptor, may in turn indirectly impact another receptor (e.g. an impact on prey fish species may in turn impact food availability for marine mammals).

11.4.5 Interactions Methodology

51. The assessment considers the potential impacts for marine mammals have the potential to interact with each other and could give rise to synergistic impacts due to that interaction.

11.5 Scope

11.5.1 Marine Mammal Species

52. The marine mammal species agreed during scoping for the Project (see **Section 11.3**) and determined from the site-specific aerial surveys (see **Section 11.6.1**) and other data sources (see **Section 11.5.3**) under consideration for the assessment are:

- Harbour porpoise
- Bottlenose dolphin
- White-beaked dolphin
- Atlantic white-sided dolphin
- Risso's dolphin
- Minke whale
- Humpback whale
- Grey seal
- Harbour seal

11.5.2 Study Area

53. The Study Area for marine mammals has been defined on the basis that marine mammals are highly mobile and transitory in nature. It is, therefore, necessary to examine species occurrence not only in and around the Project area, but also over the wider area.

54. For the marine mammal species in the assessments, the following Study Areas have been defined, based on the relevant MUs (IAMMWG, 2022), current knowledge and understanding of the biology of each species.

55. MUs provide an indication of the spatial scales at which effects of plans and projects alone, cumulatively and in-combination, need to be assessed for the key cetacean species in UK waters, aiding consistency across the UK (IAMMWG, 2022). The Study Area, MUs and reference populations have been determined based on the most relevant information and scale at which potential impacts from the Project with other plans and projects could occur.

56. Relevant marine mammal MUs for the Project:

- Harbour porpoise: North Sea (NS) MU (**Figure 11.1**; IAMMWG, 2022)
- Bottlenose dolphin: Coastal East Scotland (CES) MU and Greater North Sea (GNS) MU (**Figure 11.2**; IAMMWG, 2022)
- White-beaked dolphin: Celtic and Greater North Seas (CGNS) MU (**Figure 11.3**; IAMMWG, 2022)

- Atlantic white-sided dolphin: CGNS MU (**Figure 11.3**; IAMMWG, 2022)
- Risso's dolphin: CGNS MU (**Figure 11.3**; IAMMWG, 2022)
- Minke whale: CGNS MU (**Figure 11.3**; IAMMWG, 2022)
- Humpback whale: no MU defined for UK waters (see Section 11.6.2.6 for more information on the MU used for this species)
- Grey seal: East Scotland (EaS) and the Moray Firth (MoF) MUs (**Figure 11.4**; Special Committee on Seals (SCOS), 2020)
- Harbour seal: EaS and the MoF MUs (**Figure 11.5**; SCOS, 2021).

57. The North Sea area has been used in the CIA for all marine mammal species.

58. The nearest major haul-out sites for both seal species to the Project are:

- Ythan River mouth (19 km) and Findhorn (116 km) located from the nearest part of (closest swimmable distance) the Landfall Export Cable Corridor and landfall locations.

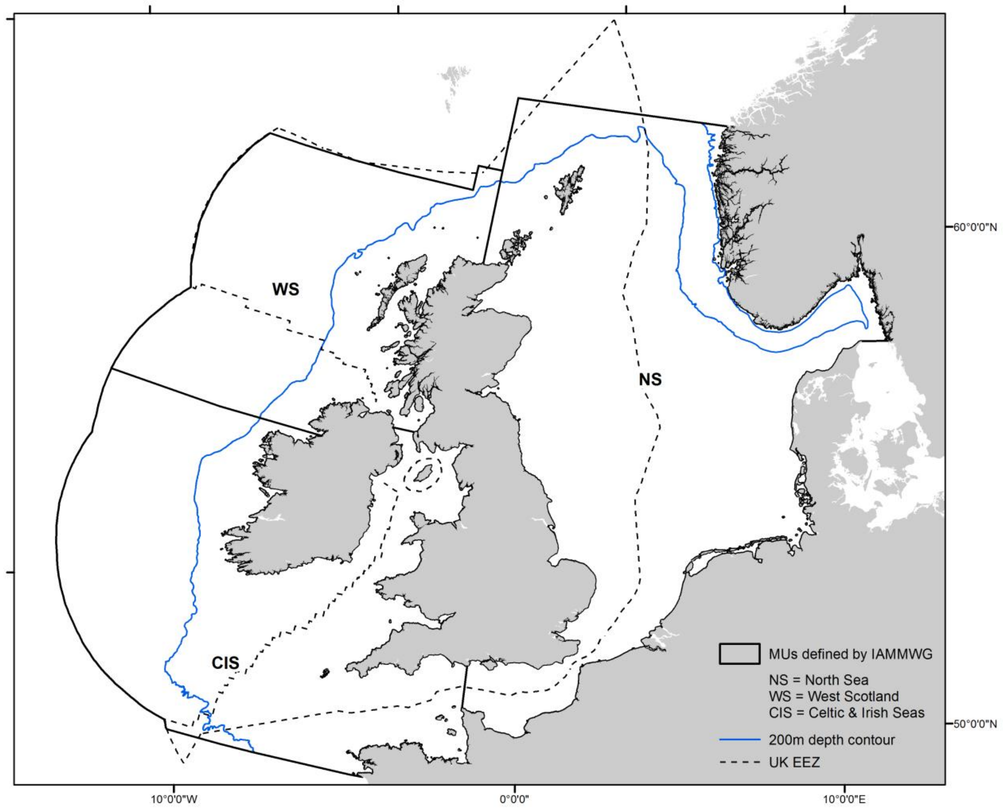

Figure 11.1: Harbour porpoise MUs (IAMMWG, 2022)

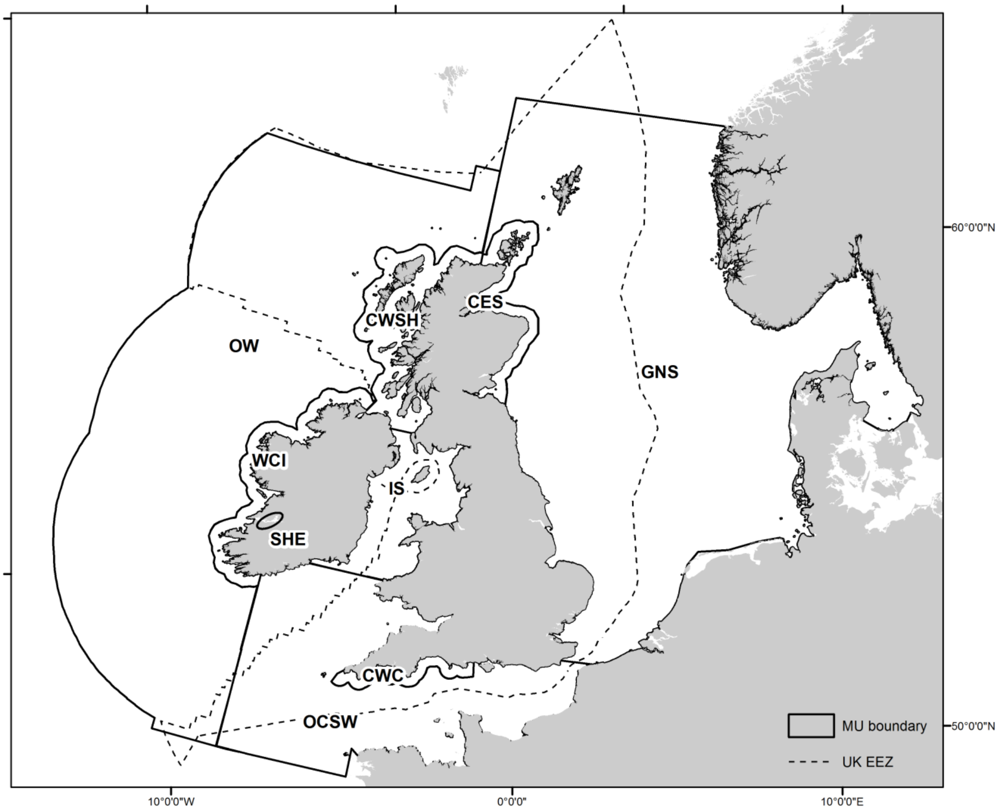

Figure 11.2: Bottlenose dolphin MUs (IAMMWG, 2022)

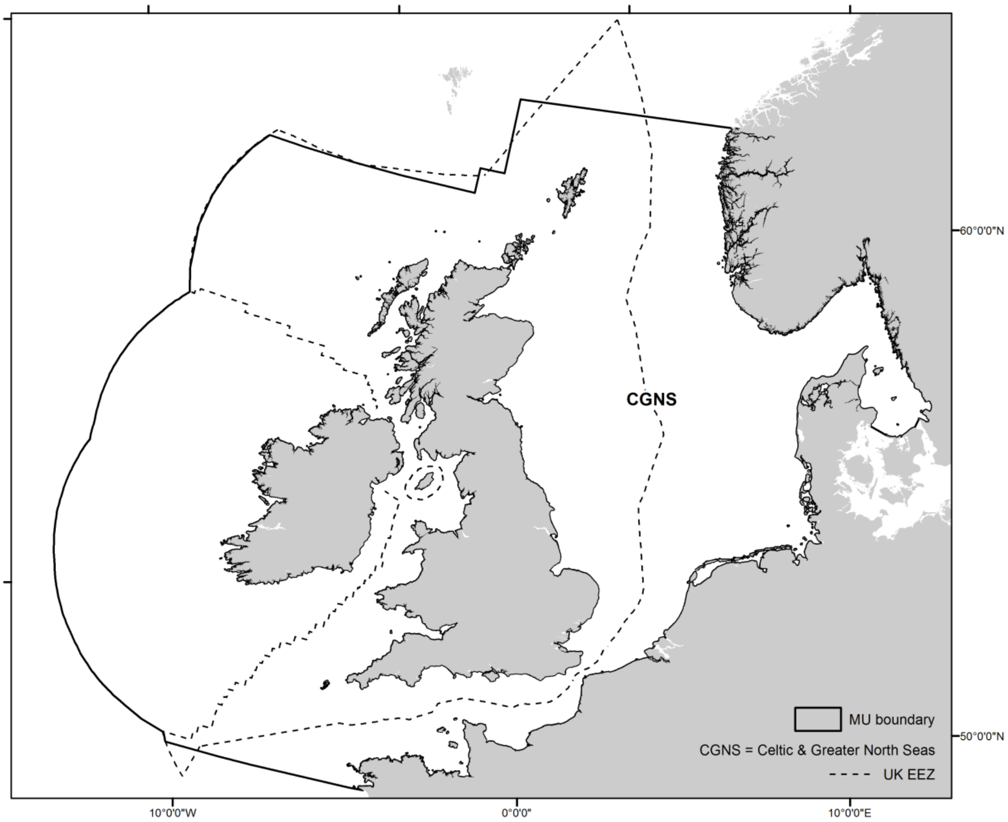

Figure 11.3: MU for white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and minke whale (IAMMWG, 2022)

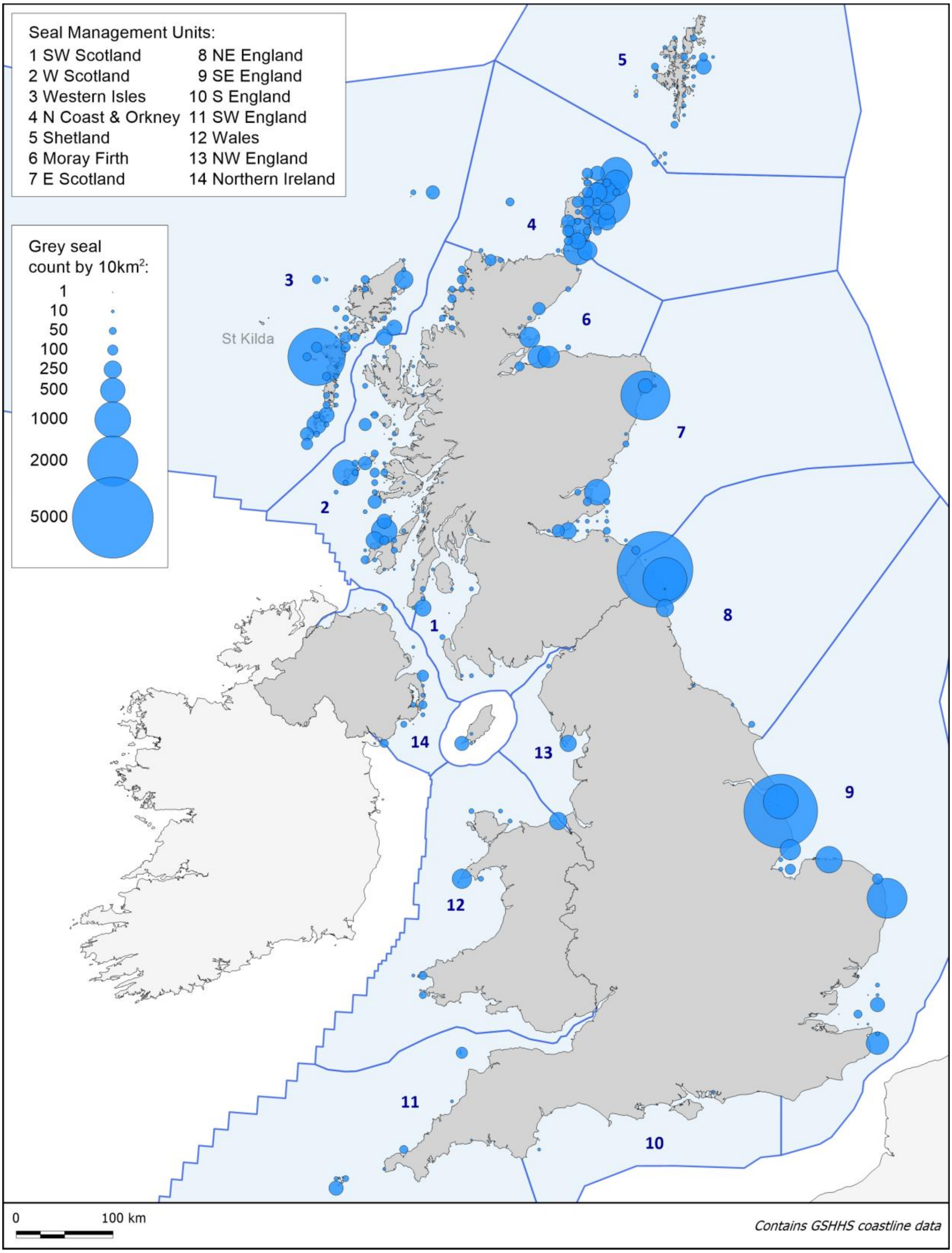

Figure 11.4: Grey seal MUs (SCOS, 2020)

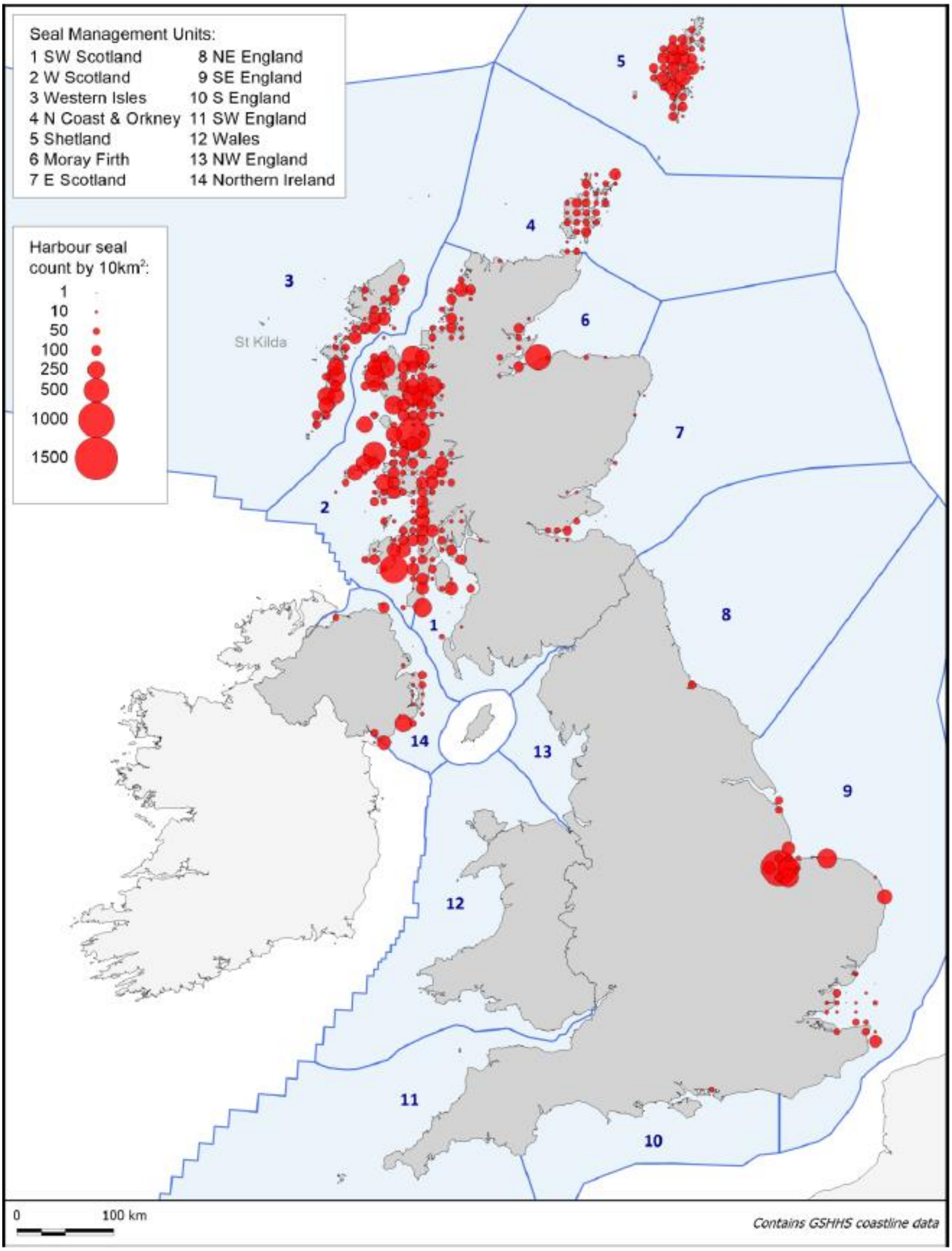

Figure 11.5: Harbour seal MUs (SCOS, 2021)

11.5.3 Data Sources

59. A number of publicly available datasets and information on marine mammal have been used to determine the baseline information and existing environment for marine mammals. These data sources have been reviewed along with the information from the site-specific aerial surveys (**Section 11.6.1**). The main data sources used in the baseline review are listed in **Table 11.9.**

Table 11.9: Data Sources

Data	Year	Coverage	Confidence	Notes
Site-specific digital aerial surveys (**Appendix 12.1**; HiDef, 2022).	May 2020 to April 2022	1 km-spaced transects across the development area plus a 4 km surrounding buffer ('the survey area'). The total survey area was approximately 391 km^2.	High	A total of 24 surveys were flown, roughly one per month, between May 2020 and April 2022.
Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond *et al*., 2021).	Summer 2016	North Sea and European Atlantic waters	High	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2016, including the proposed offshore development area.
Distribution and abundance maps for cetacean species around Europe (Waggitt *et al*., 2019).	1980-2018	Northeast Atlantic	High	Provides information on cetacean species in the wider North Sea area.
East Coast Marine Mammal Acoustic Study (ECOMMAS)	2013-2016	East coast of Scotland inshore waters	High	Passive acoustic (Cetacean Porpoise Detectors (CPODs)) data at 30 locations on the east coast. Deployed for four months (summer) in 2013 and 2014, and eight months (April to November) in 2015 and 2016.
Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (e.g. Paxton *et al*., 2016).	1994-2011	UK Exclusive Economic Zone (EEZ)	High	Provides information on cetacean species in the wider North Sea area.
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov, 2015).	1994-2011	UK EEZ	High	Data was used to determine harbour porpoise SAC sites. Provides information on harbour porpoise in the North Sea area.
MUs for cetaceans in UK waters (IAMMWG, 2022).	2022	UK waters	High	Provides information on cetacean MUs for UK waters including the Project area.
MUs for cetaceans in North Atlantic waters (North Atlantic Marine Mammal Commission (NAMMCO), 2020).	Various	North Atlantic waters	Medium	Provides additional information on cetacean MUs not included in IAMMWG (2022).
Sea Watch Foundation volunteer sightings off North-east Scotland (Sea Watch Foundation, 2022).	2019-2022	North-east Scotland	Medium to Low	Provides information on species in East Grampian region (volunteer sightings).
ORCA surveys on ferry routes from Aberdeen (ORCA, 2022).	2016-2022	Aberdeen to Lerwick	Medium	Provides information on species in the Northern North Sea ferry routes (trained volunteers)
Offshore Energy Strategic Environmental Assessment (including relevant appendices and technical reports) (Department of Energy and Climate Change (DECC) (now	2016	UK waters	High	Provides information for the wider North Sea area.

Data	Year	Coverage	Confidence	Notes
Department for Business, Energy and Industrial Strategy (BEIS)), 2016).				
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (Carter *et al*., 2020).	1991-2019	British Isles	High	Provides information on abundance and absolute density estimates (i.e. number of seals) for seal species.
Seal telemetry data (e.g. Sharples *et al*., 2008; Russell and McConnell, 2014; Russell, 2016).	1988-2010; 2015	North Sea	High	Provides information on relative density (i.e. percentage of at-sea population) for seal species.
SCOS annual reporting of scientific advice on matters related to the management of seal populations (SCOS, 2020, 2021).	2020 & 2021	North Sea	High	Provides information on movements and distribution of seal species.
Relevant information from nearby oil and gas fields, including the Buzzard, Ettrick and Blackbird fields (Nexen, 2005, 2010, 2016; EnCana, 2003; Fugro, 2013), Kincardine Offshore Windfarm Environmental Statement (ES) (Atkins, 2016) and NorthConnect ES.	2005-2016	North Sea	High to Medium	Provides information on marine mammals from surveys at nearby oil and gas fields.
Relevant information from other offshore wind farms (e.g. Moray East Offshore Wind Farm EIA characterisation surveys and Moray Firth Marine Mammals Monitoring Programme).	2014-ongoing	Moray Firth and North East Scotland	High	Provides context to the Project site-specific surveys

11.5.4 Assumptions and Limitations

60. Due to the large amount of available data and information (**Section 11.5.3**) that has been reviewed for marine mammals within the region, including the site-specific surveys, there is a good understanding of the existing environment. There are, however, some limitations to data collected by marine mammal surveys, primarily due to the highly mobile nature of marine mammals and therefore the potential variability in usage of the site; each survey provides only a ‘snapshot’. The majority of the surveys, such as SCANS are typically carried out in summer months which can result in seasonal gaps. However, the site-specific aerial surveys were conducted every month during the two year survey period (**Appendix 12.1**; HiDef, 2022). Therefore, taking into account the site-specific survey and data from other surveys, such as nearby the Ettrick, Blackbird and Buzzard fields for different months, seasons and years, there is good coverage to provide information on the species likely to present in the area.

61. There are acknowledged limitations in the detectability of marine mammals from aerial surveys, such as not being to detect those individuals that are submerged. To address these limitations a correction factor is used to account for availability bias for harbour porpoise at different times of the year and at different times of the day during the site-specific aerial surveys (**Appendix 12.1**; HiDef, 2022).

62. As a precautionary approach, density estimates for each marine mammal species used in the assessments are based on the highest for the area, see **Section 11.6**.

63. Where possible, an overview of the confidence of the data and information underpinning the assessment is presented in **Table 11.9**. Confidence is classed as High, Medium or Low depending on the type of data (quantitative, qualitative or lacking) as well as the source of information (e.g. peer reviewed publications, grey literature) and its applicability to the assessment.

64. Where possible, any data gaps have been addressed by using a wide range of data sources covering different months, seasons and years.

11.6 Existing Environment

65. In UK waters, two groups of marine mammals occur: cetaceans (whales, dolphins and porpoises) and pinnipeds (seals). Assessments of the distribution of marine mammals throughout the North Sea (data sources listed in **Table 11.9**), species recorded during the site-specific aerial surveys and consultation responses have identified nine marine mammal species that could occur in the waters in and around the Offshore Development Area. As outlined in **Section 11.5.1**, the key species of interest and therefore the focus of the assessments are:

- Harbour porpoise – present throughout the year, although may be variations in numbers.
- Bottlenose dolphin – present throughout the year, although may be variations in seasonal occurrence and could be present in coastal areas more than offshore areas.
- White-beaked dolphin – seasonal occurrence.
- Atlantic white-sided dolphin - distribution mainly in deeper offshore waters during the summer months but could be present in low numbers throughout the year, could be present in mixed groups with white-beaked dolphin.
- Risso's dolphin - present throughout the year, although there may be variations in seasonal occurrence.
- Minke whale – seasonal occurrence.
- Humpback whale - increase in sightings in the North Sea from the Forth north to Shetland in recent years.
- Grey seal – present throughout the year.
- Harbour seal – present throughout the year.

66. Other marine mammal species that have been recorded in the north-east region of Scotland include short-beaked common dolphin *Delphinus delphis*, killer whale *Orcinus orca*, long-finned pilot whale *Globicephala melas*, sperm whale *Physeter macrocephalus* and fin whale *Balaenoptera physalus*. However, these species are likely to be in lower numbers and less frequent in the waters in and around the Offshore Development Area than the key species of interest listed above.

11.6.1 Site-Specific Aerial Surveys

67. Site-specific monthly aerial surveys have been conducted for both marine mammals and seabirds by HiDef Aerial Surveying Limited (HiDef). A total of 24 high-resolution digital video aerial surveys were conducted, roughly one per month, between May 2020 and April 2022 (HiDef, 2022). HiDef designed the survey with 1 km-spaced transects across the entire Windfarm Site plus a 4 km surrounding buffer (see **Appendix 12.1** and **Chapter 12: Offshore and Intertidal Ornithology**). The total survey area was approximately 391 km^2. The survey design, with 21 strip transects extending roughly north to south, perpendicular to the depth contours along the coast, ensured that each transect samples a similar range of habitats (primarily relating to water depth), to reduce the variation in marine mammal abundance estimates between transects.

68. Surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2 cm Ground Sample Distance (GSD). Each camera sampled a strip of 125 m width, separated from the next camera by approximately 25 m, providing a combined sampled width of 500 m within a 575 m overall strip.

69. A minimum target of 25% site coverage was achieved, with data from two out of the four cameras being processed. This ensured a survey with sufficient coverage and number of transects for precise abundance estimation, with the remaining unprocessed data archived.

70. The surveys were flown along the transect pattern at a height of approximately 550 m above sea level. Position data for the aircraft was captured with differential Global Positioning System (GPS)

enabled to give 1 m accuracy for the positions and recording updates in location at one second intervals for matching to marine mammal observations.

71. Data analysis follows a two-stage process in which video footage is reviewed (with a 20% random sample used for audit) then the detected objects are identified to species or species group level (again with 20% selected at random for audit). The audit of both stages requires 90% agreement to be achieved. Further details on the data collection and analysis are provided in **Appendix 12.1**.

72. **Table 11.10** shows the numbers of marine mammals recorded during the aerial surveys from May 2020 to April 2022. The observations indicate that harbour porpoise is present in the highest numbers.

Table 11.10: Species Recorded during the HiDef Aerial Surveys between May 2020 and April 2022.

Species	Number of individuals		
	Year 1	Year 2	Total
Harbour porpoise	193	31	224
Bottlenose dolphin	0	1	1
White-beaked dolphin	0	5	5
Risso's dolphin	1	0	1
Dolphin species	1	6	7
Cetacean species	1	31	32
Grey seal	3	2	5
Seal species	4	5	9
Seal / small cetacean species	2	0	2

73. Harbour porpoise was the most abundant marine mammal species recorded during the two-year survey period, peaking in July 2020 with 106 records. July 2020 records were significantly higher than other months, which ranged from 0 to 25 individuals per month in year 1 and 0 to 8 in year 2.

11.6.2 Cetaceans

74. Marine mammal information for the Ettrick, Blackbird and Buzzard fields indicates that the cetacean species that could be present in and around the Windfarm Site area (the equivalent of the oil and gas UK Continental Shelf (UKCS) Blocks 20/2a, 20/3a, 19/5, 20/1, 19/10 and 20/6 in the central North Sea[2], shown on **Figure 17.2**) are minke whale, killer whale, bottlenose dolphin, common dolphin, white-beaked dolphin, white-sided dolphin, Risso's dolphin and harbour porpoise, based on information from UKDMap (1998), Reid *et al.* (2003), Nexen (2005, 2010, 2016) and EnCana (2003).

75. Marine mammal observations during seismic survey of the Blackbird field (UKCS Blocks 20/2, 20/3, 20/7, 20/8) in June 2013, recorded two unidentified dolphin species during transit, one minke whale during a seismic line, eight minke whale and ten white-beaked dolphin during transit between lines (Fugro, 2013). No marine mammals were observed in the Buzzard development area prior to or during either site survey operations in July/August 2001 and March 2002 (Hydrosearch, 2002; EnCana, 2003).

76. Passive Acoustic Monitoring (PAM) during the ECOMMAS, in summer months of 2013 and 2014 and April to November in 2015 and 2016, recorded harbour porpoise daily at most sites around the east coast of Scotland. Locations with the greatest porpoise detection rates were the further offshore sites at Spey Bay and Fraserburgh, in the southern Moray Firth and Arbroath, Angus. Locations with the lowest porpoise detections were coastal sites at Spey Bay, Cromarty, in the Moray Firth area and Helmsdale, Sutherland. The distribution patterns of dolphin and porpoise were similar each year. Generally, the daily detection rates for bottlenose dolphin were lower than for harbour porpoise, however where dolphin detections were higher, harbour porpoise detections were reduced.

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[2] *https://www.nstauthority.co.uk/media/1508/28r_award_map3_nsc.pdf*

77. Volunteer based sightings data from around Scotland are collected by various organisations through shore watches, distance sampling surveys on ferry routes and collection of casual observations. ORCA dedicated vessel-based marine mammal watches following various routes within Scottish waters (Hague *et al.,* 2020). ORCA has been collecting survey data from the Aberdeen to Lerwick since 2016 and have recorded sightings of harbour porpoise, bottlenose dolphin, white-beaked dolphin, common dolphin, killer whale and minke whale within the region of the project including the Landfall Export Cable Corridor and landfall (ORCA, 2022). The Offshore Development Area, including the Landfall and Export Cable Corridor are within the East Grampian region of the Sea Watch sightings data and between the 14th September 2021 – 30th January 2022 six species of cetacean including harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, Killer whale and minke whale were recorded in the region alongside both species of seal (Sea Watch Foundation, 2022).

78. A large-scale survey of the presence and abundance of cetacean species around the north-east Atlantic, undertaken in the summer of 2016 (SCANS-III survey; Hammond *et al.,* 2021), indicates harbour porpoise to be the most common cetacean species present in the relevant survey blocks (R and T). Other cetacean species recorded in survey blocks R and T include bottlenose dolphin, white-beaked dolphin, white-sided dolphin and minke whale (**Figure 11.6**).

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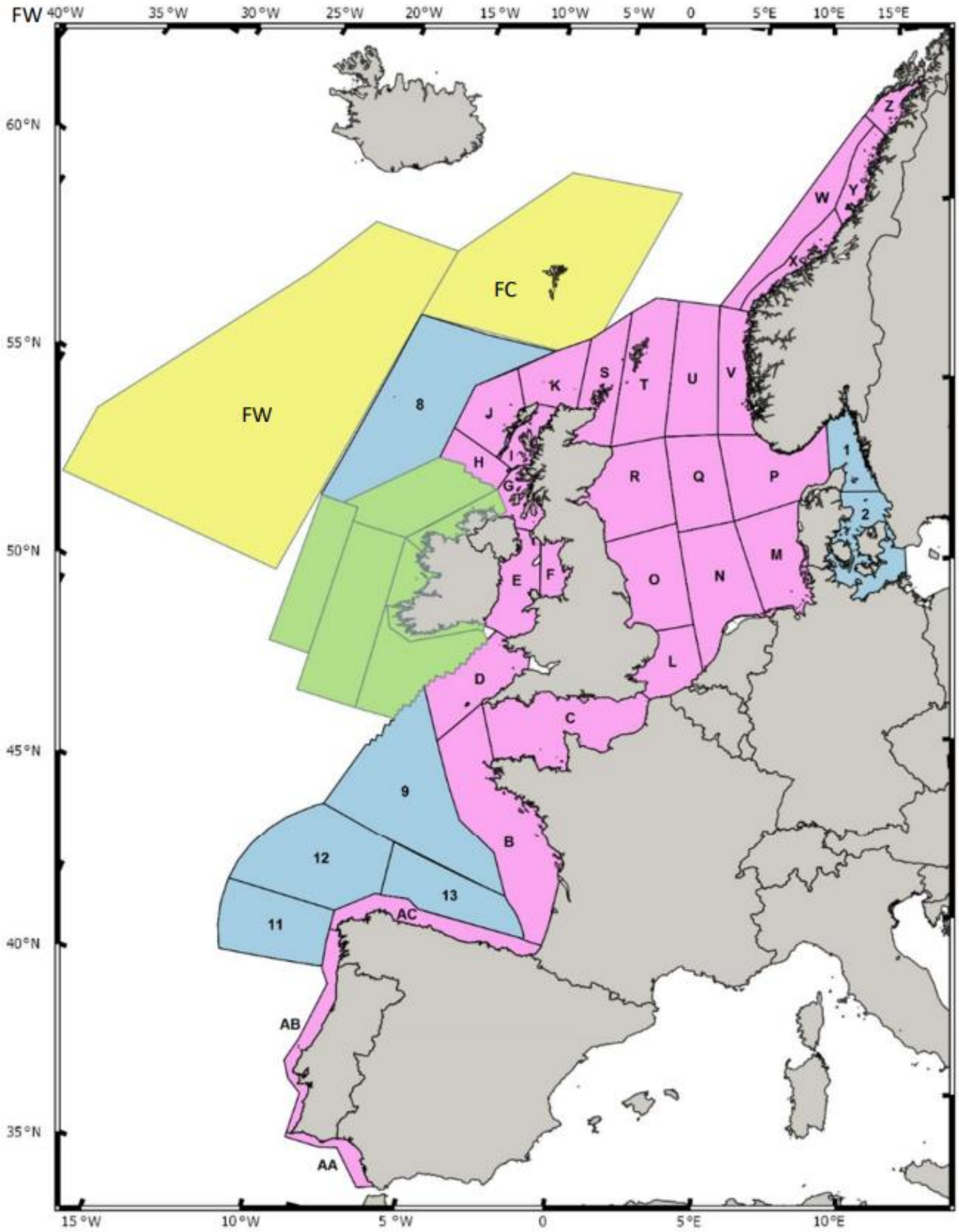

Figure 11.6 Area covered by SCANS-III and adjacent surveys. SCANS-III: pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green were surveyed by the Irish ObSERVE project. B (Hammond et al., 2021).

79. The JCP Phase III report (Paxton *et al.,* 2016) shows similar results, with relatively high densities of harbour porpoise off north-east Scotland, moderate densities of minke whale and white-beaked dolphin, and relatively low densities of bottlenose dolphin, Risso's dolphin, short-beaked common dolphin and Atlantic white-sided dolphin. Killer whale was not included within this report.

80. Distribution and abundance maps have been developed by Waggitt *et al.* (2019) for cetacean species around the north-east Atlantic. These maps were generated based on a collation of survey effort across the north-east Atlantic between 1980 and 2018, with a total of 1,790,375 km of survey effort for cetaceans. All survey data was standardised to generate distribution maps at 10 km resolution, with maps generated for each species included for each month of the year. Distribution maps of cetacean species within the north-east Atlantic also indicate that harbour porpoise and white-beaked dolphin are present off north-east Scotland in the highest densities, followed by Risso's dolphin, killer

whale and minke whale, while bottlenose dolphin[3], short-beaked common dolphin and Atlantic white-sided dolphin are present but in lower densities (Waggitt *et al.,* 2019).

11.6.2.1 Harbour Porpoise

81. Within the North Sea, harbour porpoise are the most common marine mammal species. Heinänen and Skov (2015) identified that within the North Sea, water depth and hydrodynamic variables are the most important factors in harbour porpoise densities in species areas, in both winter and summer seasons. The seabed sediments also play an important role in determining areas of high harbour porpoise density, as well as the number of vessels present in the area.

82. Harbour porpoise were detected at all ECOMMAS PAM sites along the east coast of Scotland in all survey years between 2013 and 2019. Detection rates were generally lower at the most coastal sites, and where there is overlap with known bottlenose dolphin ranges (Hague *et al*., 2020).

83. Results from the SCANS-III survey (undertaken in summer 2016; Hammond *et al.,* 2021) also indicate that the occurrence of harbour porpoise is greater in the central and southern areas of the North Sea compared to the northern North Sea. The Windfarm Site is located in survey SCANS-III survey block T and the Buzzard Platform Complex and Landfall Export Cable Corridors is located in blocks R and T where:

- Survey block T abundance estimate = 26,309 harbour porpoise (95% Confidence Interval (CI) = 14,219-45,280); density estimate = 0.402 individuals/km^2 (Coefficient of Variation (CV) = 0.295); and
- Survey block R abundance estimate = 38,646 harbour porpoise (95% CI = 20,584- 66,524); density estimate survey block R = 0.599 individuals/km^2 (CV = 0.287).

84. For harbour porpoise, the north-east Atlantic distribution maps show a clear pattern of high harbour porpoise density in the southern North Sea, and the coasts of south-east England, for both January and July, compared to north-east coast of Scotland (**Figure 11.7**; Waggitt *et al.,* 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of:

- 0.285 individuals per km^2 for the Windfarm Site; and
- 0.286 individuals per km^2 for the Buzzard and Landfall Export Cable Corridors.

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[3] These density maps show the presence of offshore bottlenose dolphin only, and do not therefore include consideration of the resident populations around the UK and northern Europe coastlines.

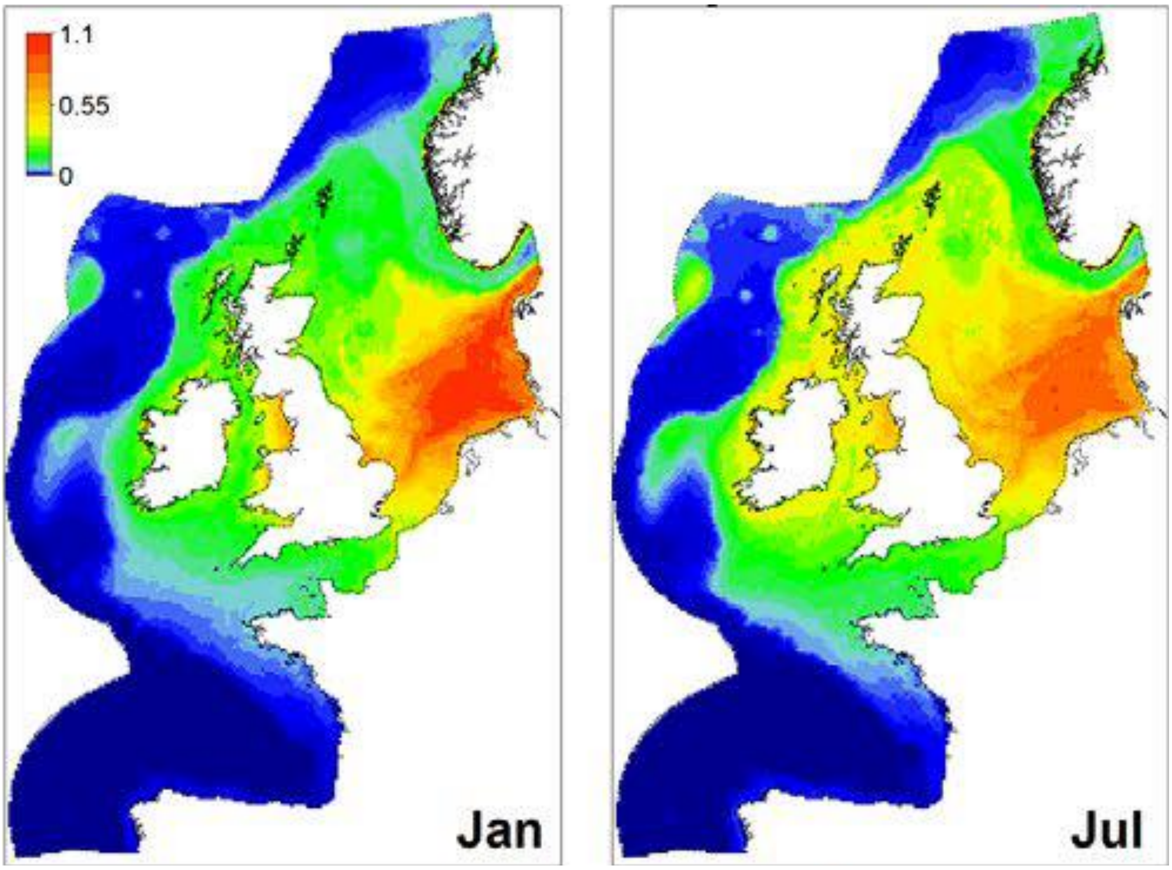

Figure 11.7 Spatial variation in predicted densities (animals per km²) of harbour porpoise in January and July in the north-east Atlantic. Values are provided at 10 km resolution (taken from Waggitt et al., 2019)

85. The IAMMWG (2022) define three MUs for harbour porpoise, the Offshore Development Area is located in the NS MU. The NS MU for harbour porpoise. has an abundance estimate of 346,601 (CV= 0.09; 95% CI = 289,498 – 419,967; IAMMWG, 2022) which will be the reference population in the assessments.

86. During the Project site-specific aerial surveys (**Appendix 12.1**), harbour porpoise were widespread across the survey area, with higher densities recorded in the southeast in July and August 2020 (**Figure 11.8**). Higher densities towards the south of the survey area were also detected, such as in November 2020 and May 2021.

87. Data from the Project site-specific surveys have also been used to generate abundance and density estimates for the sites with a 4 km buffer (see **Appendix 12.1**). In Year 1 (in months when harbour porpoise was observed), absolute density estimates ranged between 0.09 animals/km² (95% CI = 0.00 – 0.28) in December 2020 and 8.89 animals/km² (95% CI = 6.59 – 11.12) in July 2020, equating to abundance estimates of 38 animals (95% CI = 0 – 114) and 3,484 animals (95% CI = 2,586 – 4,348) respectively. In comparison, absolute density estimates for Year 2 ranged between 0.09 animals/km² (95% CI = 0.00 – 0.28) in December 2021 and 0.61 animals/km² (95% CI = 0.23 – 1.00) in August 2021, equating to abundance estimates of 47 animals (95% CI = 0 – 114) and 237 (95% CI = 100 – 398) animals respectively. The average absolute density estimate of the 24 month survey is 0.76 animals/km².

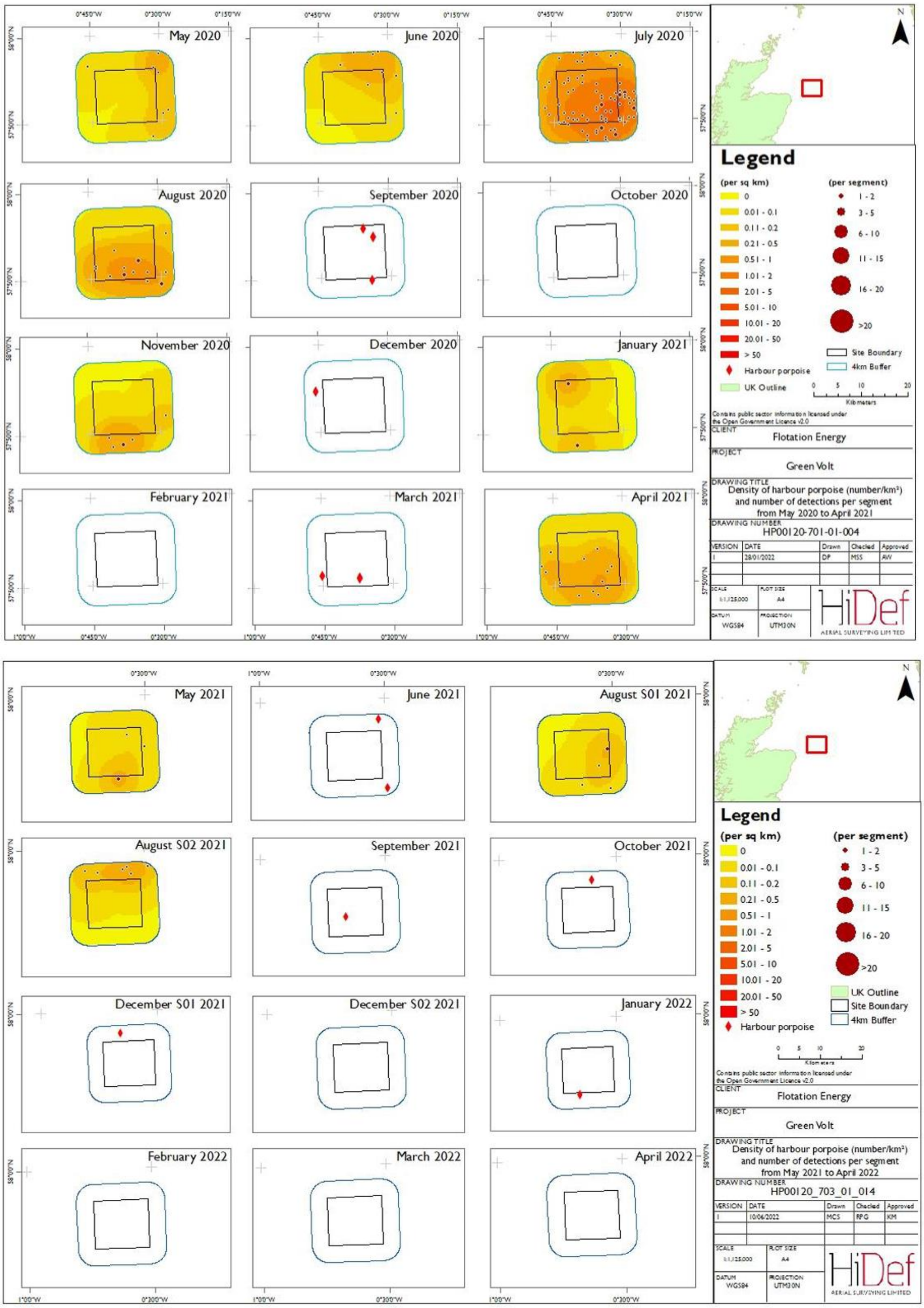

Figure 11.8 Density of harbour porpoise (number/km²) and number of detections per segment in the Project survey area between May 2020 and April 2021

11.6.2.2 Bottlenose Dolphin

88. There are two different ecotypes of bottlenose dolphin in Scottish waters: the coastal ecotype and the offshore ecotype. The north coast of Scotland is the most northerly known extent of the coastal bottlenose dolphin ecotype in the Atlantic coasts of Western Europe, and while bottlenose dolphin have been encountered further north and off the shelf edge, they are likely to be the offshore ecotype (Cheney *et al*., 2013).

89. A resident population of bottlenose dolphin is present in the Moray Firth and along the east coast of Scotland, with an estimated 224 individuals (CV= 0.023; 95% CI = 214-234; Arso Civil *et al*., 2021) which are known to travel south along the Scottish coast. Historically, very few sightings of bottlenose dolphin were recorded further south of the Firth of Forth on the east coast of the UK, however, in recent years an increase in bottlenose dolphin in the north-east of England has been reported (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands.

90. Within the Moray Firth encounters are typically very coastal (Hague *et al.,* 2020). The Moray Firth population of bottlenose dolphin also regularly use the area off Aberdeen harbour as well as Tay Estuary and St Andrews Bay area, . Bottlenose dolphin in the Tay Estuary and St Andrews Bay (300 km south of the Moray Firth SAC) are frequently encountered within 2 km of the coastline, in waters usually less than 20 m deep (Quick *et al*., 2014).

91. Dolphin acoustic detection rates were low across all ECOMMAS PAM monitoring sites, which are moored along the east coast of Scotland. The highest recorded 'dolphin species' Detection Positive were at the Cromarty site in the Moray Firth (Hague *et al*., 2020). It is highly likely that only the recording stations closest to the shore in each location were regularly detecting bottlenose dolphin, and that other ECOMMAS sites were detecting other dolphin species (Hague *et al*., 2020).

92. For the entire SCANS-III survey area, bottlenose dolphin abundance in the summer of 2016 was estimated to be 19,201, with an overall estimated density of 0.0159/km^2 (CV = 0.242; 95% CI = 11,404 - 29,670; Hammond *et al.*, 2021).

93. There is currently no density estimate for bottlenose dolphin in and around the Windfarm Site (survey block T). The SCANS-III survey block R which the Buzzard and Landfall Export Cable Corridors pass through, has abundance and density estimates for bottlenose dolphin (Hammond *et al.*, 2021) of:

- Abundance estimate = 1,924 bottlenose dolphin (95% CI = 0 - 5,048); and
- Density estimate = 0.0298 bottlenose dolphin/km^2 (CV = 0.861).

94. For bottlenose dolphin, the north-east Atlantic distribution maps (Waggitt *et al.,* 2019) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay. Densities of bottlenose dolphin in the North Sea are very low in comparison (**Figure 11.9**; Waggitt *et al.,* 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of:

- 0.0033 individuals per km^2 for the Windfarm Site; and
- 0.0031 individuals per km^2 for the Buzzard and Landfall Export Cable Corridors.

95. It is important to note that in their predicted species distribution models of bottlenose dolphin, Waggitt *et al*. (2020) did not include any sightings of bottlenose dolphin within 30 km from the coastline (Hague *et al*., 2020). Therefore, when interpreting the data and maps presented by Waggitt *et al*. (2020), care should be taken as the maps do not accurately reflect the distribution of coastal bottlenose dolphin. The maps are based on the assumption that bottlenose dolphin encountered more than 30 km from the coastline would be the 'offshore' ecotype (Breen *et al*., 2016; Hague *et al*., 2020).

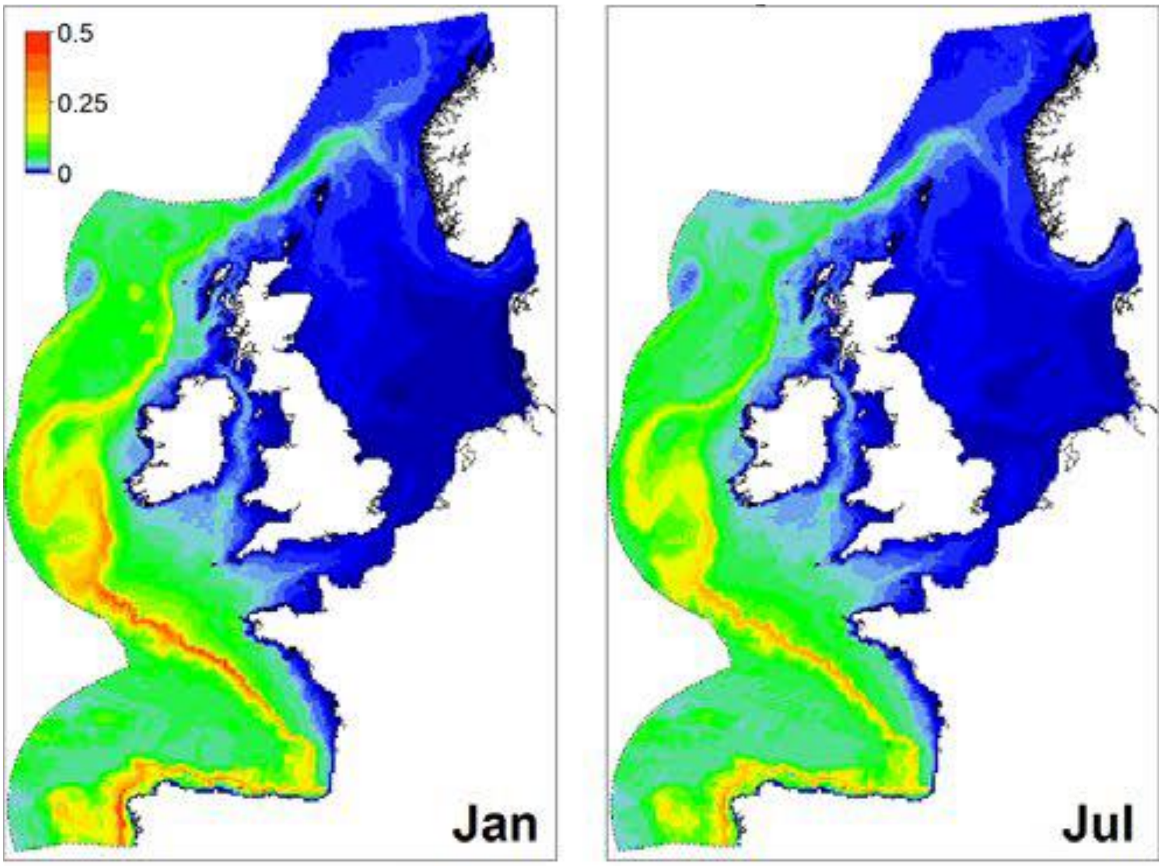

Figure 11.9 Spatial variation in predicted densities (animals per km²) of bottlenose dolphin in January and July in the north-east Atlantic. For bottlenose dolphin, these maps represent the offshore ecotype only. Values are provided at 10 km resolution (taken from Waggitt et al., 2019)

96. The IAMMWG (2022) define seven MUs for bottlenose dolphin. The Offshore Development Area is located in the GNS MU. The GNS MU for bottlenose dolphin has an abundance estimate of 2,022 (CV= 0.75; 95% CI = 548 – 7,453; IAMMWG, 2022). The population of bottlenose dolphin present within the coastal area are expected to be part of the CES MU; the CES has an abundance estimate of 224 (CV = 0.02; 95% CI = 214 – 234; IAMMWG, 2022; Arso Civil *et al*., 2021).

97. During the Project site-specific aerial surveys (**Appendix 12.1**), no bottlenose dolphin were recorded in year 1 and one was recorded in year 2 (March 2022). Due to the low numbers recorded, no density estimates could be established from the survey data.

98. As a precautionary approach, the assessments are based on the highest density estimate (0.0298 bottlenose dolphin/km² for SCANS-III survey block R (Hammond *et al*., 2021; **Table 11.11**)). The assessments have been put into the context of the CES MU and GNS MU (**Table 11.11**). The Windfarm Site is located 80 km from the coast at the closest point and therefore, the potential is for bottlenose dolphin to be offshore ecotype (GNS MU). Bottlenose dolphin close to shore and in the Landfall Export Cable Corridor more likely to be from the CES MU and Moray Firth population.

11.6.2.3 White-beaked Dolphin

99. White-beaked dolphin are the second most commonly occurring cetacean in UK shelf waters, regularly encountered in coastal and offshore waters while very rare in deeper waters beyond the shelf edge (DECC, 2016). Their distribution is generally restricted to the northern half of UK waters, with greatest abundance in the central and northern North Sea, Orkney and Shetland and northwest Scotland (DECC, 2016).

100. White-beaked dolphin are resident and abundant year-round in Scottish waters, with their distribution fairly widespread. White-beaked dolphin tend to occupy near- to offshore waters, and sightings rates tend to be higher in the summer months (Hague *et al*., 2020).

101. The results of the JCP Phase III Report (Paxton *et al.*, 2016) identified that for white-beaked dolphin, densities are low across much of UK waters, with higher densities shown to be in the Hebrides and the northern North Sea. The density of white-beaked dolphin within the northern North Sea is low, with a density of less than 0.5 individuals per km^2 across most of the northern North Sea (97.5% CI = 0.000 - 0.502 per km^2) (Paxton *et al.*, 2016).

102. For the entire SCANS-III survey area, white-beaked dolphin abundance in the summer of 2016 was estimated to be 36,287 with an overall estimated density of 0.0300/km^2 (CV = 0.288; 95% CI = 18,694 - 61,869; Hammond *et al.*, 2021).

103. The SCANS-III surveys show higher densities in the northern North Sea. The Windfarm Site and associated Buzzard and Landfall Export Cable Corridors are located in SCANS-III survey block T and R (Hammond *et al*., 2021) where:

- Survey block T abundance estimate = 2,417 white-beaked dolphin (95% CI = 593-5,091); density estimate survey block R = 0.037 individuals/km^2 (CV = 0.463); and
- Survey block R abundance estimate = 15,694 white-beaked dolphin (95% CI = 3,022-33,340); density estimate = 0.243 white-beaked dolphin/km^2 (CV = 0.484).

104. For white-beaked dolphin, the north-east Atlantic distribution maps (Waggitt *et al.,* 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (**Figure 11.10**; Waggitt *et al*., 2019). Examination of this data, including all 10 km grids that overlap with the Project and export cable areas, indicates an average annual density estimate of:

- 0.092 individuals per km^2 for the Windfarm Site; and
- 0.091 individuals per km^2 for the Buzzard and Landfall Export Cable Areas.

105. There is a single MU for white-beaked dolphin, the CGNS MU. The reference population for white-beaked dolphin in the CGNS MU is 43,951 animals (CV = 0.22; 95% CI = 28,439 – 67,924; IAMMWG, 2022).

106. During the Project site-specific aerial surveys (**Appendix 12.1**), no white-beaked dolphin were recorded in year 1 and five were recorded in one month of year 2 (August 2021). Due to the low numbers recorded, no density estimates could be established from the survey data.

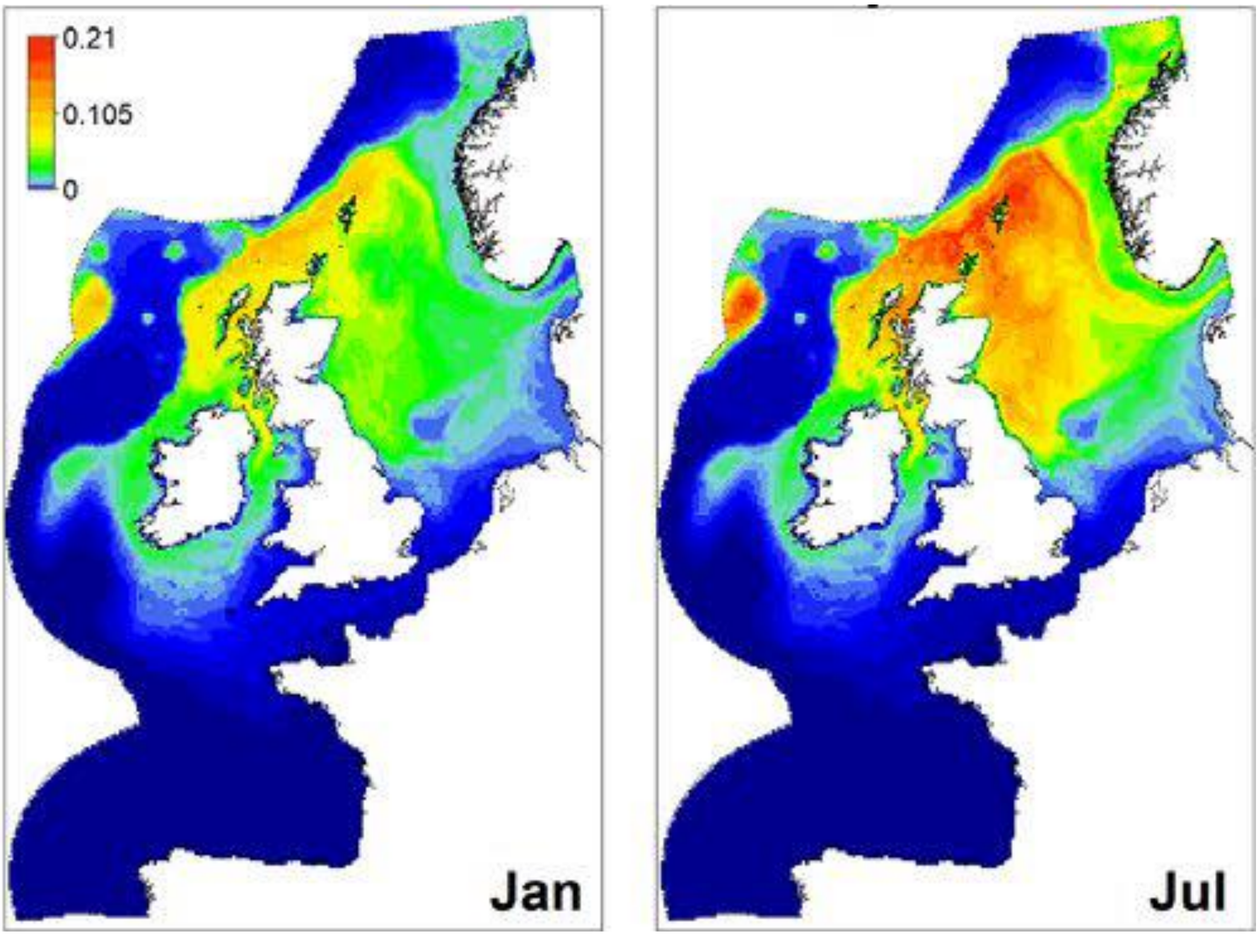

Figure 11.10 Spatial variation in predicted densities (animals per km²) of white-beaked dolphin in January and July in the north-east Atlantic. Values are provided at 10 km resolution (taken from Waggitt et al., 2019)

11.6.2.4 Atlantic white-sided Dolphin

107. Atlantic white-sided dolphin are confined to the north Atlantic. They share most of their range with the white-beaked dolphin, but in the north-east Atlantic they are primarily an offshore, oceanic species (DECC, 2016). Atlantic white-sided dolphin prefer temperate and sub-polar seas, with a preference for deeper waters beyond the continental shelf, or slope areas, the Atlantic white-sided dolphin is not commonly recorded in Scottish waters, except in areas close to the shelf edge e.g. Shetland (Evans *et al.,* 2011). Distribution is concentrated around the Hebrides, the Northern Isles, and offshore in the northern North Sea (Evans *et al*., 2011). They are also occasionally observed in offshore waters of the central and northern North Sea from July to September. In shelf waters, Atlantic white-sided dolphin have been reported as forming mixed schools with white-beaked dolphin (DECC, 2016).

108. The Scottish Marine Atlas describes Atlantic white-sided dolphin habitat as offshore along the outer continental shelf and slope (Baxter *et al.,* 2011). Mapped encounter rates show some overlap of medium-low encounter rates in the north-east and eastern regions, with the average encounter rates of 0 - 0.12 (Baxter *et al.,* 2011).

109. For the entire SCANS-III survey area, Atlantic white-sided dolphin abundance in the summer of 2016 was estimated to be 2,187 with an overall estimated density of 0.0006/km^2 (CV = 0.291; 95% CI = 0 - 6,071; Hammond *et al.*, 2021).

110. The SCANS-III surveys show higher densities in the northern North Sea area. The Offshore Development Area is located in SCANS-III survey block T and R (Hammond *et al*., 2021) where:

- Survey block T abundance estimate = 1,366 Atlantic white-sided dolphin (95% CI = 0 - 5,031); density estimate = 0.021 individuals/km^2 (CV = 0.994); and
- Survey block R abundance estimate = 644 Atlantic white-sided dolphin (95% CI = 0 - 2,069); density estimate = 0.010 individuals/km^2 (CV = 0.984).

111. For Atlantic white-sided dolphin, the north-east Atlantic distribution maps (Waggitt *et al.,* 2019) show densities in Scottish waters, with relatively low densities throughout the year in coastal waters, but an increase in density in offshore deeper waters to the west of Scotland during the summer months (**Figure 11.11**; Waggitt *et al*., 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of:

- 0.028 individuals per km^2 for the Windfarm Site; and
- 0.027 individuals per km^2 for the Buzzard and Landfall Export Cable Corridors.

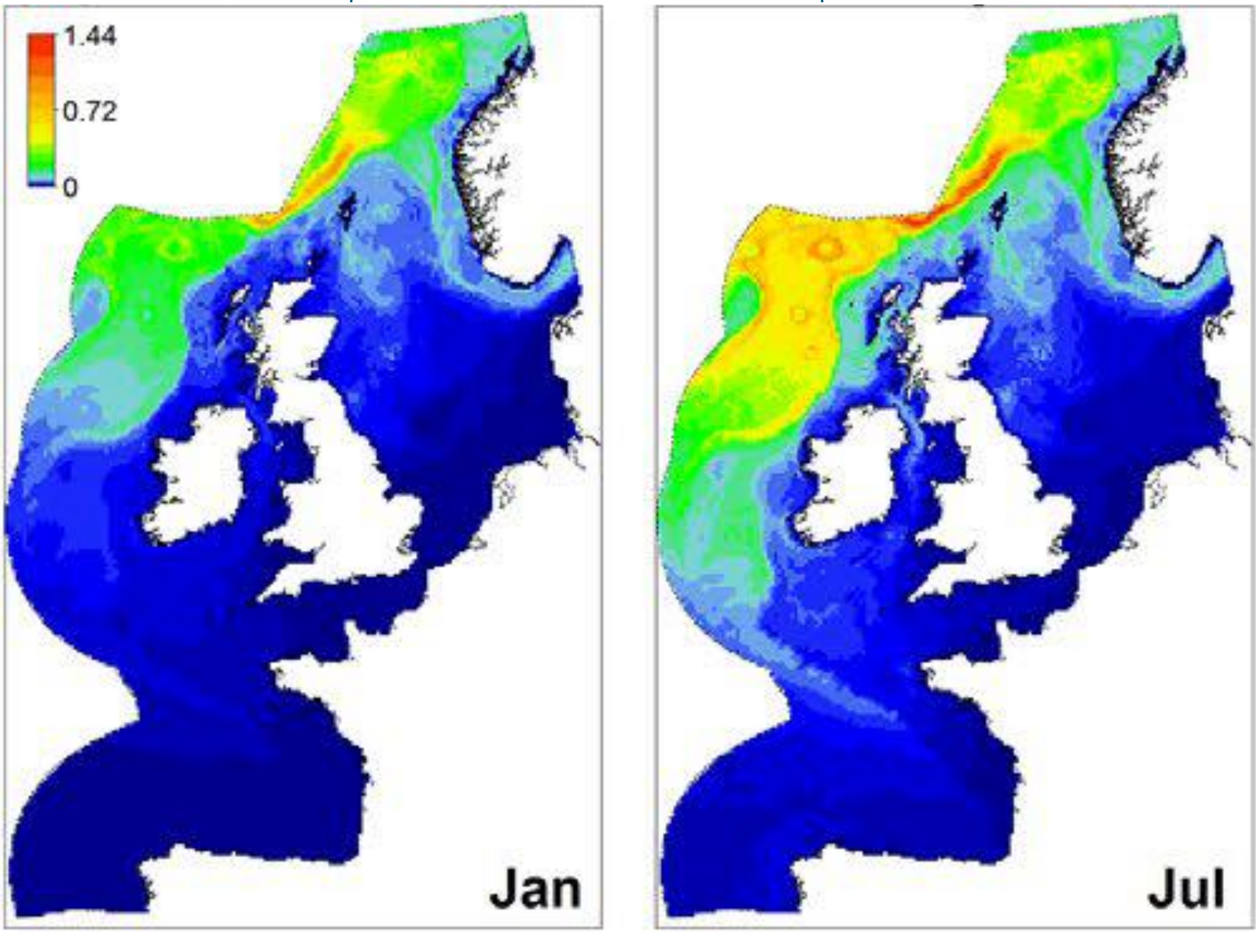

Figure 11.11 Spatial variation in predicted densities (animals per km^2) of Atlantic white-sided dolphin in January and July in the north-east Atlantic. Values are provided at 10 km resolution (taken from Waggitt et al., 2019)

112. There is a single MU for Atlantic white-sided dolphin, the CGNS MU. The reference population for Atlantic white-sided dolphin in the CGNS MU is 18,128 animals (CV = 0.61; 95% CI = 6,049 – 54,323; IAMMWG, 2022).

113. No Atlantic white-sided dolphin were recorded during the Project site-specific aerial surveys (**Appendix 12.1**).

114. Atlantic white-sided dolphin are present in low numbers in Scottish waters, with distribution mainly in deeper offshore waters during the summer months (Hague *et al*, 2020). However, as a precautionary approach they have been included in the assessments (**Table 11.11**).

11.6.2.5 Risso's Dolphin

115. Risso's dolphin are resident year-round in Scottish waters, but at higher densities during the summer months. Risso's dolphin have a preference for deeper waters, and shelf waters, or areas where water is deeper closer to land (Hague *et al*., 2020).

116. For Risso's dolphin, the northeast Atlantic distribution maps (Waggitt *et al.,* 2019) show densities in Scottish waters, with relatively low densities in January in the North Sea, but an increase in densities in the North Sea, from Scottish waters as far south as mid-England during the summer months (**Figure 11.12**; Waggitt *et al*., 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of (summer and winter densities are also provided, given the difference in presence in winter and summer):

- 0.0012 individuals per km^2 for the Windfarm Site;
- 0.0018 individuals per km2 in summer
- 0.0006 individuals per km2 in winter
- 0.0012 individuals per km^2 for the Buzzard and Landfall Export Cable Corridors.
- 0.0018 individuals per km^2 in summer
- 0.0006 individuals per km^2 in winter

117. There is single MU for Risso's dolphin, the CGNS MU. The reference population for Risso's dolphin in the CGNS MU is 12,262 animals (CV = 0.46; 95% CI = 5,227 – 28,764; IAMMWG, 2022).

118. During the Project site-specific aerial surveys (**Appendix 12.1**), one Risso's dolphin was recorded in year 1 (January 2021) and none were recorded in year 2. Due to the low numbers recorded, no density estimates could be established from the survey data.

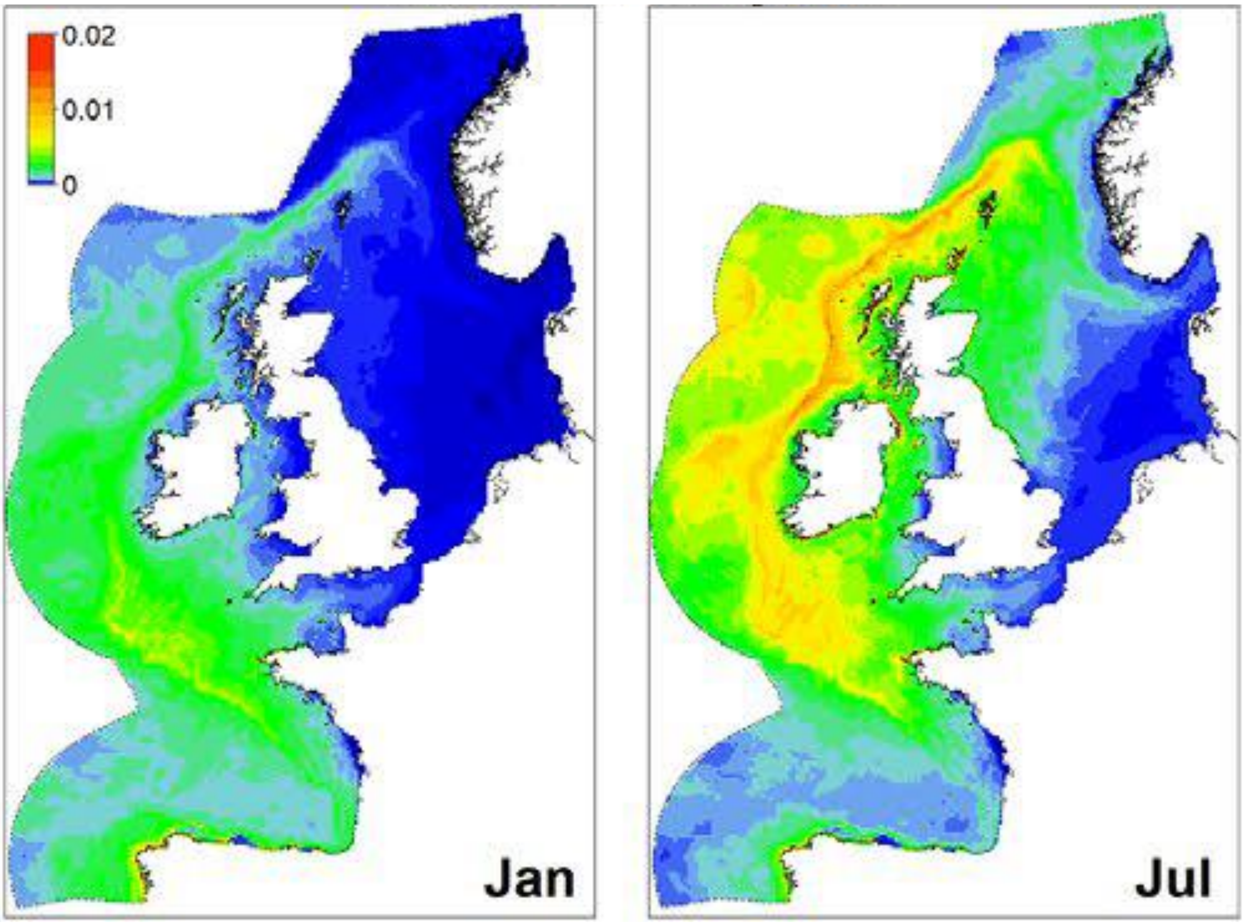

Figure 11.12 Spatial variation in predicted densities (animals per km^2) of Risso's dolphin in January and July in the north-east Atlantic. Values are provided at 10 km resolution (taken from Waggitt et al., 2019)

11.6.2.6 Minke Whale

119. Minke whale are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid *et al*., 2003). They occur mainly on the continental shelf in water depths less than 200 m and are sighted more frequently in the summer months between May and September. Although considered seasonal visitors, with most sightings in summer months, sightings do occur in some areas year-round (Hague *et al*., 2020). Minke whale distribution was instrumental in the designation of the Southern Trench MPA (**Section 11.6.4.1**).

120. The JCP Phase III Report (Paxton *et al.*, 2016) identified a total of 1,860 minke whale sightings within the UK offshore area. The density of minke whale was predicted to be highest around the northern coast of the UK. Sightings were mostly in the summer months, on the east, north and west coasts of Scotland especially around the Hebrides, in the Outer Moray Firth and off the coast of Angus (Paxton *et al.,* 2016).

121. For the entire SCANS-III survey area, minke whale abundance in the summer of 2016 was estimated to be 13,101 with an overall estimated density of 0.0108/km^2 (CV = 0.345; 95% CI = 7,050 – 26,721; Hammond *et al.*, 2021). The Project including export cable area are located within SCANS-III survey blocks T and R (Hammond *et al*., 2021) where:

- Survey block T abundance estimate = 2,068 minke whale (95% CI = 290-6,960); density estimate survey block R = 0.0387 individuals/km^2 (CV = 0.463); and
- Survey block R abundance estimate = 2,498 minke whale (95% CI = 604-6,791); density estimate = 0.0316 individuals/km^2 (CV = 0.614).

122. For minke whale, the north-east Atlantic distribution maps (Waggitt *et al.,* 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the Celtic and Irish Seas, with decreasing densities southwards of Scotland along the east coast of England. There is a clear seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (Waggitt *et al*., 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of:

- 0.006 individuals per km^2 for the Windfarm Site; and
- 0.007 individuals per km^2 for the Buzzard and Landfall Export Cable Corridors.

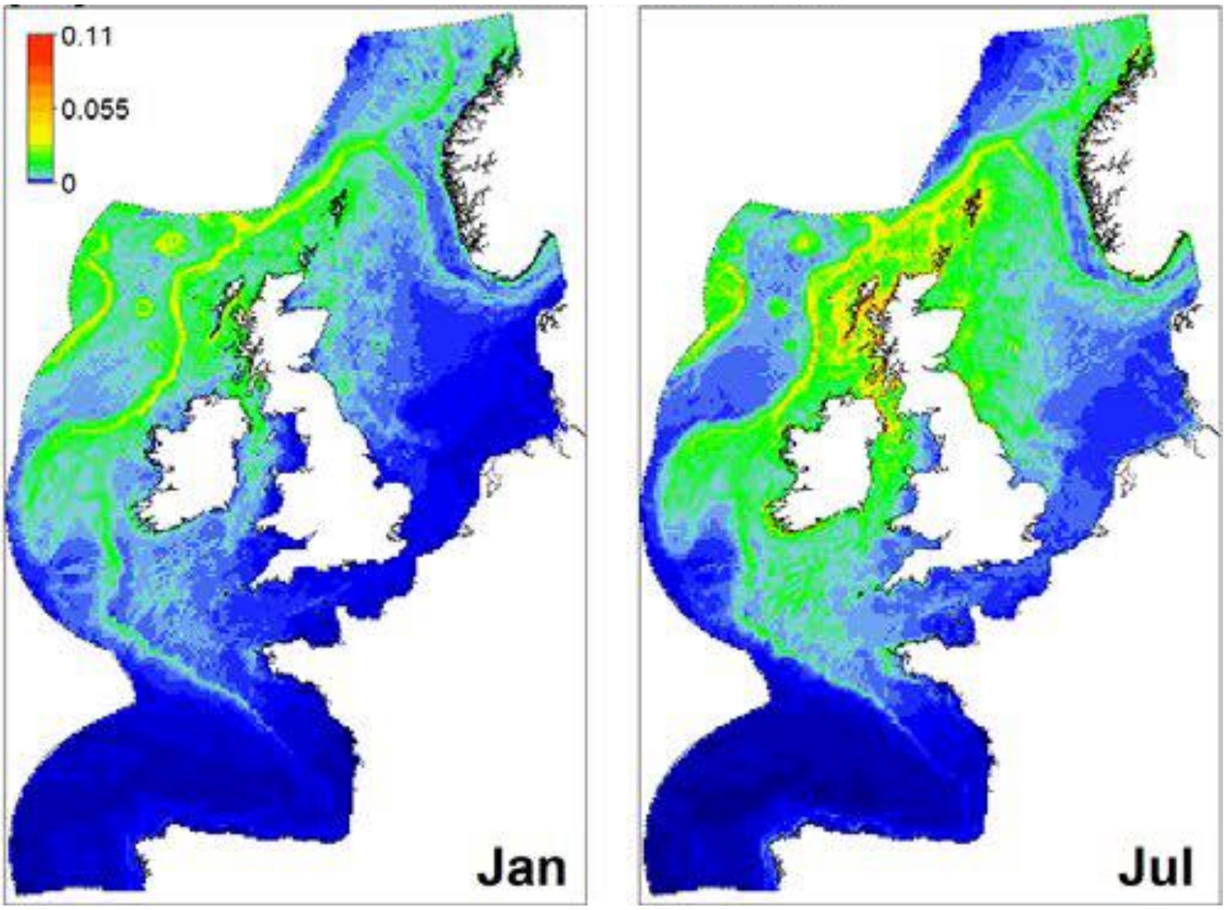

Figure 11.13 Spatial variation in predicted densities (animals per km²) of minke whale in January and July in the north-east Atlantic. Values are provided at 10 km resolution (taken from Waggitt et al., 2019)

123. There is single MU for minke whale, the CGNS MU. The reference population for minke whale in the CGNS MU is 20,118 animals (CV = 0.18; 95% CI = 14,061 – 28,786; IAMMWG, 2022).

124. No minke whale were recorded during the site-specific aerial surveys for the Project (**Appendix 12.1**).

11.6.2.7 Humpback Whale

125. Humpback whale have been sporadically sighted around much of the UK, more common off Shetland Isles and Hebrides and the Irish Sea but increasingly seen in Northern North Sea over the last decade. Sightings have been recorded in the Moray Firth (n = 3 in 2022; Hebridean Whale and Dolphin Trust (HWDT), 2022) Firth of Forth (n = 3 in 2018; HWDT, 2022) and North East England (n = 5 in 2019 and n = 2 in 2020; Sea Watch Foundation, 2022).

126. Population estimates are only available for the regions of Greenland (east and west), Iceland – Faroe Isles and Norwegian and Barents Seas but not the wider North Sea (NAMMCO, 2020). For the North Atlantic the density estimate is approximately 0.000015/km² based on one sighting of a humpback whale in SCANS-III block T (with a total area of 65,417 km²; Hammond *et al*., 2021) with an abundance estimate of 35,000 (NAMMCO 2022; Hague *et al.*, 2020).

127. No humpback whale were recorded during the site-specific aerial surveys for the Project (**Appendix 12.1**). However, as a precautionary approach, humpback whale have been included in the assessments to reflect the increase in recent sightings in the North Sea from the Firth of Forth north to Shetland (**Table 11.11**).

11.6.3 Pinnipeds

128. Two species of seal are found in the UK, the grey seal and the harbour seal. The grey seal is found on both sides of the North Atlantic Ocean although the greatest proportion of the population is found in UK waters. The UK population of harbour seal has in recent years been in decline but is now increasing and is close to the level it was before the decline occurred. The decline in population levels varies between colonies, with some in Scotland experiencing high levels of declines, while others were stable or increasing.

129. Approximately 36% of the world's grey seal breed in the UK (SCOS, 2021), of which 80% are from sites in Scotland, with the main colonies being in the Inner and Outer Hebrides and Orkney (SCOS, 2021). Approximately 32% of the European harbour seal population are found in the UK, with approximately 85% of the UK harbour seal population in Scotland (SCOS, 2021).

130. There are haul-out sites for grey and harbour seal in the Moray Firth and along the north-east coast of Scotland (**Figure 11.14**; SCOS, 2020), therefore there is the potential for foraging seal to be in the offshore areas of the Offshore Development Area. The nearest major (and protected) haul-out sites are located approximately 19 km at the Ythan River mouth and approximately 116 km at Findhorn from the nearest landfall location, for grey seal and harbour seal, respectively (**Figure 11.14**; SCOS, 2020).

131. GPS tracking data from tagged grey and harbour seals indicates there is the potential for grey seal to be present in the Offshore Development Area, although harbour seal are less likely to be present (**Figure 11.15**; Carter *et al.,* 2020).

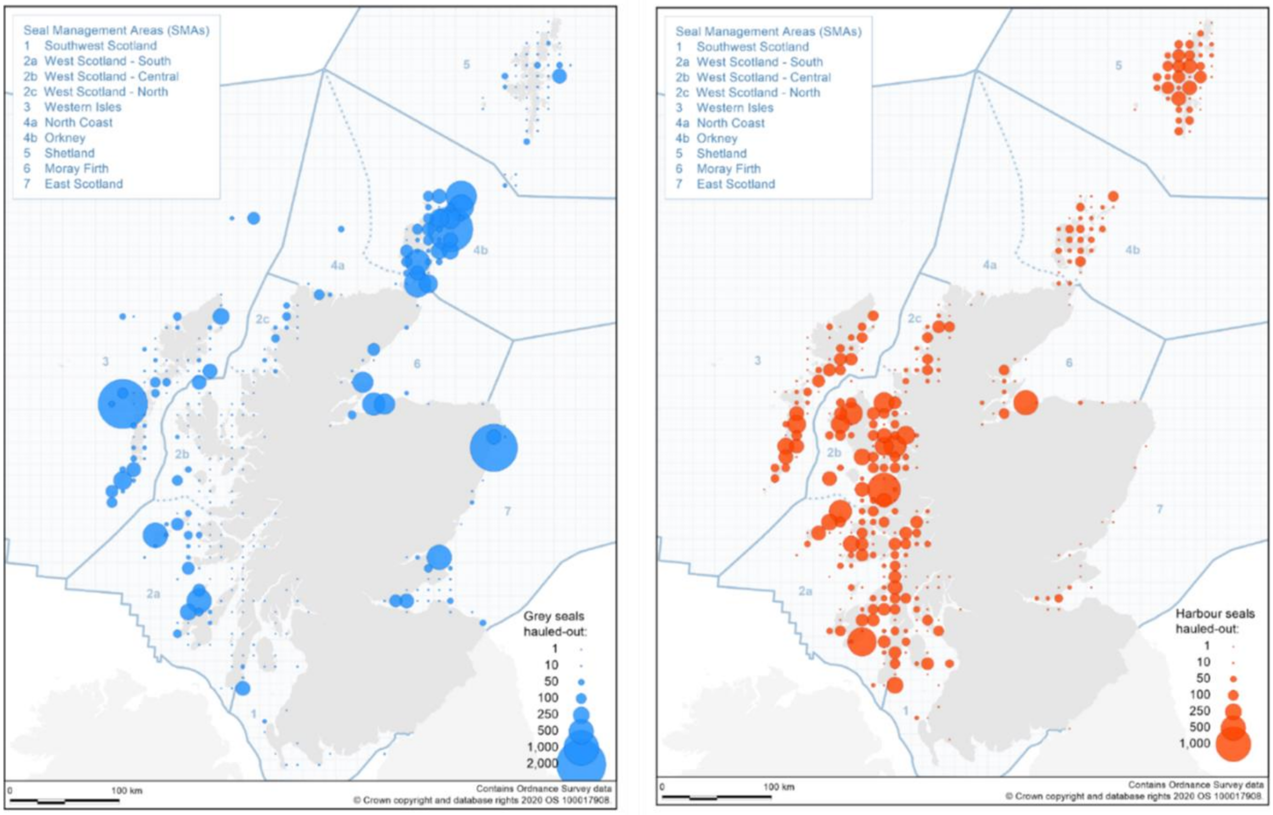

Figure 11.14 Map of (i) grey seal (blue) and (ii) harbour seal (red) distribution by 10 km squares based on haul-out counts obtained from the most recent aerial surveys carried out during the harbour seal moult in August 2016-2019 (taken from SCOS, 2020)

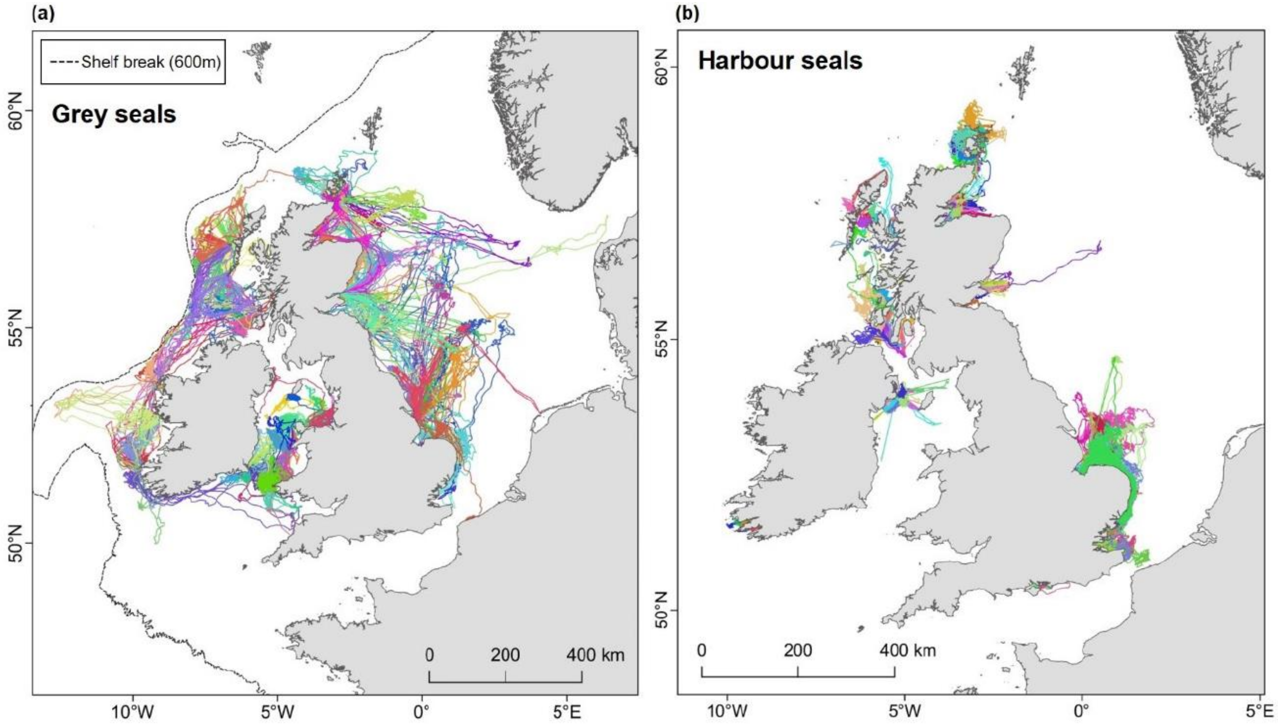

Figure 11.15 GPS tracking data for (a) grey and (b) harbour seals (taken from Carter et al., 2020)

132. Carter *et al.* (2020) provides habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. The habitat preference approach predicted distribution maps provide estimates per species for 5 km x 5 km grid squares of relative at-sea density for seals hauling-out in the British Isles (**Figure 11.16**).

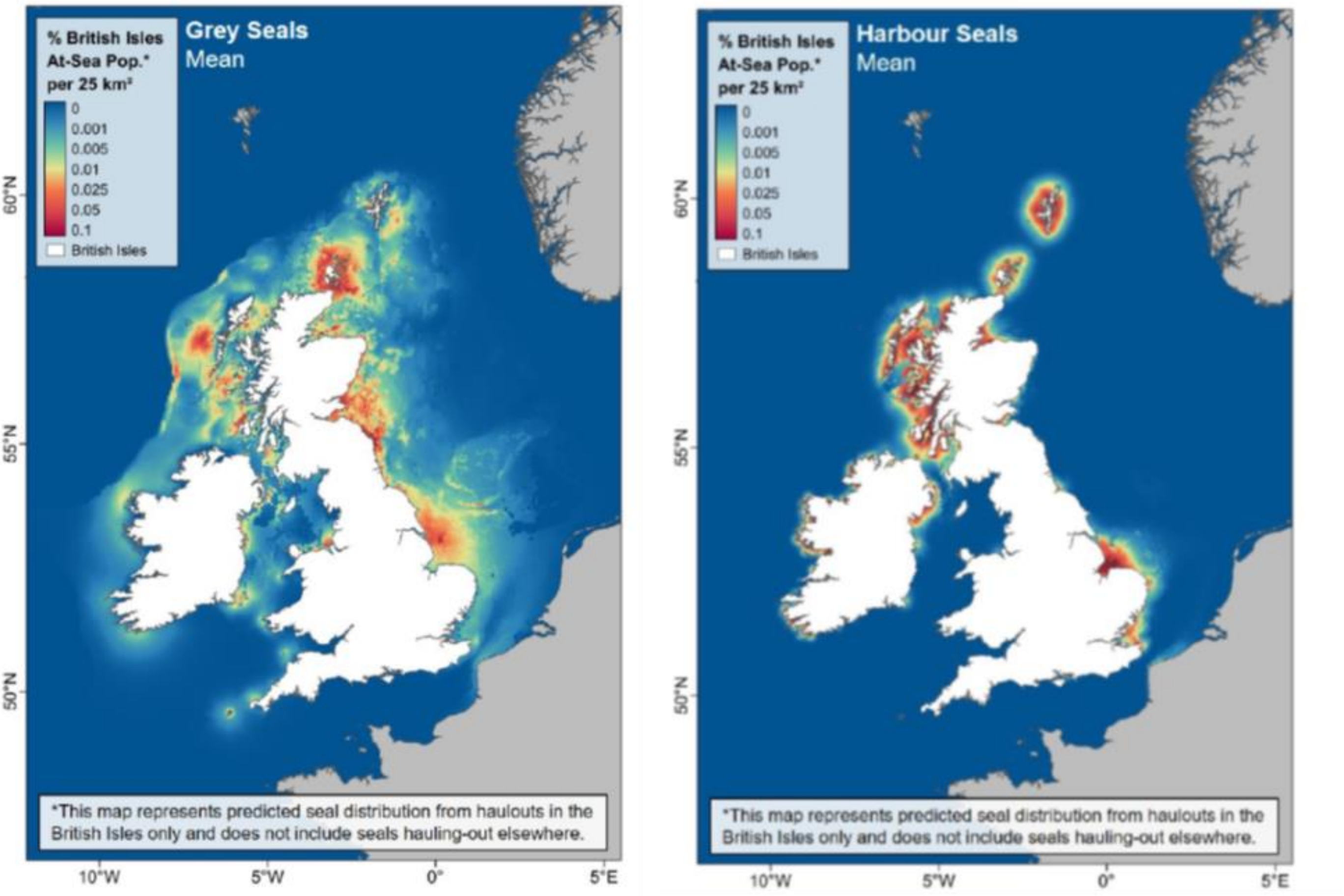

Figure 11.16 At-sea distribution of (a) grey seal and (b) harbour seal from haul-outs in the British Isles in 2018. Maps show mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid square at any one time, and the square-wise (taken from Carter et al., 2020)

11.6.3.1 Grey seal

133. Grey seal haul out on land to rest, moult and breed (SCOS, 2021). Compared with other times of the year, grey seal in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season in autumn, with the majority of seal pups in in north and west Scotland mainly between September and late November (SCOS, 2021).

134. Grey seal forage in the open sea and they may range widely to forage and frequently travel over 100 km between haul-out sites (SCOS, 2021). Foraging trips can last anywhere between one and 30 days. Tracking of individual grey seal has shown that most foraging probably occurs within 100 km of a haul-out site, although they can feed up to several hundred kilometres offshore (SCOS, 2021). The grey seal maximum foraging range is estimated to be 448 km based on tracking data (Carter *et al*., 2022).

135. Grey seal are likely to present in and around the Offshore Development Area (SCOS, 2020; Carter *et al.,* 2020). For grey seal (**Figure 11.16** (left map); Carter *et al*., 2020), the mean predicted relative density for the grid squares that overlap with the Windfarm Site is 0.008% of the overall population, with the highest percentage of the grey seal population in a single grid square of 0.0012%. For the Buzzard and Landfall Export Cable Corridor Corridors, the mean relative density for the grid squares that overlap the area is 0.17% of the overall population. Within the landfall areas, the relative density increases to a maximum of 0.064% of the population within a single grid square, a relative density of very high when compared to the overall distributions of grey seal.

136. The grey seal density estimates for the Offshore Development Area have been calculated from the 5 km x 5 km squares that overlap the relevant areas (Carter *et al*., 2020; SCOS 2021):

- 0.049 individuals per km^2 for the Windfarm Site; and
- 0.32 individuals per km^2 for the Buzzard and Landfall Export Cable Corridors.

137. The most recent surveys of the principal grey seal breeding sites Scotland, Wales, Northern Ireland and southwest England, resulted in an estimate of 67,850 pups (95% CI = 60,500 - 75,100; SCOS 2020). The UK grey seal pup production has increased by approximately 1.5% per year, since 2016, and this growth mainly occurred in the North Sea colonies (east coast of Scotland and England) with as estimated increase of 23% from 2016 to 2019, while the pup production decreased by 3.3% in the Inner and Outer Hebrides and Orkney in that same period (SCOS, 2021).

138. When the pup production estimates are converted to estimates of total population size, there was an estimated 157,300 grey seals in 2020 (approximate 95% CI = 146,000 - 169,400; SCOS, 2021). The most recent counts of grey seal in the August surveys 2016-2019, estimated that the minimum count of grey seals in the UK was 42,765 (SCOS, 2020).

139. In accordance with the agreed approach for other offshore wind farms in Scottish waters the reference population extent for grey seal is based on the MU in which the Project is located (the EaS MU) as well as incorporating the MoF MU for the wider population (IAMMWG, 2013; SCOS, 2020). In order to take account of the grey seals that were not observed during the August surveys (e.g. seals not at the haul-out site at time of counting), a population scalar is used to provide a more accurate population estimate. This population scalar is based on the proportion of seals estimated to be available to count during the August surveys (0.2515 taken from SCOS, 2021 (BP 21/02)). This leads to the below adjusted population estimates for the relevant MUs for grey seal:

- EaS MU = 14,644 grey seal.
- MoF MU = 6,589 grey seal.

140. Assessments are in the context of the nearest MU (EaS MU) as well as the wider reference population (of 21,233 grey seal, based on the EaS and MoF MUs together). As a worst case it is assumed that all seals are from the nearest MU, the EaS MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals. For the cumulative assessments, the wider reference population of 21,233 grey seal is used.

141. During year 1 of the Project site-specific aerial surveys (**Appendix 12.1**), individual grey seal were recorded in three months (August and December 2020, and March 2021). In year 2, individuals were recorded in October 2021 and March 2022. In addition, four individual sightings of unidentified seal species and two individual seal/small cetacean sightings were recorded in year 1. In year 2, unidentified seal species were recorded in four months (five animals in total) and no seal/small cetacean were recorded. Due to the low numbers recorded, no density estimates could be established from the survey data.

11.6.3.2 Harbour seal

142. Harbour seal have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina vitulina* (SCOS, 2021). Harbour seal are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast of the UK, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth (SCOS, 2021).

143. Harbour seal come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seal haul-out on land regularly in a pattern that is often related to the tidal cycle (SCOS, 2021).

144. Harbour seal normally feed within 40 km and 50 km around their haul out sites (SCOS, 2021). Tracking studies have shown that harbour seal typically travel between 50 km and 100 km offshore and can travel 200 km between haul-out sites (Lowry *et al*., 2001; Sharples *et al*., 2012). Harbour seal exhibit relatively short foraging trips from their haul out sites. The range of these trips varies depending on the location and surrounding marine habitat. The harbour seal maximum foraging range is estimated to be 273 km based on tracking data (Carter *et al*., 2022). However, along the east coast, there was a strong negative association with areas more than 50 km from the haul-out sites (Carter *et al*., 2022).

145. Harbour seal are likely present in lower number around the Offshore Development Area, as harbour seal densities in the area are generally lower than for grey seal (SCOS, 2020; Carter *et al.,* 2020). For harbour seal (**Figure 11.16** (right map); Carter *et al*., 2020), the mean predicted relative density for each grid square that overlaps with the Windfarm Site is 0.0000015% of the overall population. For the Buzzard and Landfall Export Cable Corridors, the mean relative density for each grid that overlaps is 0.003% of the overall population. Within the landfall areas, the relative density increases slightly to a maximum of 0.0025% of the population within a single grid square, a relative density of very low when compared to the overall distributions of harbour seal.

146. The harbour seal density estimates for the Offshore Development Area have been calculated from the 5 km x 5 km squares (Carter *et al*., 2020; SCOS 2020):

- 0.000002 individuals per km^2 for the Windfarm Site; and
- 0.0015 individuals per km^2 for Buzzard and Landfall Export Cable Corridors.

147. Harbour seal are counted while they are on land during their August moult, giving a minimum estimate of population size (SCOS, 2020). Combining the most recent counts (2016-2019) gives a total of 31,774 counted in the UK. Scaling this by the estimated proportion hauled out (0.72 (95% CI = 0.54 - 0.88)) produces an estimated total population for the UK in 2019 of 44,100 harbour seal (approximate 95% CI = 36,100 - 58,800; SCOS, 2020).

148. As for grey seal, the reference population extent for harbour seal will use the MU of which the Project lies within (the EaS MU) as well as incorporating the MoF MU as the wider population (IAMMWG, 2013; SCOS, 2020). In order to take account the harbour seals that were not observed during the August surveys (e.g. seals not at the haul-out site at time of counting), a population scalar is used to provide a more accurate population estimate. This population scalar is based on the proportion of seals estimated to be available to count during the August surveys (0.72 taken from Lonergan *et al*., 2013). This leads to the below adjusted population estimates for the relevant MUs for harbour seal:

- EaS MU = 476 harbour seal.
- MoF MU = 1,495 harbour seal.

149. Assessments are done in the context of the nearest MU (EaS MU) as well as the wider reference population (of 1,971 harbour seal, based on the EaS and MoF MUs together). As a worst case it is assumed that all seals are from the nearest MU, the EaS MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals. For the cumulative assessments, the wider reference population of 1,971 harbour seal is used.

150. No harbour seal were identified during the Project site-specific aerial surveys (**Appendix 12.1**). As outlined in **Section 11.6.3.1**, due to the low numbers of seals (either unidentified seal species or seal/small cetacean) recorded, no density estimates could be established from the survey data.

11.6.4 Protected Sites

151. Designated sites for marine mammals in the northeast Scotland region and east coast of Scotland include the Moray Firth SAC for bottlenose dolphin (151.7 km from the Windfarm Site and 99.1 km from the Buzzard and Landfall Export Cable Corridors) which is assessed in the **Offshore Report to Inform Appropriate Assessment**.

152. As agreed with MSS and NatureScot, due to the distances from the Offshore Development Area, the following designated sites were screened out from further assessment in **Offshore Report to Inform Appropriate Assessment**: Southern North Sea SAC; Isle of May SAC; Faray and Holm of Faray SAC; Firth of Tay and Eden Estuary SAC; and Dornoch Firth and Morrich More SAC. It was also agreed during consultation with MSS and NatureScot, that no seal SACs were screened in for further consideration, as there will be no disturbance to seal haul-out sites during construction, operation and maintenance and decommissioning.

11.6.4.1 Southern Trench Nature Conservation Marine Protected Area

153. The Southern Trench Nature Conservation Marine Protected Area (MPA) has been designated for minke whale (NatureScot, 2020). The Landfall Export Cable Corridor passes through the MPA and will therefore be considered and assessed as part of the **Offshore EIA Report**.

154. The MPA is located on the east coast of Scotland in the outer Moray Firth and is designated to protect minke whale, burrowed mud, fronts and shelf deeps. Fronts in the Southern Trench are created by mixing of warm and cold waters, which creates an area of high productivity, attracting a number of predators to the area. Minke whale are attracted by the fish species brought to the area by the fronts, as well as the abundance of sandeels in the soft sands. NatureScot (2020) advise that, in order to conserve minke whale, the risk of injury and death should be minimised, access to resources within the site should be maintained, and supporting features should also be conserved.

155. Minke whale are present in the highest numbers from June to October, although are present year-round. Within the site, minke whale are present in the northern part in higher number than in comparison to the southern part of the MPA (**Figure 11.17**; NatureScot, 2020). Adjusted densities of minke whale within the Southern Trench MPA (based on survey data from 2000 to 2012) range from 0 to 10 individuals per km^2, with adjusted densities of up to $0.1/km^2$ in the southern area of the site (NatureScot, 2020), where the Landfall Export Cable Corridor would be located.

156. The Conservation Objectives (NatureScot, 2020) of this site are to conserve the features, specifically to ensure “minke whale in the Southern Trench MPA are not at significant risk from injury or killing, conserve the access to resources (e.g. for feeding) provided by the MPA for various stages of the minke whale life cycle, and conserve the distribution of minke whale within the site by avoiding significant disturbance”. The supporting features of the minke whale (including their prey species and the habitats that support these prey species, and the presence of fronts) are also protected under these Conservation Objectives.

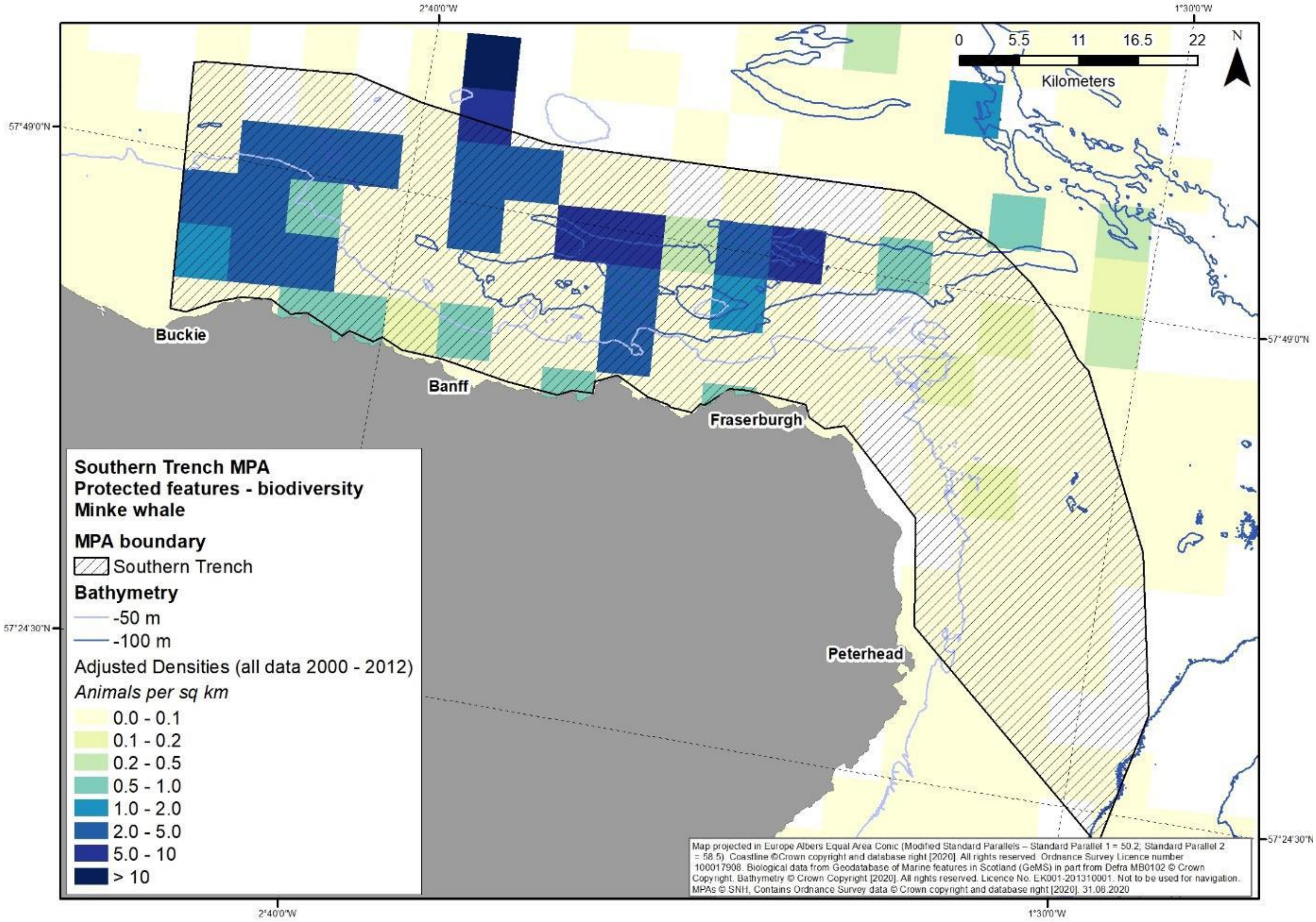

Figure 11.17 Adjusted Densities of Minke Whale within the Southern Trench MPA (NatureScot, 2020) [the Landfall will be to the North or South of Peterhead]

11.6.5 Anticipated Trends in Baseline Conditions

157. The baseline conditions for marine mammals are considered to be relatively stable, for most species. The baseline environment of the North Sea has been influenced by the oil and gas industry since the 1960s, fishing by various methods for hundreds of years and the construction and operation of offshore wind farms for 20 years, although it is acknowledged that the scale of offshore wind development will increase greatly. The baseline will continue to evolve as a result of global trends which include the effects of climate change.

158. Climate change is expected to produce a shift in the range of cetacean species. It is expected that cetaceans will track water temperature changes in order to remain within their ecological niches. Ecosystem change involving the loss or the disturbance of megafauna species such can lead to alteration in ecosystem functioning (Macleod *et al*., 2005; Lambert *et al*., 2011).

159. The potential impacts of climate change on marine mammals can be direct, such as the effects of rising sea levels on seal haul-out sites, or species tracking a specific range of water temperatures in which they can physically survive. Indirect effects of climate change include changes in prey availability affecting distribution, abundance and migration patterns, community structure, susceptibility to disease and contaminants. Ultimately, these can impact on the reproductive success and survival of marine mammals and, hence, have consequences for populations (Learmonth *et al*., 2006).

160. For harbour porpoise in the North Sea, the latest SCANS-III survey results show no evidence for trends in abundance since the mid-1990s (Hammond *et al*., 2021). Despite no overall change in population size, large scale changes in the distribution of harbour porpoise were observed between SCANS-I in 1994 and SCANS-II in 2005, with the main concentration shifting from northeastern UK and Denmark to the SNS. Such large-scale changes in the distribution of harbour porpoise are likely the result of changes to the availability of their principal prey species, such as sandeel, within the North Sea (SCANS-II, 2008).

161. The observed distribution of harbour porpoises from the SCANS-III survey in summer 2016 was similar to that observed in SCANS-II in 2005 (Hammond *et al*., 2013). Although, one notable difference is that more sightings were made throughout the English Channel (block C) in 2016 than previous surveys (Hammond *et al*., 2021). The progressive spread of sightings into most of the Channel over the past two decades indicates that harbour porpoise distribution has expanded, probably from the North Sea and the Celtic Sea, and now encompasses the entire Channel, at least in summer (Hammond *et al*., 2021).

162. The effects of climate change on harbour porpoise populations are still relatively unknown, however, it is expected that there will be impacts to the population through prey depletion and range shifts. Harbour porpoise habitat and population range is determined from their preferred prey availability, and therefore a change in prey range has the potential to cause a change in the distribution of harbour porpoise (Evans and Bjorge, 2013; Ransijn *et al*., 2019). As outlined above, a shift southward of harbour porpoise has been noted within the North Sea (Hammond *et al*., 2021), and it is possible that this was due to a loss of sandeel availability in the northern parts of the North Sea (Evans and Bjorge, 2013).

163. There has been an increasing range expansion of the bottlenose dolphin from the Moray Firth. With an increase in the number of dolphins using areas along the east coast of Scotland, such as St Andrews Bay and the Tay Estuary, 300 km south of the Moray Firth SAC (Arso Civil *et al*., 2021). There has also been a recent increase in bottlenose dolphin in the north-east of England (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands.

164. As for harbour porpoise, SCANS found no evidence of a trend in abundance of white-beaked dolphin in the North Sea since the mid-1990s (Hammond *et al*., 2021). A review of the strandings data of white-beaked dolphin in the North Sea were collated and assessed by ASCOBANS (IJsseldijk *et al*., 2018) in order to determine temporal and spatial trends in the distributions of white-beaked dolphin in the southwestern North Sea. Strandings data used within the review were from Belgium, Germany, the Netherlands and the UK, from 1991 to 2017. This review indicates that there has been a reduction in the abundance of white-beaked dolphin in the southeast coasts of the UK, with an increase in the northeast area (IJsseldijk *et al*., 2018). These changes probably reflect changes in prey distribution as a result of climate change.

165. SCANS found no evidence of a trend in abundance of minke whale in the North Sea since the mid-1990s (Hammond *et al*., 2021). However, there has been an increase in humpback whale sightings in the North Sea from the Firth of Forth north to Shetland over the last few years.

166. There has been a continual increase in the total UK grey seal pup production since regular surveys began in the 1960s (SCOS, 2020). The majority of the increase in the North Sea has been due to the continued rapid expansion of newer colonies on the mainland coasts in Berwickshire, Lincolnshire, Norfolk and Suffolk. Interestingly, these colonies are all at easily accessible sites on the mainland, where grey seal have probably not bred in significant numbers since before the last ice age (SCOS, 2020).

167. Overall, the UK population of harbour seal has increased since the late 2000s and is close to the previous high observed during the 1990s (SCOS, 2020). However, there are significant differences in the population dynamics between seal management units, with general declines in counts of harbour seal in several regions around Scotland.

168. For marine mammals, there are some changes evident as a result of climate change and it is reasonable to expect further such changes in the future and over the lifetime of the Project. However, the latest changes in population distribution and abundance have been taken into account in the assessments that has have been undertaken.

11.6.6 Summary of Marine Mammals to be Assessed

169. The key species and relevant species density estimates and reference populations used in the assessment are summarised in **Table 11.11**.

Table 11.11 Summary of Marine Mammal Density Estimates and Reference Populations used in the Impact Assessments

Species	Density	Source	Reference population	Source
Harbour porpoise	0.76/km^2	HiDef aerial survey annual survey density estimate (**Appendix 12.1**)	346,601	NS MU (IAMMWG, 2022)
Bottlenose dolphin	0.0298/km^2	SCANS-III Survey Block R (Hammond *et al.,* 2021)	224	CES MU (IAMMWG, 2022)
			2,022	GNS MU (IAMMWG, 2022)
White-beaked dolphin	0.243/km^2	SCANS-III Survey Block R (Hammond *et al.,* 2021)	43,951	CGNS MU (IAMMWG, 2022)
Atlantic white-sided dolphin	0.028/km^2	Windfarm Site (Waggitt *et al.*, 2019)	18,128	CGNS MU (IAMMWG, 2022)
Risso's dolphin	0.0018/km^2	Windfarm Site in summer (Waggitt *et al.,* 2019)	12,262	CGNS MU (IAMMWG, 2022)
Minke whale	0.0387/km^2	SCANS-III Survey Block R (Hammond *et al.,* 2021)	20,118	CGNS MU (IAMMWG, 2022)
Humpback whale	0.000015/km^2	North Atlantic (Hammond *et al.,* 2021; Hague *et al.*, 2020)	35,000	North Atlantic (NAMMCO 2022; Hague *et al.*, 2020)
Grey seal	0.049/km^2	Windfarm Site (Carter *et al.*, 2020; SCOS, 2021)	14,644	EaS MU (adjusted with availability scalar; SCOS, 2021)
	0.32/km^2	Buzzard and Landfall Export Cable Corridors (Carter *et al.,* 2020; SCOS, 2021)	21,233	EaS and MoF MU for the wider reference population estimate (adjusted with availability scalar; SCOS, 2021)
Harbour seal	0.000002/km^2	Windfarm Site (Carter *et al.*, 2020; SCOS, 2020)	476	EaS MU (adjusted with availability scalar; SCOS, 2020)
	0.0015/km^2	Buzzard and Landfall Export Cable Corridors (Carter *et al.,* 2020; SCOS, 2020)	1,972	EaS and MoF MU for the wider reference population estimate (adjusted with availability scalar; SCOS, 2020)

11.7 Potential Impacts

170. **Table 11.12** presents the impacts that were proposed to be scoped out in the **Offshore Scoping Report** (**Appendix 1.2**) and the impacts that the **Scoping Opinion** (**Appendix 1.1**) require to be scoped in for the **Offshore EIA Report**.

Table 11.12 Potential impacts scoped in or out of the EIA for marine mammal ecology

Potential Impact	Construction		O&M		Decommissioning	
	Scoping Report	Scoping Opinion	Scoping Report	Scoping Opinion	Scoping Report	Scoping Opinion
Underwater noise during UXO clearance	✓	✓	x	x	x	x
Underwater noise during foundation installation	✓	✓	x	x	x	x
Underwater noise from other activities (for example rock placement and cable laying)	✓	✓	✓	✓	✓	✓
Underwater noise and presence of vessels	✓	✓	✓	✓	✓	✓
Underwater noise from operational wind turbines	x	x	✓	✓	x	x
Auditory injury and disturbance from underwater noise during geophysical surveys.	x	✓	x	x	x	x
Barrier effects from underwater noise	✓	✓	✓	✓	✓	✓
Collision risk with vessels	✓	✓	✓	✓	✓	✓
Entanglement	x	x	✓	✓	x	x
Disturbance at seal haul-out sites	x	x	x	x	x	x
Changes in water quality	x	x	x	x	x	x
Changes to prey availability (including from habitat loss and EMF)	✓	✓	✓	✓	✓	✓

Potential Impact	Construction		O&M		Decommissioning	
	Scoping Report	Scoping Opinion	Scoping Report	Scoping Opinion	Scoping Report	Scoping Opinion
Barrier effects from physical presence of windfarm	x	**x**	✓	✓	x	**x**
Electromagnetic fields direct effects	x	**x**	x	✓	x	**x**
Cumulative impacts from underwater noise	✓	✓	✓	✓	✓	✓
Cumulative impacts from collision risk and entanglement	✓	✓	✓	✓	✓	✓
Cumulative barrier impacts	x	✓	x	✓	x	✓
Cumulative disturbance at seal haul-out sites	✓	✓	✓	✓	✓	✓
Cumulative changes to prey availability (including habitat loss)	✓	✓	✓	✓	✓	✓
Transboundary impacts	✓	✓	✓	✓	✓	✓
Inter-relationships	✓	✓	✓	✓	✓	✓
Interactions	✓	✓	✓	✓	✓	✓

171. The potential impacts from the Project during the construction, operation, maintenance and decommissioning phases, including cumulative impacts have been determined for marine mammals (**Table 11.13**),

Table 11.13 Potential Impacts for Marine Mammals

Project Phase	Potential Impact
Construction (**Section 11.7.5**)	• Auditory injury and disturbance from underwater noise during geophysical surveys. • Physical injury, auditory injury and disturbance from underwater noise during UXO clearance. • Auditory injury and disturbance from underwater noise during piling, including use of ADD. • Disturbance impacts from underwater noise during other construction activities, such as cable installation and turbine mooring installation. • Disturbance from underwater noise and presence and movements of construction vessels. • Increased collision risk with vessels. • Barrier effects as a result of underwater noise. • Changes to prey resources.

Project Phase	Potential Impact
Operation and Maintenance (**Section 11.7.6**)	• Underwater noise and disturbance from: ○ Operational wind turbines ○ Maintenance activities such as cable laying ○ Vessels • Barrier effects from underwater noise. • Increased collision risk with vessels. • Entanglement. • EMF. • Barrier effects from physical presence of windfarm. • Changes to prey resource (including habitat loss and EMF).
Decommissioning (**Section 11.7.7**)	• Underwater noise during turbine anchor and mooring substructure removal. • Underwater noise during OSP foundation removal (depended on type of foundation and method used). • Underwater noise and disturbance from other decommissioning activities, such as cable removal, rock protection removal or scour protection removal, if required. • Underwater noise and disturbance from vessels. • Barrier effects as a result of underwater noise. • Increased collision risk with vessels. • Changes to prey resources.
Cumulative (**Section 11.8**)	• Disturbance due to underwater noise during construction and piling of the Project. • Cumulative barrier effects from underwater noise or physical presence during construction or operation of the Project. • Increased collision risk with vessels during construction and operation of the Project. • Entanglement during operation of the Project. • Changes to prey resource during construction and operation of the Project.

11.7.1 Embedded Mitigation

172. Embedded mitigation has been included, where possible, into the Project. Embedded mitigation measures relevant to marine mammals include:

- Soft-start and ramp-up (part of Marine Mammal Mitigation Protocol (MMMP) for Piling Activities for the single OSP.
  - Each piling event would commence with a soft-start at a lower hammer energy followed, by a gradual ramp-up for at least 20 minutes to the maximum hammer energy required. The soft-start and ramp-up allows mobile species to move away from the area before the maximum hammer energy with the greatest noise impact area is reached.
  - The MMMP for piling would also outline any other mitigation measures required to reduce the risk of physical or auditory injury to marine mammals from underwater noise during piling (**Section 11.7.1.1**).
- The **Piling Strategy** for the single OSP installation will be submitted to MS-LOT for approval prior to the commencement of piling, outlining mitigation and management measures that will be implemented during pile installation.
- MMMP for UXO Clearance
  - The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance (**Section 11.7.1.2**).
- Best practice to reduce vessel collision risk.
  - Vessel movements, where possible, will follow set vessel routes and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals.

- The Scottish Marine Wildlife Watching Code (Scottish Natural Heritage, 2017) will be followed, to reduce the potential for a vessel collision, by reducing vessel transit speeds and by maintaining speed and course when in the presence of marine mammal species. This code will be followed for all vessels transiting to and from the Windfarm Site. In the unlikely event that a collision event occurs, this will be reported on, and full information of the incident, including the marine mammal species, will be recorded.
  - These measures will be detailed within the **Construction Environmental Management Plan** (CEMP).
- Reduce potential impact of EMF.
  - Cables, wherever possible, will be buried to a target depth of 0.6-1.5m in accordance with DECC Guidelines (2011) and other guidance as appropriate, which will reduce the potential for impacts relating to EMF.
  - Cables will be specified to reduce EMF emissions as per industry standards and best practice such as the relevant IEC (International Electrotechnical Commission) specifications.
- **Marine Pollution Contingency Plan** in the **CEMP** will set out the management measures to be implemented during construction, operation and decommissioning to mitigate the risks of accidental spills of hazardous materials, measures to reduce instances of spills, remedial action and response measures to be used in the event of a spill or collision, and detail measures for refuelling at sea.

11.7.1.1 MMMP for Piling

173. The MMMP for piling for the single OSP installation will be developed in the pre-construction period and based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will be developed in consultation with Marine Scotland and NatureScot, detailing the proposed mitigation measures to reduce the risk of any physical or permanent auditory injury / change in hearing sensitivity (Permanent Threshold Shift (PTS)) to marine mammals during all piling operations.

174. This will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the mitigation zone and any additional mitigation measures required in order to minimise potential impacts of any physical injury or PTS, for example, the activation of ADD prior to the soft-start.

11.7.1.2 MMMP for UXO Clearance

175. A detailed MMMP will be prepared for UXO clearance during the pre-construction phase. The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance.

176. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with Marine Scotland and NatureScot.

177. The MMMP for UXO clearance will include details of all the required mitigation measures to minimise the potential risk of PTS as a result of underwater noise during UXO clearance. This would consider the options, suitability and effectiveness of mitigation measures such as, but not limited to:

- Low-order clearance techniques, such as deflagration
- The use of bubble curtains if any high-order detonation is required (taking into consideration the environmental limitations)
- Monitoring requirements for marine mammal observers (MMObs)
- Requirements for ADD
- Other UXO clearance techniques, such as avoidance of UXO; or relocation of UXO. If more than one high-order detonation is required, other measures such as the use of scare charges; or multiple detonations, if UXO are located in close proximity, will also be considered.

11.7.1.3 Mitigation for Geophysical Surveys

178. If required, mitigation for geophysical surveys (particularly if using Sub-bottom profilers (SBP), Sparkers and Ultra-Short Baseline (USBL) system) will follow the JNCC (2017) '*Guidelines for Minimising the Risk of Injury to Marine Mammals from Geophysical Surveys*' including:

- Completing a pre-survey search of the monitoring area (of 500 m around the acoustic source) prior to any geophysical survey commencement, for a period of at least 30 minutes with a MMObs depending on visibility conditions (MMObs pre-survey searches only to be undertaken in daylight and in good visibility).
- The monitoring area of 500 m is greater than the maximum predicted modelled PTS impact range. The monitoring area is the same as the mitigation zone for geophysical surveys.
- As the geophysical surveys are short in nature and are using low energy sources (such as SBP), a non-dedicated MMObs can be used. A non-dedicated MMObs refers to a trained MMObs who may undertake other roles on the vessel when not conducting their mitigation role. This person can be a member of the vessel's crew provided that during the mitigation period, they do not undertake any other roles on the vessel.
- If required, and if it is feasible and safe to tow a hydrophone array alongside the geophysical survey equipment, PAM could be deployed as an additional mitigation measure (for example, PAM pre-survey searches to be undertaken during hours of darkness and in poor visibility).
- If a marine mammal is detected within the 500 m monitoring area during the pre-survey search, the geophysical survey commencement will be delayed until the monitoring area has been clear of marine mammals for a period of at least 20 minutes, and the pre-survey search has been completed.
- A soft-start will be undertaken (wherever practical) once the monitoring area has been clear for 20 minutes, and the pre-survey search has been completed, with a gradual and consistent ramp-up of power over a minimum of a 15 minute period, and the line must be commenced within 25 minutes of the start of the soft-start procedure. Once soft-start has commenced, there is no requirement to stop or delay the acoustic survey.
- If a line change is expected to take more than 40 minutes, the geophysical survey would be halted at the end of the survey line, and a full pre-survey search and soft-start procedure would begin prior to the next line.
- If a line change is expected to take less than 40 minutes, geophysical surveys can continue if the shot point interval is increased to a maximum of 5 minutes and is decreased gradually in the final 10 minutes of the line change.
- If several pieces of geophysical survey equipment are to be started sequentially or interchanged during the operation, only one pre-shooting search is required prior to commencement of the first acoustic output, only if there are no gaps in data acquisition of more than 10 minutes.
- All survey equipment in use will be operated at as low a sound level as possible.

11.7.2 Proposed Monitoring

179. The PEMP will include for monitoring for entanglement risk and will be agreed with Marine Scotland and NatureScot prior to construction. This will include:

- Monitoring for large strains on mooring lines, designed to alert if there is unexpected load which can then be examined.
- Surveys: the turbines and mooring systems would be regular checked by remotely operated vehicle.

180. The monitoring measures will be developed to reduce the potential for an entanglement event to occur. Any entanglement event that does occur through the lifetime of the project will be reported, and full information of the incident will be recorded.

181. In the event that any entanglement of a marine mammal does occur during the operation of the Project, additional mitigation and monitoring measures may be required to ensure it does not happen again.

182. Further information on proposed monitoring for entanglement risk is provided in **Section 11.7.5.5.**

11.7.3 Worst Case

183. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst case scenarios have been defined in terms of the potential effects that may arise. This approach, referred to as the Design Envelope, is common practice for developments of this nature.

184. The Design Envelope for a project outlines the realistic worst case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 6: EIA Methodology**.

185. The realistic worst case scenarios relevant for the marine mammal assessment are summarised in **Table 11.14**. These are based on the Project parameters described in **Chapter 5: Project Description**, which provides further details regarding specific activities and their durations.

186. The area of the Windfarm Site is 116 km^2, the Offshore Export Cable Corridor is 0.648 km^2, giving a total Offshore Development Area of 116.65 km^2. The Windfarm Site is located 80 km from the coast, at the closest point.

187. Offshore construction is anticipated to take approximately 24 months from Q4, 2025 to the end of Q3, 2027.

188. The operational phase will last throughout the 35-year design life of the Project.

Table 11.14 Realistic Worst-Case Parameters for Marine Mammal Assessments

<table>
<tr><th>Impact</th><th colspan="4">Parameter</th><th>Notes</th></tr>
<tr><td colspan="6">Construction</td></tr>
<tr><td>Impact 1: Auditory Injury and Disturbance from underwater noise during geophysical surveys</td><td colspan="4">Currently unknown, however, assumed to include following options:
- Multi-beam echo sounder (MBES)
- Ultra-Short Baseline (USBL)
- Side Scan Sonar (SSS)
- Sub-bottom profiler (SBP)</td><td>Indicative only.</td></tr>
<tr><td>Impact 2: Physical injury, auditory injury and disturbance impacts resulting from the underwater noise associated with clearance of UXO</td><td colspan="4">Any requirements for UXO clearance currently unknow, including locations, number, types and sizes of UXO.

Risk Assessment determined worst-case is UXO with a Net Explosive Quantity (NEQ) of 253.5 kg.

Underwater modelling and assessments based high-order detonation of UXO with NEQ of 300 kg (including donor charge).

Low-order clearance would be the first and preferred method for UXO that require clearance.

Underwater modelling and assessments include low-order deflagration with shaped charge of 80 g NEQ.

As a worst case, assessments are based on high-order detonation without mitigation.</td><td>Indicative only.

A detailed UXO survey would be completed prior to construction. The exact type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage.

Based on Appendix 5.2,5.3 and 5.4 Green Volt Unexploded Ordnance Reports (6 Alpha Associates Ltd., 2022a, 2022b).</td></tr>
<tr><td rowspan="3">Impact 3: Auditory injury and disturbance resulting from underwater noise during piling, including ADD activation</td><td colspan="4">Installation of up to four pin-piles for one Offshore Substation Platform (OSP).
Anticipated to be installed in Q1 to Q2 2027.</td><td rowspan="3">Based on 1 x 4 leg jacket OSP required.

Options for piled or suction caisson. Piled considered as worst-case.

Soft Start may be used in combination with HiLo driving methodologies to reduce noise.</td></tr>
<tr><td>Key foundation parameters:
– Max pile diameter: 3 m
– Max pile penetration depth: 50 m
– Indicative pile penetration depth: 40 m</td><td>Key piling parameters:
– Max hammer driving energy of 2300 kJ
– Max piling time per foundation (assuming issues such as low blow rate, refusal, etc): 10 hr
– Average 'active piling time' per foundation: 4.4 hr
– Total 'active piling time' for Project (based on averages): 17.6 hr (or 40 hrs for max piling time)
– One pile per day
– Undertaken over an approximate one month period</td><td>Strike rates / number of blows:
– Max blows per minutes: 40
– Min blows per minute: 1
– Average blows per minute: 40
– Max number of blows per pile: 10,406</td><td>Soft-start parameters:
– Soft start assumed duration of 20 minutes
– Soft start assumed 6 blows per minute
– Soft start starting hammer energy of ≤300 to ≤500 kJ</td></tr>
<tr><td colspan="4">Estimated ADD duration of 15 minutes.</td></tr>
</table>

Impact	Parameter	Notes
Impact 4: Disturbance impacts resulting from underwater noise during other construction activities, such as cable installation and turbine mooring installation	Seabed clearance methods: Pre-lay grapnel run, boulder grab, plough, sand wave levelling (pre-sweeping), dredging	
	Cable installation Cable installation methods: trenching, jetting, ploughing, mechanical cutting, cable laying and rock mattress Cable protection: rock placement and / or mattresses Cable lengths: Buzzard Export Cable length: 60 km Landfall Export Cable length: 240 km Inter-array cable length: 134 km Duration of cable installation: - Export cable installation estimated to take approximately 31-32 days (31.25 days) between Q1 and Q2, 027 2027 - Array cable installation estimated to take approximately 33-34 days (33.6 days) between Q1 and Q3, 2027	Underwater noise modelling undertaken for cable trenching / cutting and cable laying.
	Installation of the turbine anchoring system Total = 35 turbines Number of mooring anchors for each turbine = up to 6 based on catenary system Turbine mooring installation anchor options: - Drag embedment anchors - Torpedo anchors - Gravity-based anchors - Suction piles Mooring installation period is anticipated to be between Q4, 2025 and Q3, 2027. The duration of the mooring installation within this period will be depended on the type of mooring.	Piling is not an option for turbine mooring installation. Underwater noise during turbine mooring installation is anticipated to be similar to dredging or comparable or less than modelled impact ranges for cable trenching / cutting. Therefore, modelled impact ranges for cable trenching / cutting are considered worst case.
Impacts 5 & 6: Underwater noise, disturbance and interaction from construction vessels	Vessel movements: • Maximum number of construction vessels on site at any one time: up to 16 (in total) • Construction vessel trips to port: 227 during 2 year construction period	Maximum number of construction vessels. Construction port/s will not be confirmed until nearer the start of construction.
Impact 7: Barrier effects as a result of underwater noise	Maximum impact range from underwater noise assessments (worst-case parameters described above). Windfarm Site is located 80 km from the coast.	The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst case barrier impact.

Impact	Parameter	Notes
Impact 8: Changes to prey resource	Impacts to prey species and habitat as described in **Chapter 9: Benthic Ecology** and **Chapter 10: Fish and Shellfish Ecology**	
	Worst-case for total seabed disturbance within the Offshore Development Area = 4.55 km^2 - Total substructure moorings = 0.06825 km^2 (based on worst case for catenary system) - Total area of disturbance from ploughing/jetting inter-array cables = 1.34 km^2 - Total area of rock protection for crossings of inter-array cables = 0.0189 km^2 - Total area of disturbance from ploughing/jetting of export cables = 3.00 km^2 - Total area of rock protection for non-buried export cables = 0.800 km^2 - Total area of rock protection for crossings export cables = 0.0330 km^2 - Total area of disturbance for OSP foundations = 0.00724 km^2 (based on worst case for suction bucket foundation including scour protection)	The worst-case scenario for maximum area of temporary habitat loss / disturbance of seabed.
	Increased suspended sediments and sediment re-deposition: as assessed in **Chapter 9: Benthic Ecology** and **Chapter 10: Fish and Shellfish Ecology**	
	Remobilisation of contaminated sediments: as assessed in **Chapter 8: Marine Sediment and Water Quality**	
	Underwater noise parameters as outlined for construction noise-related impacts above (UXO, piling, other construction activities and vessels) and as assessed in **Chapter 10: Fish and Shellfish Ecology**	As above for underwater noise.
Operation		
Impact 1: Underwater noise from operational turbines causing disturbance	Turbine parameters (e.g. size and number) as outlined above and underwater noise described in **Appendix 9.1.** Operation throughout the 35-year design life of the Project	Underwater noise review for operational turbines, based on fixed foundations as worst case.
Impact 2: Underwater noise from maintenance activities and vessels causing disturbance	Cable repair, replacement or reburial works. Disturbance from operation and maintenance vessels.	Underwater noise modelling for vessels, cable trenching / cutting and cable laying.
Impact 3: Barrier effect from underwater noise	Maximum impact range from operation and maintenance phase underwater noise assessments (as above). Spacing between turbines: 2 km	The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst case barrier impact.
Impact 4: Interactions with vessels – increased collision risk	Vessel movements: • Vessel round trips to port per year: 8 • Upper estimate of a single movement: 150 km	
Impact 5: Potential entanglement with mooring lines	• Max 210 mooring lines (6 per wind turbine generator (WTG)) • Max 70 cables (2 per WTG) • Mooring lines made up of anchor chain, mooring cables or polyester mooring line • Mooring lines extend out to between 650 m (catenary system) and 100 m (Tension Leg Platform (TLP) system) from the WTG.	One buoy per mooring line

<table>
<tr><th>Impact</th><th>Parameter</th><th>Notes</th></tr>
<tr><td>Impact 6: EMF</td><td>EMF from export cable options, inter-array cables and dynamic cables from turbines to seabed in water column, based on potential direct effects of magnetic and electric fields.</td><td>EMF assessment for Project (Appendix 9.2 National Grid, 2022).</td></tr>
<tr><td>Impact 7: Barrier effects from physical presence of wind farm</td><td>35 floating turbines
Spacing between turbines: 2 km

The mooring line radius around each turbine would be 100 m or 650 m, depending on mooring system.
Spacing between mooring systems: 1.8 km or 700 m depending on mooring system and line configurations.

Area of Windfarm Site: 116 km^2
Maximum footprint of moorings and OSP foundations: 0.0755 km^2
- Total substructure moorings = 0.06825 km^2 (based on worst case for catenary system)
- Total area of disturbance for OSP foundations = 0.00724 km^2 (based on worst case for suction bucket foundation)</td><td>Maximum area taken up by WTG and OSP (including spacing between)</td></tr>
<tr><td rowspan="6">Impact 8: Changes to prey resources</td><td colspan="2">Impacts to prey species and habitat as described in Chapter 9: Benthic Ecology and Chapter 10: Fish and Shellfish Ecology</td></tr>
<tr><td>Temporary seabed disturbance / habitat loss
Less than construction phase: 4.34 km^2
- Total area of disturbance from ploughing/jetting inter-array cables during construction = 1.34 km^2
- Total area of disturbance from ploughing/jetting of export cables during construction = 3.00 km^2

- Catenary drag footprint = 1.134 m^2 per WTG at low water when mooring line radius is at a maximum</td><td>The worst-case scenario, based on construction, for maximum area of temporary habitat loss / disturbance of seabed from cable repair, replacement and reburial footprint.</td></tr>
<tr><td>Total permanent habitat loss and introduction of hard substrate for operational lifetime:

Area of sediment disturbed = 0.8519 km^2
• Total area of rock protection for crossings of inter-array cables = 0.0189 km^2
• Total area of rock protection for non-buried export cables = 0.800 km^2
• Total area of rock protection for crossings export cables = 0.0330 km^2

-</td><td>The worst-case scenario for maximum area of permanent habitat loss / introduction of wind turbine moorings / anchors, OSP foundations, scour protection and hard substrate (including subsea cable surface protection and pipeline crossing).</td></tr>
<tr><td>Temporary increases in Suspended Sediment Concentrations (SSCs) due to maintenance activities could result from cable repair, replacement and reburial activities.</td><td></td></tr>
<tr><td>Underwater noise parameters as outlined for operation noise-related impacts above and Appendix 9.1 (operational turbines, maintenance activities, vessels).</td><td>As above for underwater noise.</td></tr>
<tr><td>EMF offshore cables
Up to 486 km of offshore cables comprising:
• Two High Voltage Alternating Current (HVAC) export cables up to 60 km in length to Buzzard
• Two HVAC export cables up to 240 km to Landfall
• 134 km of inter-array cables
• Burial depth: minimum 0.6 m to maximum 1.5 m.
• Non burial technique: rock placement and / or mattresses</td><td>For inter-array and export cables and dynamic cables form the turbine to the seabed.

EMF assessment for the Project (Appendix 9.2; National Grid, 2022).</td></tr>
</table>

Impact	Parameter	Notes
Decommissioning		
Impact 1: Underwater noise from foundation removal of WTGs wind turbines and substation – injury & disturbance effects	No final decision has yet been made regarding the final decommissioning policy for the offshore project infrastructure. It is also recognised that legislation and industry best practice change over time. However, the following infrastructure is likely be removed, reused or recycled where practicable: • Turbines including anchor moorings; • OSP including topsides and steel jacket foundations; • Offshore cables may be removed or left in situ depending on available information at the time of decommissioning; and • Cable protection. The following infrastructure is likely to be decommissioned in situ depending on available information at the time of decommissioning: • Scour protection; and • Offshore cables may be removed or left in situ; The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. For the purposes of the worst-case scenario, it is anticipated that the impacts will be no greater than those identified for the construction phase, as no piling will be required.	Assumed to be no worse than during construction. Decommissioning arrangements will be detailed in a Decommissioning Programme, which will be drawn up and agreed with the MS-LOT prior to construction.
Impact 2: Underwater noise from other decommissioning activities		
Impacts 3 & 5: Underwater noise from vessels disturbance effects, and vessel collision risk		
Impact 4: Barrier effect from underwater noise		
Impact 6: Changes to prey resources		
Cumulative Impacts		
Impact 1: Disturbance from underwater during construction and piling of the Project	Duration of offshore construction of up to 2 years and relative areas of MUs to determine long list of projects and activities. Disturbance impact ranges based on worst case, including underwater noise modelling for the Project for similar activities (as outlined above). Precautionary approach to determine projects and all potential noise sources which could have cumulative effects. Precautionary approach to determine density estimates and reference populations for all marine mammal species.	Offshore construction is anticipated to take approximately 24 months from Q4 2025 to Q3, 2027. Construction activities and piling would be a small duration of the overall construction period. However, as a worst case it is assumed works could require up to three years (excluding pre-construction activities such as geophysical surveys and UXO clearance). Further information provided in **Appendix 11.1**

Impact	Parameter	Notes
Impact 2: Barrier effects from underwater noise or physical presence during construction or operation of the Project	As outlined above for potential barrier effects from underwater noise during construction or physical presence during operation, based on current information.	
Impact 3: Increased collision risk with vessels during construction and operation of the Project	Potential increased collision risk to marine mammals from projects and activities identified in the CIA including the Project (as outlined above), compared to current number of vessel movements.	
Impact 4: Entanglement during operation of the Project	Based on assessment for the Project and current information.	
Impact 5: Changes to prey resources during construction and operation of the Project	Based on assessment for the Project and current information.	

11.7.4 Underwater Noise

189. Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (**Table 11.15**) and the sound levels are greater than thresholds for the species (**Table 11.16**; Southall *et al*., 2019).

190. The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure.

191. The potential impact of underwater noise will depend on a number of factors which include, but are not limited to:

- The source levels of noise
- Frequency relative to the hearing bandwidth of the animal (dependent upon species)
- Propagation range, which is dependent upon
- Sediment/sea floor composition
- Water depth
- Duration of exposure
- Distance of the animal to the source
- Ambient noise levels.

192. Noise sources are categorised as either impulsive or non-impulsive (Southall *et al*., 2019):

- Impulsive (single or multiple pulsed) - high peak sound pressure, short duration, fast rise-time and broad frequency content at source. Explosives, impact piling and seismic airguns are considered impulsive noise sources.
- Non-impulsive - continuous non-pulsed sound. Vessel engines, sonars, vibro-piling, drilling and other low-level continuous noises are considered non-impulsive. However, a non-impulsive noise does not necessarily have to have a long duration.

193. Activities that have the potential to generate underwater noise associated with the Project are:

- Geophysical surveys (**Section 11.7.5.1**)
- Clearance of UXO, if required, for example along the cable route (**Section 11.7.5.2**)
- Piling of the pin-piles for the offshore substation (**Section 11.7.5.3**)
- Construction activities such as seabed preparation, and cable laying (**Section 11.7.5.4**)
- Construction vessels (**Section 11.7.5.5**)
- Operational turbines (**Section 11.7.6.1**)
- Maintenance activities and vessels (**Section 11.7.6.2**)

11.7.4.1 Thresholds and Criteria

194. The metrics and criteria that have been used to assess the potential impact of underwater noise on marine mammals are based on, at the time of writing, the most up to date publications and recommended guidance.

195. Southall *et al*. (2019) presents unweighted peak Sound Pressure Level (SPL) criteria (SPL_{peak}) for single strike, weighted Sound Exposure Level (SEL) criteria for single strike (SEL_{ss}) and cumulative (i.e. more than a single sound impulse) weighted sound exposure criteria (SEL_{cum}) for both permanent auditory injury (PTS) where unrecoverable reduction in hearing sensitivity may occur and temporary auditory injury (Temporary Threshold Shift (TTS)) where a temporary reduction in hearing sensitivity may occur (**Table 11.16**).

196. Southall *et al*. (2019) categorises marine mammal species into hearing groups and applies filters to the unweighted noise to approximate the hearing sensitivities of the species to approximate for the specific hearing abilities and sensitivities of each group. This provided the weighted SEL criteria,

which corrects the sound level based on the sensitivity of the receiver, for example, harbour porpoise are less sensitive to low frequency sound than minke whale. Marine mammal hearing ranges are summarised in **Table 11.15**.

197. Southall *et al*. (2019) also includes criteria based on SPL_{peak}, which are unweighted and do not take species sensitivity into account. It is important to note that they are different criteria and as such they should not be compared directly. All decibel SPL values are referenced to 1μPa and all SEL values are referenced to $1μPa^2s$. Assessments have been based on the criteria with the greatest predicted impact ranges.

198. Note that the Southall *et al*. (2019) Marine Mammal Noise Exposure Criteria are the same as the National Marine and Fisheries Service (NMFS) (2018) criteria, although Southall *et al*. (2019) renames the species groupings: Medium-Frequency (MF) Cetaceans are now classed as High-Frequency (HF) Cetaceans, and previous HF Cetaceans as Very High Frequency (VHF) Cetaceans.

Table 11.15 Southall et al. (2019) Marine Mammal Hearing Ranges

Species Hearing Group	Generalised Hearing Range
Harbour porpoise Very high-frequency cetaceans (VHF)	275 Hz to 160 kHz
Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin High-frequency cetaceans (HF)	150 Hz to 160 kHz
Minke whale and humpback whale Low-frequency cetaceans (LF)	7 Hz to 35 kHz
Grey seal and harbour seal Phocid carnivores in water (PCW)	50 Hz to 86 kHz

Table 11.16 Southall et al. (2019) Thresholds and Criteria used in the Underwater Noise Modelling and Assessments

Species	Species Hearing Group	Impact	SPL_{peak} Unweighted (dB re 1 μPa) Impulsive	SEL_{ss} and SEL_{cum} Weighted (dB re 1 $μPa^2s$)	
				Impulsive	Non-impulsive
Harbour porpoise	VHF	PTS	202	155	173
		TTS	196	140	153
Bottlenose dolphin White-beaked dolphin Atlantic white-sided dolphin Risso's dolphin	HF	PTS	230	185	198
		TTS	224	170	178
Minke whale Humpback whale	LF	PTS	219	183	199
		TTS	213	168	179
Grey seal Harbour seal	PCW	PTS	218	185	201
		TTS	212	170	181

199. The PTS thresholds are extrapolated from TTS thresholds. These PTS thresholds ultimately are used to indicate the potential number of animals that could be at risk of PTS (e.g. experience permanent hearing sensitivity loss even once exposure to sound ceases or in between successive sounds exposures) as a opposed to the number of animals that will develop TTS (temporary hearing sensitivity loss that will recover completely once exposure to sound ceases or in between successive sounds exposures).

200. The likelihood of individual animals experiencing PTS and TTS is also dependent on the frequency band at which PTS and TTS is predicted to occur and whether that frequency band is in the critical hearing sensitivity band for that species. If PTS or TTS is predicted to occur at a frequency outside the critical hearing band, potential effects will be minimal.

Disturbance

201. The Marine Scotland (2020) guidance specifies disturbance as occurring if the activity is likely "*to significantly affect the local distribution or abundance of the species to which it belongs*." The equivalent European Commission guidance (2007) suggests that a disturbance must significantly impact the local distribution or abundance of a species, including temporary impacts. The JNCC *et al*. (2010) guidance proposes that "*any action that is likely to increase the risk of long-term decline of the population(s) of (a) species could be regarded as disturbance under the Regulations*."

202. To assess the potential for disturbance it is necessary to consider the likelihood that exposure of the animal(s) elicits a response which is likely to generate a significant population-level effect. Assessment of population-level impacts from a temporary disturbance is made complicated by the highly variable nature of the introduced disturbance (e.g. the complex nature of sound and its propagation in the marine environment), the variability of behavioural response in different species and individuals.

203. There are currently no agreed thresholds or criteria for modelling the disturbance of marine mammals from underwater noise. The JNCC *et al*. (2010) guidance indicates that a score of 5 or more on the Southall *et al*. (2007) behavioural response severity scale could be significant (**Table 11.17**). The more severe the response on the scale, the less time animals will likely tolerate the disturbance before there could be significant negative effects on life functions, which would constitute a disturbance. The assessments of disturbance consider the potential for the behaviours described by Southall *et al*. (2007) occurring as a result of underwater noise sources.

204. It is important to note, if there is the potential for significant disturbance to result in a population-level effect, then alternatives and mitigation options will be considered and, if required, an EPS licence application submitted.

Table 11.17 Southall et al. (2007) Severity Scale for Ranking Observed Behavioural Responses of Free-Ranging Marine Mammals

Response score	Corresponding behaviours in free-ranging subjects
0	No observable response.
1	Brief orientation response (investigation / visual orientation).
2	Moderate or multiple orientation behaviours Brief or minor cessation/modification of vocal behaviour Brief or minor change in respiration rates
3	Prolonged orientation behaviour Individual alert behaviour Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of soundsource Moderate change in respiration rate Minor cessation or modification of vocal behaviour
4	Moderate changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source Brief, minor shift in group distribution Moderate cessation or modification of vocal behaviour
5	Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but noavoidance of sound source Moderate shift in group distribution Change in inter-animal distance and/or group size (aggregation or separation) Prolonged cessation or modification of vocal behaviour
6	Minor or moderate individual and/or group avoidance of sound source Brief or minor separation of females and dependent offspring Aggressive behaviour related to sound exposure (e.g. tail/flipper slapping, fluke display, jawclapping/gnashing teeth, abrupt directed movement, bubble clouds) Extended cessation or modification of vocal behaviour Visible startle response Brief cessation of reproductive behaviour
7	Extensive or prolonged aggressive behaviour Moderate separation of females and dependent offspring Clear anti-predator response Severe and/or sustained avoidance of sound source Moderate cessation of reproductive behaviour

Response score	Corresponding behaviours in free-ranging subjects
8	Obvious aversion and/or progressive sensitisation Prolonged or significant separation of females and dependent offspring with disruption ofacoustic reunion mechanisms Long-term avoidance of area Prolonged cessation of reproductive behaviour
9	Outright panic, flight, stampede, attack of conspecifics, or stranding events Avoidance behaviour related to predator detection

205. Southall *et al*. (2007) present a summary of observed behavioural responses for various mammal groups exposed to different types of noise: continuous (non-pulsed) or impulsive (single or multiple pulsed). See **Appendix 9.1** for further information.

206. The underwater noise modelling (**Appendix 9.1**) is based on a conservative approach and uses the NMFS (2005) Level B harassment threshold of 160 dB re 1 µPa (Root Mean Square (rms)) for impulsive sound. Level B Harassment is defined by NMFS (2005) as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. This is similar to the JNCC *et al*. (2010) description of non-trivial disturbance and has therefore been used as the basis for potential behavioural change in this assessment.

207. It is important to understand that exposure to sound levels in excess of the behavioural change threshold does not necessarily imply that the sound will result in significant disturbance. The assessments take into account the likelihood that the sensitive receptors will be exposed to that sound, the duration of exposure and whether the numbers exposed are likely to be significant at the population level.

*Table 11.18 Disturbance Criteria for Marine Mammals used in the Underwater Noise Modelling (**Appendix 9.1**)*

Effect	Non-Impulsive Threshold	Impulsive Threshold (Other than Piling)	Impulsive Threshold (Piling)
Mild disturbance (all marine mammals)	-	140 dB re 1µ Pa (rms)	Based on SEL 5 dB contours
Strong disturbance (all marine mammals)	120 dB re 1µ Pa (rms)	160 dB re 1µ Pa (rms)	Based on SEL 5 dB contours
Disturbance (harbour porpoise)	-	Based on SEL 5 dB contours	Based on SEL 5 dB contours

Dose-response curve

208. Where sufficient scientific evidence exists, current best practice is to apply a species-specific dose-response assessment rather than the fixed behavioural threshold approach that is described above (and still used in most assessments).

209. The application of a dose-response curve allows for an evidence-based estimate which accounts for the fact that the likelihood of an animal exhibiting a response to a stressor or stimulus will vary according to the dose of stressor or stimulus received (Dunlop *et al*., 2017). Therefore, unlike the traditional threshold assessments commonly used, a dose-response analysis assumes that not all animals in an impacted area will respond (with behavioural disturbance response in this case). For the purposes of this assessment, the dose is the received single-strike SEL_{SS}. The use of SEL_{SS} in a dose-response analysis, where possible, is considered to be best practice in the latest guidance provided by Southall *et al*. (2021).

210. The dose-response methodology has been adopted in this assessment for species where there are appropriate dose-response experiments published in the scientific literature, namely harbour porpoise, harbour seal and grey seal.

211. To estimate the number of animals disturbed by piling, SEL_{SS} contours at 5 dB increments (generated by the noise modelling – see **Appendix 9.1**) were overlain on the relevant species density surfaces (see **Sections 11.6.2.1**; **11.6.3.1**; and **11.6.3.2**) to quantify the number of animals receiving each SEL_{SS}, and subsequently the number of animals likely to be disturbed based on the corresponding dose-response curve. For harbour porpoise, the Waggitt *et al*. (2020) density estimates were used. As August was the month with the greatest harbour porpoise densities within the Study Area, density estimates from this month were conservatively used for the analysis. For both seal species, the Carter *et al*. (2020) density estimates were used.

212. The dose-response relationship used for harbour porpoise was developed by Graham *et al*. (2017) using data collected on harbour porpoises during Phase 1 of piling at the Beatrice Offshore Wind Farm. This dose response relationship is displayed in

213. **Figure** 11.18 Dose-response relationship developed by Graham et al. (2017) used for harbour porpoise in this assessment

214. . Following the development of this dose-response relationship, further study revealed that the responses of harbour porpoises to piling noise diminishes over the construction period (Graham *et al*., 2019). Therefore, the use of the dose-response relationship related to an initial piling event for all subsequent piling events in this assessment can be considered conservative.

215. In the absence of species-specific dose-response data for dolphins or whales, harbour porpoise is the only species of cetacean that this analysis is applied to. Due to differences in audiograms and behaviour, it would not be appropriate to extrapolate the findings of Graham *et al*. (2017) to other cetacean species.

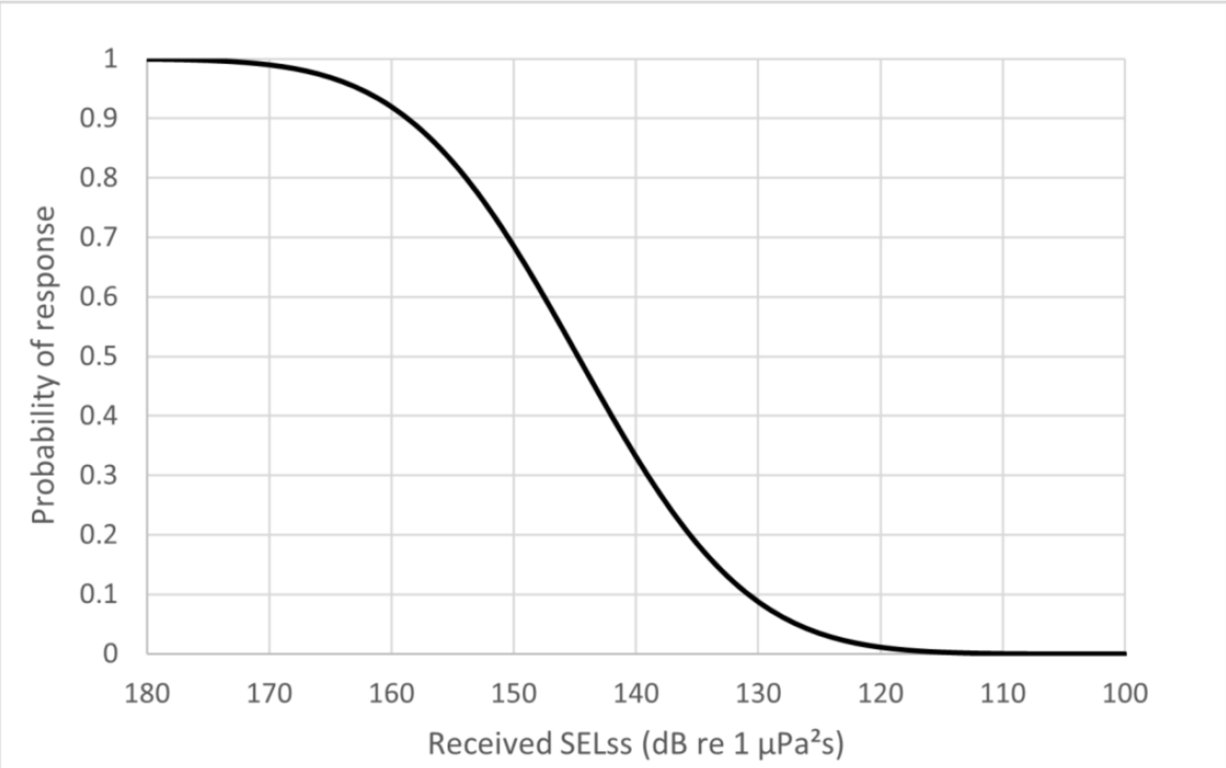

Figure 11.18 Dose-response relationship developed by Graham et al. (2017) used for harbour porpoise in this assessment

216. For both harbour seal and grey seal, a dose-response relationship that is derived from harbour seal telemetry data collected during several months of piling at the Lincs Offshore Wind Farm has been used (Whyte *et al*., 2020). As seen in **Figure 11.19**, the greatest SEL_{SS} considered in the Whyte *et al*. (2020) study was 180 dB re 1 μPa^{2}s. This assessment has therefore conservatively assumed that at SEL_{SS} > 180 dB re 1 μPa^{2}s all seals will be disturbed. The dose-response curve for harbour seal has been used for grey seal, as both species have similar hearing audiograms (see **Table 11.15**).

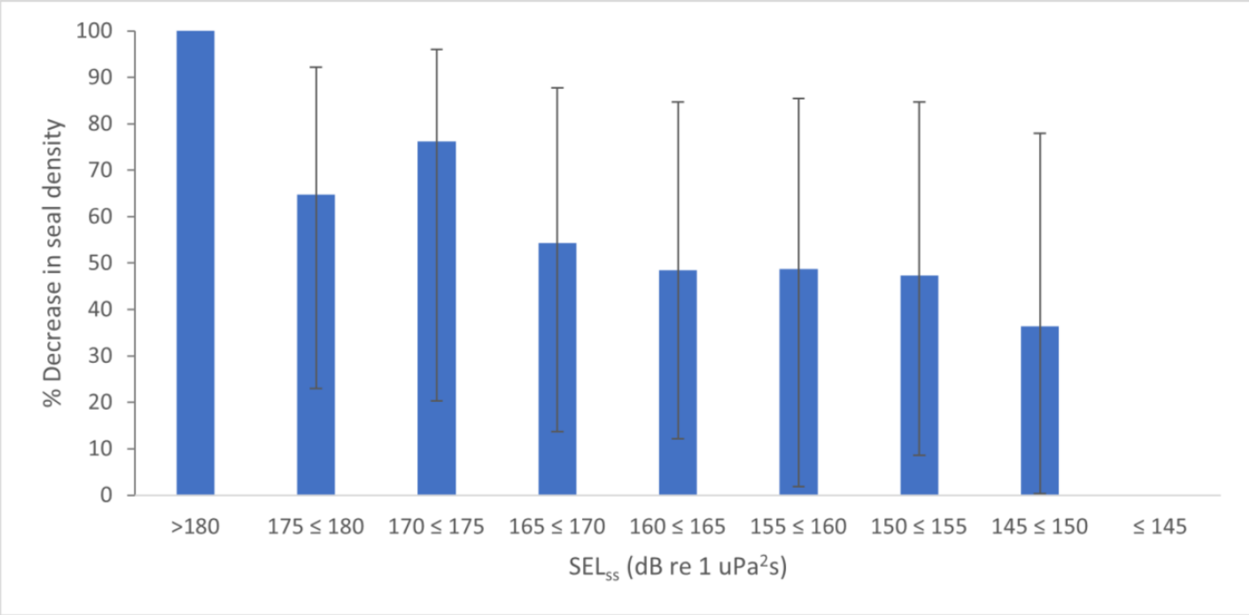

Figure 11.19 Dose-response behavioural disturbance data for harbour seal derived from the data collected and analysed by Whyte et al. (2020). This data has been used for harbour and grey seals in this assessment

11.7.4.2 Underwater Noise Modelling

217. Seiche Ltd. (2022) conducted underwater noise modelling for the potential noise sources during the construction and operation of the Project. The full underwater noise modelling report is provided in **Appendix 9.1**, and includes detail on the methodologies used for modelling, and modelling input parameters.

11.7.4.3 Magnitude

218. The magnitude for underwater noise impacts has been assessed based on the maximum number of each marine mammal species that could be impacted in the maximum area of potential impact.

219. As a precautionary approach, the maximum area of potential impact has been determined based on the area of a circle with the maximum impact range as the radius. This is very precautionary as the impact area would not be a defined circle around the sound source, but would vary based on noise propagation, water depth, bathymetry and seabed conditions.

220. The magnitude (see **Section 11.4.1.4**) is assessed based on number of each marine mammal species that could be impacted in the context of the relevant reference population (**Table 11.11**).

11.7.4.4 Sensitivity

221. All species of cetaceans (whales, dolphins and porpoise) rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall *et al*., 2007). As such, sensitivity to PTS from underwater noise is assessed as high for all cetacean species (**Table 11.19**). The hearing abilities and function of baleen whale species (minke whale and humpback whale) is less understood, however a sensitivity of high is applied to these species on a precautionary basis. When considering the impact that any auditory injury has on an individual, the frequency range over which the auditory injury occurs must be considered. PTS would normally only be expected in the critical hearing bands in and around the critical band of the fatiguing sound (Kastelein *et al*., 2012). Auditory injury resulting from sound sources like piling (where most of the energy occurs at lower frequencies) is unlikely to negatively affect the ability of high-frequency cetaceans to communicate or echo-locate. PTS would not result in an individual being unable to hear but could result in some permanent change to hearing sensitivity.

222. Pinnipeds (seal species) use sound both in air and water for social and reproductive interactions (Southall *et al*., 2007), but not for finding prey. Therefore, Thompson *et al*. (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. Pinnipeds also have the ability to hold their heads out of the water during exposure to loud noise, and potentially avoid PTS during piling. As such, sensitivity to PTS in harbour and grey seal is expected to be lower than cetacean species such as harbour porpoise, with the individual showing some tolerance to avoid, adapt to or accommodate or recover from the impact (for example, Russell *et al*., 2016), but as a precautionary approach they are also considered as having high sensitivity in this assessment (**Table 11.19**).

223. Any PTS would be permanent and marine mammals within the potential impact area are considered to have very limited capacity to avoid such impacts, and unable to recover from the effects (see **Table 11.3**).

224. All marine mammal species are assessed as having medium sensitivity to TTS (**Table 11.19**). Any TTS would be temporary, and individuals would recover from any temporary changes in hearing sensitivity after the noise source has ceased. However, as a precautionary approach, medium sensitivity to TTS assumes an individual has limited capacity to avoid, adapt to, tolerate or recover from the anticipated impact (**Table 11.3**).

225. Marine mammals may exhibit varying intensities of behavioural response at different noise levels. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment. The response can vary due to exposure level, the hearing sensitivity of the individual, context, previous exposure history or habituation, motivation and ambient noise levels (e.g. Southall *et al*., 2007).

226. The response of individuals to a noise stimulus will vary and not all individuals will respond; however, for the purpose of this assessment, it is assumed that at the disturbance range, 100% of the individuals exposed to the noise stimulus will respond and be displaced from the area. However, it is unlikely that all individuals would be displaced from the potential disturbance area, therefore this a very precautionary approach.

227. The sensitivity of marine mammals to disturbance is considered to be medium in this assessment as a precautionary approach (**Table 11.19**). Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased (**Table 11.3**).

228. The sensitivity of marine mammals to possible mild behavioural response (140 dB threshold) from underwater noise for all marine mammal species is considered to be low (**Table 11.19**). Not all individuals in the impact area would respond, any response would be temporary and short-term. Individual receptors in the potential impact area have some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact (**Table 11.3**).

Table 11.19: Summary of Marine Mammal Sensitivity to Underwater Noise

Species	PTS	TTS	Disturbance	Mild behavioural response (140 dB threshold)
Harbour porpoise	High	Medium	Medium	Low
Bottlenose dolphin	High	Medium	Medium	Low
White-beaked dolphin	High	Medium	Medium	Low
Atlantic white-sided dolphin	High	Medium	Medium	Low

Species	PTS	TTS	Disturbance	Mild behavioural response (140 dB threshold)
Risso's dolphin	High	Medium	Medium	Low
Minke whale	High	Medium	Medium	Low
Humpback whale	High	Medium	Medium	Low
Grey seal	High	Medium	Medium	Low
Harbour seal	High	Medium	Medium	Low

11.7.5 Potential Impacts during Construction

229. Potential impacts during construction may arise from activities during the installation of offshore infrastructure leading to auditory injury or disturbance. Underwater noise during piling may cause auditory injury, as well as disturbance associated with underwater noise from other construction activities and the presence of vessels offshore, are assessed. Potential displacement from important habitat areas and impacts on prey species are also considered.

230. The potential impacts during construction assessed for marine mammals are:

- Impact 1: Geophysical surveys - auditory injury and disturbance from underwater noise
  - Potential effects of any geophysical surveys will be assessed and submitted as a separate Marine Licence and EPS Licence application. However, as a precautionary approach and to cover any requirements for geophysical surveys an assessment has been included in the EIA.
- Impact 2: UXO clearance - auditory injury and disturbance from underwater noise
  - Potential effects of any UXO clearance will be assessed and submitted as a separate Marine Licence and EPS Licence application. However, as a precautionary approach and to cover any requirements for UXO clearance an assessment has been included in the EIA.
- Impact 3: Piling - auditory injury and disturbance from underwater noise, including ADD activation
- Impact 4: Other construction activities - disturbance from underwater noise during cable and mooring installation
- Impact 5: Vessels - underwater noise disturbance and disturbance from presence and movements of vessels
- Impact 6: Vessel interaction – increased collision risk with vessels:
- Impact 7: Barrier effects as a result of underwater noise
- Impact 8: Changes to prey resource

231. The realistic worst-case scenario on which the assessments are based is outlined in **Table 11.14**.

11.7.5.1 Impact C1: Geophysical Surveys - Auditory Injury and Disturbance from Underwater Noise

232. Geophysical surveys may be required to be undertaken to inform project design work, to enable the development team to make responsible project design decisions, and to inform the ongoing technical design and delivery of assessments.

233. It is important to note, that prior to any geophysical surveys an EPS Risk Assessment (RA) will be conducted to determine if the proposed geophysical survey could have the potential risk of disturbance or auditory injury to cetacean species. All cetacean species (harbour porpoise, dolphin and whale species) are EPS. The EPS RA will be undertaken based on the geophysical survey

specification, including equipment to be used, number of survey vessels, area(s) to be surveyed, duration of surveys and time of year.

234. The information provided in this assessment for the **Offshore EIA Report**, is based on a precautionary worst-case scenario. Geophysical surveys could involve different types of survey equipment, these are summarised in **Table 11.20**. **Table 11.21** presents a summary of examples of the frequency ranges and sound levels for geophysical survey equipment and potential risk to marine mammals.

Table 11.20 Geophysical Survey Equipment

Type of survey equipment	Description
Sub-Bottom Profilers (SBP) (such as pingers, sparkers, boomers and CHIRP systems)	SBP systems are used to identify and characterise layers of sediment or rock under the seafloor. A transducer emits a sound pulse vertically downwards towards the seafloor, and a receiver records the return of the pulse once it has been reflected off the seafloor. SBPs comprise of boomer, pingers and sparkers, which use an electrical discharge to generate sound similar to boomers, but their use is now infrequent. A high voltage impulse generates a spark across a pair of electrodes forming a gas bubble whose oscillations generate the sound. Sparkers are powerful devices and can be used to penetrate seabed layers up to 1 km (JNCC, 2017).
Multibeam Echo Sounder (MBES)	MBES are used to obtain detailed maps of the seafloor which show water depths. They measure water depth by recording the two- way travel time of a high frequency pulse emitted by a transducer. The beams produce a fanned arc composed of individual beams (also known as a swathe). MBES can, typically, carry out 200 or more simultaneous measurements.
Side Scan Sonar (SSS)	SSS is used to generate an accurate image of the seabed. An acoustic beam is used to obtain an accurate image of a narrow area of seabed to either side of the instrument by measuring the amplitude of back- scattered return signals. The instrument can either be towed behind a ship at a specified depth or mounted on to a Remotely Operated Vehicle (ROV). The higher frequency systems provide higher resolution, but shorter-range measurements.
Single Beam Echo Sounder (SBES)	SBES operate in a similar manner to MBES; rather than measuring multiple points per acoustic echo wave (echo) emitted, SBES can only measure one point at a time. SBES specifications are defined by beam angle and frequency of transmitted acoustic wave from the transducer as well as many other sonar parameters which may be selected in order to provide water depth capabilities from less than 1m.
Ultra-Short Baseline (USBL) system	USBL systems are used to determine the position of subsea survey items, including ROVs, towed sensors, etc. This involves the emission of sound from a hull-mounted transducer to a subsea transponder, thereby introducing sound into the marine environment. A complete USBL system consists of a small transducer array, which is mounted under a ship, and a transponder attached to the subsea unit. An acoustic pulse is transmitted by the transducer, travels through the water and is detected by the shipboard transducer on an onboard computer calculates the time from the transmission of the initial acoustic pulse until the reply is detected and is measures by the USBL system. This is converted into a range and bearing, and thus the position of the subsea unit / sampling equipment is determined. These systems can either be used continuously or intermittently through the operation they are supporting.
2D Ultra High Resolution (UHR)	Ultra-high resolution geophysical survey to assess the subsurface condition of the seabed.
Magnetometer	Magnetometer surveys are used to detect any ferrous metal objects on the seabed, such as wrecks, unexploded ordnance (UXO), or any other obstructions. Marine magnetometers come in two types: surface towed and near-bottom. Both are towed a sufficient distance (about two ship lengths) away from the ship to allow them to collect data without it being polluted by the ship's magnetic properties. Surface towed magnetometers allow for a wider range of detection at the price of precision accuracy that is afforded by the near-bottom magnetometers.
Vibrocore sampling / Cone Penetration Tests (CPT)	For the vibro-cores, underwater electric motors generate vibrations to 'drive' the core barrel into the seabed in order to obtain a seabed core. For the CPTs, underwater hydraulic power units push an instrumented cone into the seabed and the resistance encountered is recorded.

Table 11.21 Frequency Ranges and Sound Levels for Geophysical Survey Equipment and Potential Risk to Marine Mammals

Type of survey equipment	Predicted source levels and frequencies	Notes	Potential Risk to marine mammal
SBP	Sub bottom profilers typically emit noise within the frequency range 100 Hz to 22 kHz. SBP source levels (peak) typically range between 185 – 250 dB re 1µPa at 1m (Hartley Anderson Ltd, 2020).	Although source levels are likely to be too low to result in injury, they will be audible to most species, and thus have the potential to result in disturbance.	Frequency ranges of the SBP can be within cetacean hearing range and will therefore be audible to cetacean species that could be present in the area. There is therefore the potential for disturbance impacts to occur. Most of the sound energy generated by the SBP equipment will be directed towards the seabed and the pulse duration is extremely short, with the continuous movement of the survey. Auditory injury effects are not predicted, as an animal would need to remain in the very small zone of ensonification for a prolonged period, which is highly unlikely (JNCC *et al.,* 2010).
MBES	MBES source levels range from 200 – 240 dB re 1µPa (rms) (Hartley Anderson Ltd, 2020). MBES emit noise over a frequency of 12 – 500 kHz (Prideaux, 2017).	Source levels have a minimum peak pressure level which has been identified as having the potential to cause injury to harbour porpoise (200 dB re 1µPa) and could be audible to marine mammal species in the area.	JNCC *et al*. (2010) assessed MBES system to have the potential to emit sound sources of up to 236 dB re 1 µPa @1m, with frequencies of between 10 and 200 kHz. Due to the high amplitude of MBES, there is the potential for auditory injury to marine mammal species, however this is highly unlikely as an animal would need to be within very close proximity of the source. JNCC *et al*. (2010) also determined that it is also unlikely that the MBES could cause disturbance when active for a short period due to the operating frequencies being outside the audible range of all marine mammals MBES surveys that are carried out in waters of less than 200m in depth are not considered to be a risk to marine mammals, as it is thought that the higher frequencies typically used (200 to 400 kHz) fall outside of their hearing ranges, and the sounds are likely to attenuate quickly due to the high frequencies used. JNCC therefore advise that mitigation is unlikely to be required for MBES surveys in shallow (less than 200m water depth) surveys (JNCC, 2017).
SSS	SSS source levels (peak) range from 205 – 230 dB re 1µPa at 1m. Frequencies can range between 80 – 950 kHz (Hartley Anderson Ltd, 2020).	Source levels have a minimum peak pressure level which has been identified as having the potential to cause injury to harbour porpoise (200 dB re 1µPa) and a maximum peak pressure level which has been identified as having the potential to cause injury to bottlenose dolphin (230 dB re 1µPa).	The frequencies used by SSS are generally very high and outside of the main hearing range of all marine species (JNCC *et al*., 2010). As for MBES, the sounds are likely to attenuate quickly due to the high frequencies used. Therefore, as for the MBES, mitigation in shallow waters (less than 200 m) is not required (JNCC *et al*., 2010).
SBES	SBES source levels (peak) typically range between 0 – 240 dB re 1µPa. Typical SBES emits noise within the frequency range 12 – 700 kHz (Prideaux, 2017).	Source levels have a minimum peak pressure level which has been identified as having the potential to cause injury to harbour porpoise (200 dB re 1µPa) and a maximum peak pressure level which has been identified as having the potential to cause injury	As for MBES and SSS, SBES generally operate at high frequencies. These frequencies are generally beyond the hearing range of most cetaceans, including high-frequency sensitive species such as harbour porpoise. Given the increased attenuation associated with these high frequencies, it can be concluded that use these surveys present a negligible risk (JNCC *et al*., 2010; DECC, 2011).

Type of survey equipment	Predicted source levels and frequencies	Notes	Potential Risk to marine mammal
		to bottlenose dolphin (230 dB re 1μPa)	
USBL	USBL source levels range from 188 – 204 dB re 1μPa (rms), with a frequency range of 17 –50 kHz (National Oceanic and Atmospheric Administration (NOAA), 2019)	Source levels have a minimum peak pressure level which has been identified as having the potential to cause injury to harbour porpoise (200 dB re 1μPa) and are audible to marine mammal species in the area increasing the risk of disturbance.	Since low frequency emissions propagate further than high frequency sounds, cetaceans may be exposed to these noise emissions over a greater spatial area than they would higher frequency sounds (such as those from MBES or SSS). The USBL system is likely to be employed intermittently, with time in-between noise emissions, allowing animals to move away from the source and avoid continuous exposure. Considering that the surveys themselves will be transient (i.e. the vessel will be moving while the USBL is employed), the cumulative exposure level from the USBL system will be low, as marine mammals are highly unlikely to follow the noise source. Therefore, the potential risk of auditory injury is low. The low noise frequency sound emissions generated by the USBL system are within the hearing range of the cetacean species anticipated to be within the project area. For this reason, there is potential for USBL survey activities to potentially illicit a disturbance response in animals that are present during the surveys (JNCC *et al*., 2010).
UHR	Pulsed waveform Sparkers used in UHR have a frequency range of 100 Hz to 5kHz, and average approx. 1.5 kHz. Sparker surveys source levels (peak) range from 220 - 226 dB re 1μPa at 1m (Hartley Anderson Ltd, 2020).	UHR will be audible to most species, and thus have the potential to result in disturbance.	UHR profiling uses sparker technology which could cause localised short-term behavioural impacts such as avoidance, however, injury effects are not predicted, as an animal would need to remain in the very small zone of ensonification for a prolonged period, which is highly unlikely.
Magnetometer	Not applicable	Magnetometers do not emit noise as a part of their normal functioning, so there is no possibility of injury or disturbance from noise emissions.	None
Vibrocore sampling / CPT	Not applicable	Do not emit noise as a part of their normal functioning, so there is no possibility of injury or disturbance from noise emissions	None

235. An initial desk-based review of impact ranges for SBP was conducted, to determine potential worst case for geophysical surveys (**Table 11.22**).

236. The Review of Consents (RoC) Habitats Regulations Assessment (HRA) for the Southern North Sea (SNS) SAC (BEIS, 2020) undertook underwater noise modelling to determine the potential impact ranges of geophysical surveys for harbour porpoise. The BEIS (2020) assessment was undertaken using the maximum source levels that could be expected from geophysical equipment, a SBP with a maximum source noise level of 267 dB re 1 µPa-m. The noise modelling indicates that the permanent loss of hearing sensitivity (PTS) in harbour porpoise could occur within a maximum of 23m (an area of 0.0017 km^2) from the source location (BEIS, 2020). This is based on the PTS cumulative threshold of 155 dB SEL weighted (Southall *et al*., 2019). The modelling for BEIS (2020) predicted a maximum impact range of 3.77 km (44.65 km^2) for possible behavioural disturbance of harbour porpoise, based on a threshold of 140 dB re 1 µPa SPL unweighted (BEIS, 2020).

Table 11.22 Summary of the Desk-Based Review of Potential Impact Ranges for SBP

Equipment	Species	Potential effect	Threshold	Reported range of effect	Reference
Sub bottom profiler	Harbour porpoise	PTS	155 SEL_{cum} dB re 1 µPa	23m	BEIS (2020)
		Behavioural	140 SPL_{RMS} dB re 1 µPa unweighted	3.77 km	
Sub bottom profiler (220 dB re 1 µPa @ 1m peak)	Harbour porpoise	PTS	Not reported	32m	Neart na Gaiothe Offshore Wind (2019)
	Dolphin species	PTS	Not reported	0m	
	Whale species	PTS	Not reported	5m	
	Cetaceans	Disturbance	Not reported	1.5 km	
Sub bottom profiler (215 SPL_{peak} dB)	Dolphin species	PTS	230 dB_{peak} / 185 dB SEL_{cum}	0m	Wieting (2019)
	Whale species	PTS	219 dB_{peak}, 183 dB SEL_{cum}	<1m	
	Harbour porpoise	PTS	202 dB_{peak} / 155 dB SEL_{cum}	<3m	

237. In addition to the desk-based review, underwater noise modelling was undertaken (**Appendix 9.1**). The characteristics assumed for the geophysical survey modelled in this assessment are summarised in **Table 11.23**. For the purpose of impacts, these sources are considered to be continuous (non-impulsive).

*Table 11.23 Geophysical Survey Equipment Parameters used in the Underwater Noise Modelling (**Appendix 9.1**)*

Survey Type	Unit	Frequency (kHz)	Source Level, (dB re 1 µPa re 1 m) (rms)	Pulse Rate, s^{-1}	Pulse Width, ms	Beam Width
Parametric SBP	Innomar SES 2000 Standard	100	247	40	1.5	2°
MBES	Kongsberg 2040	200 - 400	245 Dual Head: 248	40	3	1°
MBES	Reson 7125	200 - 400	220 Dual Head: 224	40	20	2°
SSS	Edgetech 4200	100 - 900	196	30	0.5	1°

238. The underwater modelling results for geophysical surveys are summarised in **Table 11.24**, based on a comparison to the non-impulsive thresholds set out in Southall *et al*. (2019).

239. The impact ranges (rounded to the nearest 5 m) for geophysical surveys vary based on the frequencies of operation and source levels (**Table 11.24**). It should be noted that, for the sonar-based surveys, many of the PTS ranges are limited to approximately 100 m. Sonar based systems have very strong directivity which effectively means that there is only potential for injury (PTS) when a marine mammal is directly underneath the sound source. Once the animal moves outside of the main beam, there is no potential for injury. The same is true in many cases for TTS where an animal is only exposed to enough energy to cause TTS when inside the direct beam of the sonar. For this reason, many of the TTS and PTS ranges are similar (**Appendix 9.1**).

*Table 11.24 Potential Impact Ranges (m) for Marine Mammals During Geophysical Surveys from Underwater Noise Modelling (**Appendix 9.1**)*

Geophysical Survey	Potential Impact Range (m)								
	VHF cetacean		HF cetacean		LF cetacean		PCW pinniped		All
	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS	Disturbance
SBP Innomar	330	530	125	205	120	125	120	125	1,425
MBES Kongsberg	135	175	120	125	120	125	120	125	855
MBES Reason	120	145	120	125	95	125	120	125	455
SSS Edgetech	120	125	50	50	N/E	25	5	50	235

240. It is important to note, that the modelled impact ranges for geophysical surveys (**Table 11.24**) are based on non-impulsive (continuous) sound, compared to the impact ranges from the desk based review (**Table 11.22**) which are based on impulsive sound sources.

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241. The maximum modelled impacted ranges for PTS (**Table 11.24**) for each species for different geophysical survey equipment has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.25**).

242. The magnitude of the potential impact without any mitigation is assessed as negligible for all marine mammal species, with less than 0.001% of the relevant reference populations anticipated to be exposed to any permanent impact (**Table 11.25**).

Table 11.25 Maximum Number of Individuals (and % of Reference Population) that could be at Risk of PTS from Geophysical Survey based on Underwater Noise Modelling

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	0.33 km (0.34 km^2)	0.26	0.000075% of NS MU	Negligible	High	Minor adverse
Bottlenose dolphin	0.125 km (0.05 km^2)	0.0015	0.00065% of CES MU (0.000072% GNS MU)	Negligible	High	Minor adverse
White-beaked dolphin	0.125 km (0.05 km^2)	0.012	0.000027% of CGNS MU	Negligible	High	Minor adverse
Atlantic white-sided dolphin	0.125 km (0.05 km^2)	0.0014	0.000008% of CGNS MU	Negligible	High	Minor adverse
Risso's dolphin	0.125 km (0.05 km^2)	0.00009	0.0000007% of CGNS MU	Negligible	High	Minor adverse
Minke whale	0.12 km (0.05 km^2)	0.0018	0.000009% of CGNS MU	Negligible	High	Minor adverse
Humpback whale	0.12 km (0.05 km^2)	0.0000007	0.000000002% of North Atlantic	Negligible	High	Minor adverse

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Grey seal – windfarm site	0.12 km (0.05 km²)	0.0022	0.000015% of EaS MU (0.00001% of EaS & MoF MU)	Negligible	High	Minor adverse
Grey seal - cable route	0.12 km (0.05 km²)	0.014	0.0001% of EaS MU (0.00007% of EaS & MoF MU)	Negligible	High	Minor adverse
Harbour seal - windfarm site	0.12 km (0.05 km²)	0.00000009	0.00000002% of EaS MU (0.000000005% of EaS & MoF MU)	Negligible	High	Minor adverse
Harbour seal - cable route	0.12 km (0.05 km²)	0.00007	0.000014% of EaS MU (0.000003% of EaS & MoF MU)	Negligible	High	Minor adverse

243. The number of harbour porpoise affected based on the PTS ranges from the desk based study and threshold for impulsive sound is presented in **Table 11.26**. The magnitude of the potential impact is assessed as negligible (**Table 11.26**).

Table 11.26 Number of Harbour Porpoise (and % of Reference Population) that Could be at Risk of PTS from Geophysical Survey Based on Desk Based Review

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	0.023 km (0.0017 km²)	0.0013	0.00000036% of NS MU	Negligible	High	Minor adverse
	0.032 km (0.0032 km²)	0.0024	0.0000007% of NS MU	Negligible	High	Minor adverse

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244. The maximum modelled impacted ranges for TTS (**Table 11.24**) for each species for different geophysical survey equipment has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be affected (**Table 11.27**).

245. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be affected by any temporary impact (**Table 11.27**).

Table 11.27 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS from Geophysical Survey Based on Underwater Noise Modelling

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	0.53 km (0.88 km²)	0.67	0.00019% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	0.205 km (0.13 km²)	0.0039	0.0018% of CES MU (0.0002% GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	0.205 km (0.13 km²)	0.032	0.00007% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	0.205 km (0.13 km²)	0.004	0.00002% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	0.205 km (0.13 km²)	0.00024	0.000002% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	0.125 km (0.05 km²)	0.002	0.000009% of CGNS MU	Negligible	Medium	Minor adverse

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Humpback whale	0.125 km (0.05 km²)	0.0000007	0.000000002% of North Atlantic	Negligible	Medium	Minor adverse
Grey seal – windfarm site	0.125 km (0.05 km²)	0.0024	0.000016% of EaS MU (0.00001% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	0.125 km (0.05 km²)	0.016	0.00011% of EaS MU (0.00007% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	0.125 km (0.05 km²)	0.0000001	0.00000002% of EaS MU (0.000000005% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - cable route	0.125 km (0.05 km²)	0.00007	0.000015% of EaS MU (0.000004% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Impact Assessment for the Potential for Disturbance during Geophysical Surveys Undertaken in the Offshore Development Area

246. The modelled ranges for disturbance impacts for all species (**Table 11.24**) for different geophysical survey equipment has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be affected (**Table 11.28**).

247. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be affected by any temporary impact (**Table 11.28**).

Table 11.28 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Disturbance from Geophysical Survey Based on Underwater Noise Modelling

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	1.425 km (6.38 km²)	4.85	0.0014% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	1.425 km (6.38 km²)	0.19	0.085% of CES MU (0.0094% GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	1.425 km (6.38 km²)	1.55	0.0035% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	1.425 km (6.38 km²)	0.18	0.001% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	1.425 km (6.38 km²)	0.01	0.00009% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	1.425 km (6.38 km²)	0.25	0.0012% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	1.425 km (6.38 km²)	0.0001	0.0000003% of North Atlantic	Negligible	Medium	Minor adverse
Grey seal – windfarm site	1.425 km (6.38 km²)	0.31	0.0021% of EaS MU (0.0015% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	1.425 km (6.38 km²)	2.04	0.014% of EaS MU (0.01% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	1.425 km (6.38 km²)	0.000013	0.0000027% of EaS MU (0.00000065% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour seal - cable route	1.425 km (6.38 km^2)	0.010	0.002% of EaS MU (0.0005% of EaS & MoF MU)	Negligible	Medium	Minor adverse

248. The desk-based review of ranges for disturbance impacts (**Table 11.22**) for cetacean species from geophysical surveys has also been assessed. The magnitude of the potential impact is assessed as negligible for all cetacean species, with less than 1% of the relevant reference populations anticipated to be affected by temporary impacts (**Table 11.29**).

Table 11.29 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Disturbance from Geophysical Survey based on Desk Based Review

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	3.77 km (44.65 km^2)	34	0.01% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	1.5 km (7.07 km^2)	0.2	0.1% of CES MU (0.01% GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	1.5 km (7.07 km^2)	1.7	0.004% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	1.5 km (7.07 km^2)	0.2	0.001% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	1.5 km (7.07 km^2)	0.01	0.0001% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	1.5 km (7.07 km^2)	0.27	0.0014% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	1.5 km (7.07 km^2)	0.0001	0.0000003% of North Atlantic	Negligible	Medium	Minor adverse

Mitigation Requirements for Geophysical Surveys Undertaken in the Offshore Development Area

249. Although the potential risk of PTS is negligible (Table 11.25 and Table 11.26), prior to any geophysical surveys an assessment will be conducted to determine if any mitigation is required, based on equipment to be used, number of survey vessels, area(s) to be surveyed, duration of surveys and time of year.

250. If required, mitigation for geophysical surveys (particularly if using SBP, Sparkers and USBL) will follow the JNCC (2017) '*Guidelines for Minimising the Risk of Injury to Marine Mammals from Geophysical Surveys*' for seismic surveys as outlined in **Section 11.7.1.3**.

EPS Licence Requirements for Geophysical Surveys Undertaken in the Offshore Development Area

251. As outlined above, prior to any geophysical surveys an EPS RA will be conducted to determine if the proposed geophysical survey could have the potential risk of disturbance or auditory injury to cetacean species, based on the geophysical survey requirements, including equipment to be used, number of survey vessels, area(s) to be surveyed, duration of surveys and time of year, and any cumulative impacts at the time.

Summary of Effect Significance for Geophysical Surveys Undertaken in the Offshore Development Area

252. The effect significance for all marine mammal species for PTS, TTS or disturbance during geophysical surveys is **minor adverse (not significant)** (**Table 11.30**).

Table 11.30 Assessment of Effect Significance for PTS, TTS and Disturbance from Underwater Noise during Geophysical Surveys

Species	Impact	Sensitivity	Magnitude	Significance of Effect	Mitigation	Residual Effect Significance
Harbour porpoise	PTS	High	Negligible	Minor	**Mitigation for geophysical surveys (Section 11.7.1.3)**	Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Bottlenose dolphin	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
White-beaked dolphin	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Atlantic white-sided dolphin	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Risso's dolphin	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Minke whale	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Humpback whale	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Grey seal	PTS	High	Negligible	Minor		Minor adverse
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse
Harbour seal	PTS	High	Negligible	Minor		Minor adverse

Species	Impact	Sensitivity	Magnitude	Significance of Effect	Mitigation	Residual Effect Significance
	TTS	Medium	Negligible	Minor		Minor adverse
	Disturbance	Medium	Negligible	Minor		Minor adverse

Assessment for the Southern Trench MPA

253. For minke whale, there is a predicted PTS range of 120m, as a result of geophysical surveys being undertaken in the Offshore Development Area, with a predicted maximum disturbance range of 1.425 km (**Table 11.24**). In total, up to 0.002 minke whale may be at risk of PTS, and 0.3 may be disturbed, as a result of geophysical surveys being undertaken at the Offshore Development Area. This equates to less than 0.00001% and 0.002% of the reference population at risk of PTS and disturbance, respectively (see **Table 11.25**, **Table 11.28** and **Table 11.29**).

254. The Conservation and Advice document for the Southern Trench MPA (NatureScot, 2020) states that all scientific acoustic surveys should be minimised through the use of the best practice mitigation guidelines for geophysical surveys developed by JNCC (2017), to ensure minke whale within the site are not disrupted between June and October. As noted above, these guidelines will be followed for geophysical surveys.

255. Taking into account the very small number of minke whale at risk of either PTS or disturbance, and that the required mitigation for geophysical surveys will be followed, it is not expected that there would be any potential for impact to the minke whale population in relation to the Southern Trench MPA.

11.7.5.2 Impact C2: UXO Clearance – Auditory Injury and Disturbance from Underwater Noise

256. Prior to construction, there is the potential for UXO clearance to be required. While any identified UXO will either be avoided or removed and disposed of onshore in a designated place, there is the potential that underwater detonation could be required where it is necessary and unsafe to remove the UXO.

257. In order to undertake any UXO clearance work a marine licence is required from MS-LOT under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. In addition, the clearance of UXO by detonation will require an EPS Licence under the Conservation of Offshore Marine Habitats and Species Regulations 2017. A separate Marine Licence (ML) application will be submitted when a detailed UXO survey has been completed prior to construction and a detailed assessment based on the latest available information has been undertaken.

258. The number of possible UXO that may require to cleared and duration of UXO clearance operations are currently unknown. It is important to note, therefore, that the assessments for UXO clearance here are for information only.

UXO Risk Assessment

259. 6 Alpha Associates Ltd. (2022a) (**Appendix 5.3**) conducted a desk-based Unexploded Ordnance Threat and Risk Assessment to support the development of the Green Volt Offshore Windfarm and associated cable installations. A summary of the risk assessment is presented in **Table 11.31** for the construction locations and activities. The UXO risk is based on several factors, including the nature, scope, and location of UXO threat sources within the proposed Windfarm Site and along both the Offshore Export Cable Corridors, taking into account the expected water depths.

Table 11.31 UXO Risk Assessment Summary

Location / Activity	Type of UXO	Potential UXO Risk				
		Ultra- Nearshore ~10m LAT	**Nearshore ~26m LAT**	**Shallow Offshore ~40m LAT**	**Offshore ~60m LAT**	**Deep Offshore ~100m LAT**
Wind Turbine Generator Mooring Operations	Aerial Bombs	N/A: Wind turbine generator mooring and offshore substation platform installation operations will not occur at these water depths.				Very low
	Torpedoes					Low
	Naval Mines					Medium
	Artillery and Naval Projectiles					Very low
Offshore Substation Platform Foundation Installation Operations	Aerial Bombs					Very low
	Torpedoes					Low
	Naval Mines					Low
	Artillery and Naval Projectiles					Very low
Pre-Lay and Cable Installation and Burial Operations	Aerial Bombs	High	High	Medium	Low	Very low
	Torpedoes	Low	Low	Medium	Low	Low
	Naval Mines	Low	Medium	Medium	Low	Medium
	Artillery and Naval Projectiles	High	Medium	Low	Low	Low

260. Based on the information currently available (6 Alpha Associates Ltd., 2022a; **Appendix 5.3**), the types of UXO may pose a threat at the Windfarm Site and along the Offshore Export Cable Corridors are summarised in **Table 11.32**, including estimated ferrous mass and expected Net Explosive Quantity (NEQ) - based upon equivalent Trinitrotoluene (TNT) masses).

261. The largest potential UXO identified in the desk-based risk assessment (6 Alpha Associates Ltd., 2022a) is a 50 cm G7 torpedo with a NEQ of 253.5 kg (**Table 11.32**). 6 Alpha Associates Ltd. (2022a) have estimated the vessel and diver safety distances for a 50 cm G7 Torpedo with an NEQ of 253.5 kg is 1,647 m (**Appendix 5.3**).

Table 11.32 Potential UXO and Net Explosive Quantity (NEQ)

Type of UXO	Designation	Ferrous Mass	NEQ
Aerial bombs	SC-500 High Explosive (HE) Bomb	280 kg	220 kg
	SC-250 HE Bomb	126 kg	130 kg
	SC-50 HE Bomb	25-30 kg	25 kg
Torpedoes	50 cm G7 Torpedo	1,170 kg	253.5 kg
	50 cm G6 Torpedo	1,364 kg	213.2 kg
Naval Mines	Mark XVII/XX Mine	68-236 kg	227 kg
	E-Mine 1	208 kg	165 kg
	UC-200 Mine	191 kg	141.1 kg
Projectiles and Land Service	6” Artillery Projectile	39.4 kg	6 kg
	8.8 cm Naval Projectile	12.4 kg	1.42 kg

Type of UXO	Designation	Ferrous Mass	NEQ
Ammunition (LSA)	3.7" Artillery Projectile	11.6 kg	0.93 kg
	3" Mortar Bomb	3.99 kg	0.55 kg
	Mills Bomb	0.66 kg	0.1 kg
	12 pounder Naval Projectile	5.26 kg	0.43 kg
	20 mm Naval Projectile	0.11 kg	0.01 kg

262. When a UXO detonates on the seabed underwater, several effects are generated, most of which are localised at the point of detonation, such as crater formation and movement of sediment and dispersal of nutrients and contaminants. After detonation, there is the rapid expansion of gaseous products known as the "bubble pulse". Once it reaches the surface, the energy of the bubble is dissipated in a plume of water and the detonation shock front rapidly attenuates at the water/air boundary. Fragmentation (that is shrapnel from the weapon casing and surrounding seabed materials) is also ejected but does not pose a significant hazard beyond 10 m from source.

263. The potential effects of underwater explosions on marine mammals include: (i) physical injury from direct or indirect blast wave effect of the high amplitude shock waves and sound wave produced by underwater detonation, which could result in immediate or eventual mortality; (ii) auditory impairment (from exposure to the acoustic wave), resulting in permanent auditory injury or permanent loss of hearing sensitivity (PTS) or temporary loss in hearing sensitivity (TTS); or (iii) behavioural change, such as disturbance to feeding, mating, breeding, and resting (Richardson *et al.,* 1995; Ketten, 2004; von Benda-Beckmann *et al.,* 2015).

264. The severity of the consequences of UXO detonation will depend on many variables, but principally, on the charge weight and its proximity to the receptor. After detonation, the shock wave will expand spherically outwards and will travel in a straight line (i.e. line of sight), unless the wave is reflected, channelled or meets an intervening obstruction.

265. There are limited acoustic measurements for underwater explosions, and there can be large differences in the noise levels, depending on the charge size, as well as water depth, bathymetry and seabed sediments at the site, which can also influence noise propagation. The water depth in which the explosion occurs has a significant influence on the effect range for a given charge mass (von Benda-Beckmann *et al.,* 2015).

UXO Survey Requirements Prior to Clearance

266. 6 Alpha Associates Ltd. (2022b) has provided an overview of the survey requirements for acquiring and processing geophysical UXO survey data for the Project (**Appendix 5.2**). A summary of this report has been included for information purposes only as the detailed requirements of the UXO surveys will be determined prior to the surveys being undertaken.

267. The UXO survey area will likely include a survey corridor width of not less than 50 m for the planned inter-array and export cable routes and the area around the intended WTG locations, when finalised.

268. The geophysical UXO survey will be performed by an experienced Survey Contractor, utilising a magnetometer array, SSS with a minimum operating frequency of not less than 600kHz and high resolution MBES.

269. For the magnetometer survey, the line spacing, magnetometer configuration and survey specification will be designed in such a way as to be capable of detecting a minimum threat item with a ferrous mass of 25 kg, equivalent to that contained in a German SC-50 HE bomb. Survey line spacing will be determined based on the number and type of magnetometers in the gradiometer array as well as their lateral separation and flying altitude. For the survey, the acquired magnetometer coverage will be calculated based on detection range for UXO, taking into account water depths, with the aim to target burial depth of 2 m below the seabed.

270. In addition to a magnetometer survey, a high resolution SSS survey will be undertaken to detect low ferrous content UXO that may be located upon on the surface of the seabed, such as mines. The high-resolution images that result from SSS survey will be used to identify the locations, sizes and shapes of those items that might be associated with UXO. The towed survey equipment will be tracked and positioned using acoustic positioning.

271. A high resolution MBES survey, with operating frequency of 400 kHz or more, would be used to corroborate surface contacts identified with SSS and to further inform about seabed morphology in relation to the potential for UXO migration, movement, and burial. The MBES will be hull-mounted to the survey vessel in order to enable concurrent MBES data capture as the magnetometer and SSS survey work is undertaken.

272. An initial assessment of the potential impacts for geophysical surveys has been included in **Section 11.7.5.1**. The information provided in this assessment, is based on a precautionary worst-case scenario and currently available information.

273. It is important to note, that prior to any geophysical surveys an EPS RA will be conducted to determine if the proposed geophysical survey could have the potential risk of disturbance or auditory injury to cetacean species. Assessments for the EPS RA will be undertaken based on the UXO geophysical survey requirements, including equipment to be used, number of survey vessels, area(s) to be surveyed, duration of surveys and time of year.

Underwater Noise Modelling

274. Seiche Ltd. (2022) conducted underwater noise modelling to predict the potential impacts during UXO clearance (see **Appendix 9.1**).

275. The precise details and locations of potential UXO is unknown at this time. For the purposes of the underwater noise modelling and this assessment, it has been assumed that the maximum realistic worst-case is for a UXO with a NEQ of 300 kg. Which is greater than the largest potential UXO identified in the desk-based risk assessment (6 Alpha Associates Ltd., 2022a) for a 50 cm G7 torpedo with a NEQ of 253.5 kg (**Table 11.32**).

276. It is important to note that assessments are based on the worst case for high-order UXO detonations with no mitigation, which is highly unlikely, as the preferred and first option for any UXO requiring detonation would be a low-order clearance method.

277. Low-order clearance using deflagration is the preferred method for UXO clearance. This is a method that uses a small shaped charge to burn out the explosive material within a UXO, without detonating it. It is a less impactful method in terms of the range of underwater noise and seabed disturbance, when compared to explosive high-order detonation.

278. Deflagration is a safer technique for UXO disposal as it is intended to avoid the high pressures associated with an explosion, which would lead to an increased risk of adverse effects to marine life. Where the UXO device cannot be moved, deflagration represents the best-case scenario in respect to environmental effects.

279. Deflagration is still not without noise impact, although it will be significantly less than the high-order detonation of the UXO (Merchant and Robinson, 2020; National Physical Laboratory (NPL), 2020). Controlled experiments show low-order deflagration to result in a substantial reduction in underwater noise levels compared to full high-order detonation. SPL_{peak} and SEL being typically significantly lower for the deflagration of the same size munition, and with the acoustic output being proportional to the size of the shaped charge, rather than the size of the UXO itself (Robinson *et al*., 2020).

280. Underwater noise modelling (**Appendix 9.1**) was conducted for low-order deflagration, with a single shaped charge of 0.08 kg NEQ and for the high-order detonation without mitigation, maximum realistic worst-case of a UXO with a NEQ of 300 kg (including donor charge). Further details on the UXO underwater noise modelling are provided in **Appendix 9.1**.

281. All assessments have been based on the worst case scenario and maximum predicted impact ranges for impulsive thresholds based on the Southall *et al*. (2019) criteria (see **Table 11.16**).

Results

282. The results of the underwater noise modelling (**Appendix 9.1**) for low-order UXO deflagration with 0.08 kg charge are presented in **Table 11.33** and for high-order detonation of UXO with NEQ of 300 kg including donor charge are presented in **Table 11.34**.

283. As a precautionary approach, the impact area has been calculated based on the area of circle with the maximum impact range as the radius. This approach is precautionary as using the maximum impact range as the radius of a circle does not take into account the variation in impact range around the noise source, due to variations in bathymetry and seabed conditions. This approach also assumes no overlap with land.

284. The largest impact areas (in bold) for PTS and TTS are used in the assessments.

Table 11.33 Maximum Modelled Impact Ranges (km) and Calculated Impact Area (km²) for Marine Mammal Species for Low-Order UXO Deflagration with 0.08kg NEQ Charge (those in bold highlight which of the thresholds have resulted in the worst-case impact ranges)

Marine Mammal Species (Hearing Group)	PTS				TTS			
	SPL_{peak}		SEL		SPL_{peak}		SEL	
	Threshold Unweighted (dB re 1 µPa) Impulsive	Maximum predicted range (km) and area (km²)	Threshold Weighted (dB re 1 µPa²s) Impulsive	Maximum predicted range (km)	Threshold Unweighted (dB re 1 µPa) Impulsive	Maximum predicted range (km) and area (km²)	Threshold Weighted (dB re 1 µPa²s) Impulsive	Maximum predicted range (km) and area (km²)
Harbour porpoise (VHF)	202	**0.685 km (1.47 km²)**	155	0.19 km	196	1.265 km	140	**1.495 km (7.02 km²)**
Dolphin species (HF)	230	**0.04 km (0.005 km²)**	185	0	224	**0.075 km (0.018 km²)**	170	0.025 km
Minke whale and humpback whale (LF)	219	**0.12 km (0.045 km²)**	183	0.05 km	213	0.225 km	168	**0.66 km (1.37 km²)**
Grey seal and harbour seal (PCW)	218	**0.135 km (0.057 km²)**	185	0.01 km	212	**0.25 km (0.2 km²)**	170	0.125 km

Table 11.34 Maximum Modelled Impact Ranges (km) and Calculated Impact Area (km²) for Marine Mammal Species for High-Order Detonation of 300kg NEQ UXO (including Donor Charge) with no Mitigation (those in bold highlight which of the thresholds have resulted in the worst-case impact ranges)

Marine Mammal Species (Hearing Group)	PTS				TTS			
	SPL_{peak}		SEL		SPL_{peak}		SEL	
	Threshold Unweighted (dB re 1 µPa) Impulsive	Maximum predicted range (km) and area (km²)	Threshold Weighted (dB re 1 µPa²s) Impulsive	Maximum predicted range (km) and area (km²)	Threshold Unweighted (dB re 1 µPa) Impulsive	Maximum predicted range (km) and area (km²)	Threshold Weighted (dB re 1 µPa²s) Impulsive	Maximum predicted range (km) and area (km²)
Harbour porpoise (VHF)	202	**10.63 km (354.99 km²)**	155	3.045 km	196	**19.59 km (1,205.64 km²)**	140	7.69 km
Dolphin species (HF)	230	**0.615 km (1.19 km²)**	185	0.09 km	224	**1.13 km (4.01 km²)**	170	0.935 km
Minke whale and humpback whale (LF)	219	1.885 km	183	**2.53 km (20.11 km²)**	213	3.47 km	168	**23.845 km (1,786.26 km²)**
Grey seal and harbour seal (PCW)	218	**2.085 km (13.66 km²)**	185	0.48 km	212	3.84 km	170	**4.520 km (64.18 km²)**

Sensitivity of Marine Mammals to Underwater Noise Impacts of UXO Clearance in the Offshore Development Area

285. As outlined in **Section 11.7.4.4**, in this assessment, all species of marine mammal are considered to have high sensitivity to UXO detonations if they are within the potential impact ranges for physical injury or permanent auditory injury (PTS). Marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

286. The sensitivity of marine mammals to TTS and flee response / likely disturbance as a result of underwater UXO detonations is considered to be medium in this assessment as a precautionary approach. This is for animals within the potential TTS and flee response / likely disturbance range, but beyond the potential impact range for PTS. Marine mammals within the potential impact area are considered to have limited capacity to avoid such impacts, although any impacts on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

Impact Assessment for the Potential for PTS due to UXO Clearance in the Offshore Development Area

Potential for PTS from Low-Order Deflagration

287. The maximum impacted ranges for PTS (**Table 11.33**) for each species for low-order UXO deflagration with 0.08 kg charge has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.35**).

288. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 0.001% of the relevant reference populations anticipated to be affected by any permanent impact (**Table 11.35**).The effect significance is minor adverse (not significant) based on high sensitivity for PTS from underwater noise for all marine mammal species (**Table 11.35**).

289. Although the potential effect significance is minor adverse (not significant), further mitigation is recommended as outlined in **Mitigation Requirements for UXO Clearance in the Offshore Development Area**, to reduce the risk of physical or permanent auditory injury in marine mammals during low-order deflagration.

Table 11.35 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of PTS from Low-Order UXO Deflagration with 0.08 kg Charge

Species	Maximum impact area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	1.47 km^2	1.12	0.0003% of NS MU	Negligible	High	Minor adverse
Bottlenose dolphin	0.005 km^2	0.00015	0.00007% of CES MU (0.000007% GNS MU)	Negligible	High	Minor adverse
White-beaked dolphin	0.005 km^2	0.0012	0.000003% of CGNS MU	Negligible	High	Minor adverse
Atlantic white-sided dolphin	0.005 km^2	0.00014	0.0000008% of CGNS MU	Negligible	High	Minor adverse
Risso's dolphin	0.005 km^2	0.000009	0.00000007% of CGNS MU	Negligible	High	Minor adverse
Minke whale	0.045 km^2	0.0018	0.000009% of CGNS MU	Negligible	High	Minor adverse
Humpback whale	0.045 km^2	0.0000007	0.000000002% of North Atlantic population	Negligible	High	Minor adverse
Grey seal – windfarm site	0.057 km^2	0.0028	0.00002% of EaS MU (0.00001% of EaS & MoF MU)	Negligible	High	Minor adverse

Species	Maximum impact area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Grey seal - cable route	0.057 km^2	0.018	0.0001% of EaS MU (0.00009% of EaS & MoF MU)	Negligible	High	Minor adverse
Harbour seal - windfarm site	0.057 km^2	0.0000001	0.00000002% of EaS MU (0.000000006% of EaS & MoF MU)	Negligible	High	Minor adverse
Harbour seal - cable route	0.057 km^2	0.00009	0.00002% of EaS MU (0.000004% of EaS & MoF MU)	Negligible	High	Minor adverse

Potential for PTS from High-Order Detonation

290. The maximum impacted ranges for PTS (**Table 11.34**) for each species for high-order detonation of UXO with NEQ of 300 kg including donor charge with no mitigation has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.36**).

291. The magnitude of the potential impact is assessed as medium to negligible for marine mammal species, based on the percentage of the relevant reference populations anticipated to be affected by any permanent impact (**Table 11.36**).

292. The effect significance, based on high sensitivity for PTS from underwater noise, is minor adverse (not significant) for white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, humpback whale and harbour seal in the windfarm site; moderate adverse (significant) for minke whale, grey seal in the windfarm site and harbour seal in the cable route; and major adverse (significant) for harbour porpoise, bottlenose dolphin and grey seal in the cable route (**Table 11.36**).

293. Mitigation as outlined in Mitigation Requirements for UXO Clearance in the Offshore Development Area, is required to reduce the risk of physical or permanent auditory injury in marine mammals during any high-order detonations.

Table 11.36 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of PTS from High-Order Detonation of UXO with NEQ of 300 kg including Donor Charge with No Mitigation

Species	Maximum impact area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	355 km^2	270	0.078% of NS MU	Medium	High	**Major adverse**
Bottlenose dolphin	1.19 km^2	0.035	0.016% of CES MU (0.0018% GNS MU)	Medium (Low)	High	**Major (Moderate) adverse**
White-beaked dolphin	1.19 km^2	0.29	0.0007% of CGNS MU	Negligible	High	Minor adverse
Atlantic white-sided dolphin	1.19 km^2	0.033	0.0002% of CGNS MU	Negligible	High	Minor adverse
Risso's dolphin	1.19 km^2	0.0021	0.00002% of CGNS MU	Negligible	High	Minor adverse
Minke whale	20.11 km^2	0.78	0.004% of CGNS MU	Low	High	**Moderate adverse**
Humpback whale	20.11 km^2	0.0003	0.0000009% of North Atlantic population	Negligible	High	Minor adverse
Grey seal – windfarm site	13.66 km^2	0.67	0.0046% of EaS MU (0.0032% of EaS & MoF MU)	Low	High	**Moderate adverse**

Species	Maximum impact area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Grey seal - cable route	13.66 km²	4.37	0.030% of EaS MU (0.021% of EaS & MoF MU)	Medium	High	**Major adverse**
Harbour seal - windfarm site	13.66 km²	0.000027	0.000006% of EaS MU (0.0000014% of EaS & MoF MU)	Negligible	High	Minor adverse
Harbour seal - cable route	13.66 km²	0.020	0.0043% of EaS MU (0.0010% of EaS & MoF MU)	Low	High	**Moderate adverse**

Impact Assessment for the Potential for TTS due to UXO Clearance in the Offshore Development Area

Potential for TTS from Low-Order Deflagration

294. The maximum impacted ranges for TTS (**Table 11.33**) for each species for low-order UXO deflagration with 0.08 kg charge has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.37**).

295. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be affected by any permanent impact (**Table 11.37**).

296. The effect significance is minor adverse (not significant) based on medium sensitivity for TTS from underwater noise for all marine mammal species (**Table 11.37**).

Table 11.37 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS from Low-Order UXO Deflagration with 0.08 kg Charge

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	7.02 km²	5.34	0.0015% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	0.018 km²	0.0005	0.0002% of CES MU (0.00003% GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	0.018 km²	0.004	0.00001% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	0.018 km²	0.0005	0.000003% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	0.018 km²	0.00003	0.0000003% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	1.37 km²	0.053	0.0003% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	1.37 km²	0.00002	0.00000006% of North Atlantic population	Negligible	Medium	Minor adverse
Grey seal – windfarm site	0.2 km²	0.01	0.00007% of EaS MU (0.00005% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	0.2 km²	0.06	0.0004% of EaS MU (0.0003% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	0.2 km²	0.0000004	0.00000008% of EaS MU (0.00000002% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour seal - cable route	0.2 km²	0.0003	0.00006% of EaS MU (0.000015% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Potential for TTS from High-Order Detonation

297. The maximum impacted ranges for TTS (**Table 11.34**) for each species for high-order detonation of UXO with NEQ of 300 kg including donor charge with no mitigation has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.38**).

298. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be affected by any permanent impact (**Table 11.38**).

299. The effect significance is minor adverse (not significant) based on medium sensitivity for TTS from underwater noise for all marine mammal species (**Table 11.38**).

Table 11.38 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS from High-Order Detonation of UXO with NEQ of 300 kg including Donor Charge with No Mitigation

Species	Maximum impact area (km²)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	1,205.64 km²	916	0.26% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	4.01 km²	0.12	0.05% of CES MU (0.006% GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	4.01 km²	0.97	0.002% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	4.01 km²	0.11	0.0006% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	4.01 km²	0.007	0.00006% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	1,786.26 km²	69	0.34% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	1,786.26 km²	0.027	0.00008% of North Atlantic population	Negligible	Medium	Minor adverse
Grey seal – windfarm site	64.18 km²	3.15	0.021% of EaS MU (0.015% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	64.18 km²	21	0.14% of EaS MU (0.10% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	64.18 km²	0.00013	0.00003% of EaS MU (0.000007% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - cable route	64.18 km²	0.10	0.02% of EaS MU (0.005% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Impact Assessment for the Potential for Disturbance due to UXO Clearance in the Offshore Development Area

300. For the marine mammal species considered there is currently no agreed threshold for disturbance from underwater noise, however, a fleeing response is assumed to occur at the same noise levels as TTS. As outlined in Southall *et al*. (2007) the potential for behavioural disturbance is proposed to

occur at the lowest level of noise exposure that has a measurable transient impact on hearing (i.e. TTS). Although, as Southall *et al*. (2007) recognise that this is not a behavioural effect per se, exposures to lower noise levels from a single pulse are not expected to cause disturbance. However, any compromise, even temporarily, to hearing functions could have the potential to affect behaviour.

Potential for Disturbance from Low-Order Deflagration

301. The potential disturbance for low-order clearance using deflagration (the first option and preferred method) is currently unknown, however as a precautionary approach it has been assumed that there could be an estimated worst case of 5 km disturbance range (78.54 km^2) including vessels[4]. As a worst case, marine mammals could be temporarily disturbed from this area for UXO clearances by low-order deflagration. Using 5 km for the temporary disturbance of all marine mammal species during is a precautionary approach to the assessments.

302. The effect significance for temporary disturbance from low-order deflagration has been assessed as minor for all marine mammal species (**Table 11.39**).

Table 11.39 Maximum Number of Individuals (and % of Reference Population) that Could be Disturbed from 5 km Impact Range during Low-Order UXO Deflagration with 0.08 kg Charge including Vessels

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	78.54 km^2	60	0.017% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	78.54 km^2	2.34	1.04% of CES MU (0.12% GNS MU)	Low (Negligible)	Medium	Minor adverse
White-beaked dolphin	78.54 km^2	19	0.043% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	78.54 km^2	2.2	0.012% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	78.54 km^2	0.14	0.0012% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	78.54 km^2	3.04	0.015% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	78.54 km^2	0.0012	0.0000034% of North Atlantic population	Negligible	Medium	Minor adverse
Grey seal – windfarm site	78.54 km^2	3.85	0.026% of EaS MU (0.018% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	78.54 km^2	25	0.17% of EaS MU (0.12% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	78.54 km^2	0.00016	0.000033% of EaS MU (0.000008% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - cable route	78.54 km^2	0.12	0.025% of EaS MU (0.006% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Potential for Disturbance from High-Order Detonation

303. The use of the TTS threshold is appropriate for UXO disturbance, because the noise from the UXO explosion is only fleetingly in the environment. Therefore, the assumption is that although noise levels lower than TTS threshold may startle the individual, this has no lasting effect. TTS results in a

[4] *This figure is based on expert judgement, based on estimated disturbance from vessels and low-order deflagration.*

temporary reduction in hearing ability, and therefore may affect the individuals' fitness temporarily (as recommended in Southall *et al*. (2007) for a single pulse).

304. As outlined in Southall *et al.* (2021) thresholds that attempt to relate single noise exposure parameters (e.g. received noise level) and behavioural response across broad taxonomic grouping and sound types can lead to severe errors in predicting effects. Differences between species, individuals, exposure situational context, the temporal and spatial scales over which they occur, and the potential interacting impacts of multiple stressors can lead to inherent variability in the probability and severity of behavioural responses.

305. The assessments for TTS / fleeing response have therefore been used for assessing the potential disturbance ranges for UXO high-order detonation. The potential for effect has been assessed as negligible (i.e. less than 1% of the reference population anticipated to be exposed to the temporary impact) with or without the use of mitigation for all marine mammal species (**Table 11.37** and **Table 11.38**).

306. The SNCBs currently recommend that a potential disturbance range based on an Effective Deterrent Radius (EDR) of 26 km around UXO high-order detonation is used to assess harbour porpoise disturbance from the Southern North Sea SAC (JNCC *et al*., 2020). The maximum number of harbour porpoise based on the 26 km EDR (an area of up to 2,124 km^2) that could be disturbed would be up to 1,614 (up to 0.47% of NS MU). The potential effect would be negligible with less than 1% of the North Sea MU reference population anticipated to be exposed to the temporary impact.

Potential for Disturbance from Acoustic Deterrent Device (ADD) Activation

307. As outlined in Mitigation Requirements for UXO Clearance in the Offshore Development Area, prior all to UXO clearance (low-order deflagration and high-order detonations), the activation of an ADD is recommended.

308. Duration of the ADD activation will be dependent on the UXO clearance method (low-order deflagration, high-order detonation with bubble curtain or high-order detonation without bubble curtain) and size of UXO for high-order detonation.

309. Disturbance of marine mammals during ADD activation is determined based on animals swimming away during from the ADD location during the ADD activation period. The swimming speeds for marine mammal species has been based on the swimming speeds used in the underwater noise modelling (**Table 11.40**; **Appendix 9.1**).

*Table 11.40 Marine Mammal Swimming Speeds (see **Appendix 9.1**)*

Species	Swim Speed (m/s)
Harbour porpoise	1.5
Bottlenose dolphin	1.52
White-beaked dolphin	1.52
Other dolphin species	1.52
Minke whale	2.3
Humpback whale	2.3
Grey seal	1.8
Harbour seal	1.8

310. The maximum predicted impact range for PTS during low-order deflagration is 0.685 km for harbour porpoise (Table 11.33). Table 11.41 provides information on recommended ADD activation of eight minutes prior to low-order deflagration.

311. The potential disturbance of marine mammals for eight minutes ADD activation prior to low-order deflagration is assessed in **Table 11.42**. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact (**Table 11.42**). The effect significance is minor adverse (not significant) based on medium sensitivity for disturbance from ADD activation for all marine mammal species (**Table 11.42**).

Table 11.41 ADD Activation Duration for Low-Order Deflagration

Species	Maximum PTS impact range (km) for low-order deflagration	Swim speed (m/s)	ADD activation duration	Distance (km) from ADD / UXO location after ADD activation duration
Harbour porpoise	0.685 km	1.5m/s	8 minutes	0.72 km
Dolphin species	0.04 km	1.52m/s	8 minutes	0.73 km
Minke whale and humpback whale	0.12 km	2.3m/s	8 minutes	1.1 km
Grey seal and harbour seal	0.135 km	1.8m/s	8 minutes	0.864 km

Table 11.42 Disturbance of Marine Mammals for ADD Activation Prior to Low-Order Deflagration

Species	Maximum disturbance area (km^2)	Maximum number of individuals	% of reference population	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour porpoise	1.63 km^2	1.24	0.00036% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	1.67 km^2	0.05	0.022% of CES MU (0.0025% GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	1.67 km^2	0.41	0.0009% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	1.67 km^2	0.05	0.0003% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	1.67 km^2	0.003	0.000025% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	3.80 km^2	0.15	0.0007% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	3.80 km^2	0.00006	0.00000016% of North Atlantic population	Negligible	Medium	Minor adverse
Grey seal – windfarm site	2.35 km^2	0.11	0.0008% of EaS MU (0.00054% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	2.35 km^2	1.01	0.007% of EaS MU (0.0047% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	2.35 km^2	0.000005	0.000001% of EaS MU (0.00000024% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - cable route	2.35 km^2	0.005	0.001% of EaS MU (0.00024% of EaS & MoF MU)	Negligible	Medium	Minor adverse

312. The maximum predicted impact range for PTS during high-order detonation is 10.63 km for harbour porpoise (**Table 11.34**). To reduce the risk of PTS the duration of ADD activation must be adequate to ensure marine mammals are at a sufficient distance from the UXO location. For harbour porpoise, based on a swimming speed for 1.5 m/s, the ADD would have to be activated for 120 minutes (two hours) for harbour porpoise to swim 10.8 km, beyond the maximum PTS impact range of 10.63 km. However, a maximum ADD activation of 60 minutes could be sufficient to deter mammals from the area around the UXO high-order detonation, without causing increased disturbance for a prolonged

period of time. The maximum ADD activation duration will be agreed with the relevant stakeholders, including Marine Scotland and NatureScot.

313. **Table 11.43** provides information on ADD activation of 60 minutes prior to high-order detonation. However, the use of a bubble curtain or other mitigation measures could reduce the ADD activation duration required.

314. The potential disturbance of marine mammals for 60 minute ADD activation prior to high-order detonation, without a bubble curtain or other mitigation measures is assessed in **Table 11.44**. The effect significance is minor adverse (not significant) based on medium sensitivity for disturbance from ADD activation for all marine mammal species (**Table 11.44**).

Table 11.43 ADD Activation Duration for High-Order Detonation Without a Bubble Curtain or Other Mitigation Measures

Species	Maximum PTS impact range (km) for high-order detonation	Swim speed (m/s)	ADD activation duration	Distance (km) from ADD / UXO location after ADD activation duration
Harbour porpoise	10.63 km	1.5m/s	60 minutes	5.4 km
Dolphin species	0.615 km	1.52m/s	60 minutes	5.5 km
Minke whale and humpback whale	2.53 km	2.3m/s	60 minutes	8.3 km
Grey seal and harbour seal	2.085 km	1.8m/s	60 minutes	6.5 km

Table 11.44 Disturbance of Marine Mammals for 60 minute ADD Activation Prior to High-Order Detonation Without a Bubble Curtain or Other Mitigation Measures

Species	Maximum disturbance area (km^2)	Maximum number of individuals	% of reference population	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour porpoise	92 km^2	70	0.021% of NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin	95 km^2	3	1.26% of CES MU (0.14% GNS MU)	Low (Negligible)	Medium	Minor adverse
White-beaked dolphin	95 km^2	23	0.053% of CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	95 km^2	3	0.015% of CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin	95 km^2	0.2	0.0014% of CGNS MU	Negligible	Medium	Minor adverse
Minke whale	216 km^2	8	0.042% of CGNS MU	Negligible	Medium	Minor adverse
Humpback whale	216 km^2	0.003	0.000009% of North Atlantic population	Negligible	Medium	Minor adverse
Grey seal – windfarm site	133 km^2	6.5	0.044% of EaS MU (0.031% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	133 km^2	42	0.29% of EaS MU (0.20% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	133 km^2	0.0003	0.00006% of EaS MU (0.000013% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - cable route	133 km^2	0.2	0.04% of EaS MU (0.010% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Mitigation Requirements for UXO Clearance in the Offshore Development Area

315. As outlined in **Section 11.7.1.2**, a detailed MMMP will be prepared for UXO clearance during the pre-construction phase. The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance.

316. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with Marine Scotland and NatureScot. The following information is provided as a recommendation but will be agreed prior to any UXO clearance work.

317. For all low-order deflagration and high-order detonations, the following mitigation methods are recommended:

- All controlled explosions of any UXO to be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO.
- All UXO clearance to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less).
- Establishment of a monitoring area with minimum of 1 km radius (area of 3.24 km^2)
  - The observation of the monitoring area will be by dedicated and trained MMObs during daylight hours and suitable visibility.
  - The pre-clearance search will commence at least one hour prior to the start of any UXO clearance, with at least two dedicated and trained MMObs positioned so the entire monitoring area can be monitored at all times.
  - The use of PAM is unlikely to be required, as all UXO clearances are to take place in daylight and in favourable conditions with good visibility.
  - Marine mammals must be clear of the monitoring area for at least 30 minutes before any low-order clearance or high-order detonation with or without bubble curtain.
- ADD activation
  - Duration of the ADD activation will be dependent on the UXO clearance method (low-order deflagration, high-order detonation with bubble curtain or high-order detonation without bubble curtain) and size of UXO for high-order detonation (**Table 11.41** and **Table 11.43** provide information on recommended ADD activation based on the underwater noise modelling used in the assessments).
  - ADD will be activated at the appropriate time during the pre-clearance search of the monitoring area.
- When marine mammals are clear of the monitoring zone for at least 30 minutes and the one hour pre-search and required ADD activation duration has been completed, then UXO clearance can proceed.

318. In addition, for any potential high-order UXO detonations, the use of bubble curtains may be used as potential mitigation, if possible, taking into consideration environmental conditions.

EPS Licence Requirements for UXO Clearance in the Offshore Development Area

319. Prior to any UXO clearance work an EPS Licence application will be submitted. This will include an assessment of the risk of any physical or auditory injury and disturbance to cetacean (EPS) species during the UXO clearance work, for low-order deflagration, high-order detonation with and without bubble curtains, disturbance from ADD activation, disturbance from vessels and increased collision risk with vessels, also the duration and location of UXO clearance works and time of year, and any cumulative impacts at the time. The EPS Licence application will also include a detailed MMMP for all UXO clearances.

Summary of Effect significance for UXO Clearance in the Offshore Development Area

Effect significance of Low-Order Deflagration

320. The effect significance for all marine mammal species for PTS, TTS or disturbance for low-order deflagration is **minor adverse (not significant)** (**Table 11.45**).

Table 11.45 Assessment of Effect significance for PTS, TTS and Disturbance for Low-Order Deflagration

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Harbour porpoise	PTS	High	Negligible	Minor adverse	MMMP for UXO Clearance **(Section 11.7.1.2)**	Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Bottlenose dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Low (Negligible)	Minor adverse		Minor adverse
White-beaked dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Atlantic white-sided dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Risso's dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Minke whale	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Humpback whale	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Grey seal	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Harbour seal	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse

Effect significance of High-Order Detonation

321. The effect significance for high-order detonation without mitigation is minor adverse (not significant) for white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, humpback whale and harbour seal in the windfarm site; moderate adverse (significant) for minke whale, grey seal in the windfarm site and harbour seal in the cable route; and major adverse (significant) for harbour porpoise, bottlenose dolphin and grey seal in the cable route (**Table 11.46**).

322. With adequate and effective mitigation, such as bubble curtain, ADD activation and monitoring zone which will be detailed in the MMMP for UXO clearance the residual effect would be **minor adverse (not significant).**

Table 11.46 Assessment of Effect significance for PTS, TTS and Disturbance for High-Order Detonation

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Harbour porpoise	PTS	High	Medium	**Major adverse**	MMMP for UXO Clearance **(Section 11.7.1.2)**	Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Bottlenose dolphin	PTS	High	Medium (Low)	**Major (Moderate) adverse**		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
White-beaked dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Atlantic white-sided dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Risso's dolphin	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Minke whale	PTS	High	Low	**Moderate adverse**		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Humpback whale	PTS	High	Negligible	Minor adverse		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Grey seal	PTS	High	Medium to Low	**Major to Moderate adverse**		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Harbour seal	PTS	High	Low to Negligible	**Moderate to Minor adverse**		Minor adverse
	TTS	Medium	Negligible	Minor adverse		Minor adverse
	Disturbance	Medium	Negligible	Minor adverse		Minor adverse

Effect significance of ADD Activation

323. The effect significance for all marine mammal species for disturbance from recommended ADD activation prior to low-order deflagration is **minor adverse (not significant)** (**Table 11.47**).

Table 11.47 Assessment of Effect significance for Disturbance from ADD Activation Prior to Low-Order Deflagration

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Harbour porpoise	Disturbance	Medium	Negligible	Minor adverse	N/A	Minor adverse
Bottlenose dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
White-beaked dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Atlantic white-sided dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Risso's dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Minke whale	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Humpback whale	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Grey seal	Disturbance	Medium	Negligible	Minor adverse		Minor adverse

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Harbour seal	Disturbance	Medium	Negligible	Minor adverse		Minor adverse

324. The effect significance for all marine mammal species for disturbance from recommended ADD activation prior to high-order detonation without a bubble curtain or other mitigation measures is **minor adverse (not significant)** (**Table 11.48**).

Table 11.48 Assessment of Effect significance for Disturbance from ADD Activation Prior to High-Order Detonation Without a Bubble Curtain or Other Mitigation Measures

Species	Impact	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Harbour porpoise	Disturbance	Medium	Negligible	Minor adverse	N/A	Minor adverse
Bottlenose dolphin	Disturbance	Medium	Low (Negligible)	Minor adverse		Minor adverse
White-beaked dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Atlantic white-sided dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Risso's dolphin	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Minke whale	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Humpback whale	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Grey seal	Disturbance	Medium	Negligible	Minor adverse		Minor adverse
Harbour seal	Disturbance	Medium	Negligible	Minor adverse		Minor adverse

Assessment for the Southern Trench MPA

325. For low-order UXO clearance, there is the potential for a predicted PTS range of 120 m, with a predicted TTS range of 0.66 km (**Table 11.33**). For high-order clearance, there is the potential for a PTS range of 2.53 km, and TTS range of 23.845 km (**Table 11.34**). For high-order UXO clearance, a disturbance range of 5 km has been predicted, and for high-order clearance, the TTS ranges have been used to inform the assessment.

326. In total, up to 0.002 and 0.8 minke whale may be at risk of PTS for low-order and high-order clearances, respectively. This equates to up to 0.00001% and 0.004% of the reference population at risk of PTS, respectively (see **Table 11.35** and **Table 11.36**). For TTS, up to 0.05 (0.0003% of the reference population) and up to 69 minke whale (0.34% of the reference population) may be at risk, from low-order and high-order clearance respectively (**Table 11.37** and **Table 11.38**). Up to 3.1 minke whale may be at risk of disturbance from low-order clearance (**Table 11.39**). In addition, due to the required ADD activation period for high-order clearance, up to 15 minke whale may be disturbed (up to 0.073% of the reference population) (**Table 11.44**).

327. In order to minimise the potential for impacts to all marine mammal species, the JNCC (2010a) guidelines for explosives will be followed, and a MMMP for UXO clearance will be developed, as stated in **Section 11.7.1.2**. In addition, low-order clearance will be undertaken as standard, with high-order clearance only to be undertaken where low-order clearance is either not possible, or failed.

328. Taking into account the mitigation that will be undertaken for all UXO clearances, and the low number of minke whale at risk of either PTS or disturbance (due to the planned low-order clearance operations), and that a full mitigation protocol for UXO clearance will be developed, it is not expected

that there would be any potential for impact to the minke whale population in relation to the Southern Trench MPA.

11.7.5.3 Impact C3: Piling - Auditory Injury and Disturbance from Underwater Noise, Including ADD Activation

329. There is the potential for impact piling to be used to install the four pin-piles for the OSP. Impact piling is a source of high-level underwater noise. Underwater noise can cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals.

330. The high peak pressure sound levels have the potential to cause death or physical injury to any marine mammal that is close to the source of piling, with any severe injury potentially leading to death, if no adequate mitigation is in place. High exposure levels from underwater noise sources can cause auditory injury or hearing impairment taking the form of a permanent loss of hearing sensitivity (PTS) or a temporary loss in hearing sensitivity (TTS). The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The level of impact on an individual is a function of the SEL that an individual receives as a result of underwater noise. Therefore, an assessment for both peak single strike noise levels (SPL_{peak}) as well as cumulative exposure levels for the duration of piling (SEL_{cum}) have been undertaken.

331. Underwater noise modelling has been undertaken to determine the potential auditory impact ranges (PTS and TTS), as well as the potential disturbance ranges. **Appendix 9.1** provides the full underwater noise modelling report, which has been summarised below.

Underwater Noise Modelling

332. Underwater noise modelling was undertaken by Seiche Ltd. (2022), using the relevant impulsive noise thresholds from Southall *et al*. (2019) for each marine mammal species, for both peak and cumulative thresholds. The modelling was also undertaken for all thresholds, both with and without ADD activation of 15 minutes prior to piling. See **Appendix 9.1** for more information on the methodologies and input parameters for the underwater noise modelling for piling.

333. When reviewing the results of the underwater noise modelling for piling, it is important to note that as sound travels through the water column, the interactions with the seafloor and absorption means that the sound waves will lose their 'impulsivity' over distance, and within a few kilometres, the sound waves would lose their impulsive shape (and act as a non-impulsive source of noise). Therefore, for any of the results under the impulsive criteria presented below, that are in the tens of kilometres, the results are likely to be an overestimation.

Results

334. The modelled maximum instantaneous permanent or temporary auditory injury ranges (PTS and TTS) are presented in **Table 11.49**, with results for both the maximum hammer energy (2,300kJ) and the first hammer strike (300 kJ).

335. The largest instantaneous PTS range from the first hammer strike is 170 m for harbour porpoise, and from the maximum predicted hammer energy is 234 m for harbour porpoise. The maximum potential PTS ranges will be mitigated with the MMMP for piling (**Section 11.7.1.1**). Therefore, following mitigation, it can be assumed that for the maximum hammer energy, marine mammals would no longer be present within PTS ranges, as the full mitigation procedure would have taken place prior to the hammer reaching maximum hammer energy.

Table 11.49 Summary of Maximum Modelled SPL Peak Pressure PTS and TTS Ranges and Calculated Impact Areas for Marine Mammals for Impact Piling of OSP Pin-Piles for First Hammer Strike of Soft-Start (300kJ) and Single Strike of Maximum Hammer Energy (2,300kJ)

Marine Mammal Species (Hearing Group)	Threshold (Unweighted SPL Peak)	Impact range (km) and area (km^2)	
		First Hammer Strike (300kJ)	Maximum Hammer Energy (2,300kJ)
Harbour porpoise (VHF)	PTS - 202 dB re 1 µPa	0.17 km (0.091 km^2)	0.234 km (0.172 km^2)
	TTS - 196 dB re 1 µPa	0.295 km (0.273 km^2)	0.407 km (0.520 km^2)
Dolphin species - bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin (HF)	PTS - 230 dB re 1 µPa	0.013 km (0.00053 km^2)	18m (0.0010 km^2)
	TTS - 224 dB re 1 µPa	0.022 km (0.0015 km^2)	0.031 km (0.003 km^2)
Minke whale and humpback whale (LF)	PTS - 219 dB re 1 µPa	0.035 km (0.0038 km^2)	0.049 km (0.0075 km^2)
	TTS - 213 dB re 1 µPa	0.062 km (0.012 km^2)	0.085 km (0.023 km^2)
Grey seal and harbour seal (PCW)	PTS - 218 dB re 1 µPa	0.039 km (0.0048 km^2)	0.054 km (0.0092 km^2)
	TTS - 212 dB re 1 µPa	0.068 km (0.015 km^2)	0.093 km (0.027 km^2)

336. The cumulative injury ranges (SEL_{cum} for both PTS and TTS) are summarised in **Table 11.50**. The results of the modelling are presented for both the inclusion of 15 minutes of ADD activation prior to soft-start, and without ADD activation. The modelled results with the inclusion of 15 minutes of ADD activation assume that marine mammals would be a certain distance from piling at the start of the soft-start piling. This distance is based on the swim speeds of each marine mammal species used in the modelling (**Table 11.40**).

337. The largest cumulative PTS range with no ADD activation is 1.085 km for whale species, and with ADD activation for 15 minutes, the PTS cumulative range is not exceeded for any marine mammal species. The TTS ranges for whale species are up to 41.9 km with no ADD activation, and 39.8 km with ADD activation, however, as noted in **Table 11.50** below, this is considered to be conservative, due to the change in impulsive sound to non-impulsive over several kilometres. Therefore, the TTS cumulative ranges for whale species are likely to be an over-estimation (**Appendix 9.1**).

Table 11.50 Modelled PTS, TTS and Behavioural Response Ranges Based on the Cumulative SEL Metric for Marine Mammals due to Impact Pile Driving of One Pin-Pile in 24 Hours for the OSP, with and without 15 min ADD Activation (0 = threshold not exceeded)

Marine Mammal Species (Hearing Group)	Threshold (Weighted SEL)	Impact range (km) and area (km^2)	
		1 pile in 24 hours, without ADD	1 pile in 24 hours, with 15 mins ADD
Harbour porpoise (VHF)	PTS - 155 dB re 1 µPa^{2}s	0.227 km (0.162 km^2)	0
	TTS - 140 dB re 1 µPa^{2}s	35.8 km (40.264 km^2)	2.19 km (15.067 km^2)
Dolphin species - bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin (HF)	PTS - 185 dB re 1 µPa^{2}s	0	0
	TTS - 170 dB re 1 µPa^{2}s	0	0
Minke whale and humpback whale (LF)	PTS - 183 dB re 1 µPa^{2}s	1.085 km (3.698 km^2)	0
	TTS - 168 dB re 1 µPa^{2}s	41.9 km* (5,515.411 km^2)	39.8 km* (4,976.408 km^2)

Marine Mammal Species (Hearing Group)	Threshold (Weighted SEL)	Impact range (km) and area (km^2)	
		1 pile in 24 hours, without ADD	1 pile in 24 hours, with 15 mins ADD
Grey seal and harbour seal (PCW)	PTS - 185 dB re 1 µPa^{2}s	0	0
	TTS - 170 dB re 1 µPa^{2}s	1.245 km (4.870 km^2)	0
Behavioural response / disturbance – all species	Strong - 160 dB re 1 µPa (rms)	3.491 km (38.287 km^2)	
	Mild - 140 dB re 1 µPa (rms)	46.705 km (6,852.935 km^2)	
Notes: ** These ranges are likely an overestimate due to the noise at this range no longer being impulsive as described above*			

Sensitivity of Marine Mammals to Underwater Noise Impacts of Piling at the Windfarm Site

338. As outlined in **Section 11.7.4.4**, in this assessment, all species of marine mammal are considered to have high sensitivity if they are within the potential impact range for permanent auditory injury (PTS). Marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

339. The sensitivity of marine mammals to TTS and disturbance as a result of underwater noise is considered to be medium in this assessment as a precautionary approach. This is for animals within the potential TTS and likely disturbance range, but beyond the potential impact range for PTS. Marine mammals within the potential TTS impact area are considered to have limited capacity to avoid such effects, although any impacts on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

Impact Assessment for the Potential for PTS due to Piling at the Windfarm Site

340. PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy applied during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

341. For seal species, the assessments for piling are based on the densities at the windfarm site only.

<u>PTS from a Single Strike</u>

342. The maximum impacted ranges for PTS due to a single hammer strike (**Table 11.49**) for each species, for both a single strike at starting hammer energy of 300 kJ and a maximum hammer energy strike at 2,300 kJ has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.51**).

343. Less than one individual of any species could be at risk of PTS due to a single hammer strike, from either the starting or maximum hammer energy. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 0.001% of the relevant reference populations anticipated to be exposed to any permanent effect (**Table 11.51**).

344. The effect significance is minor adverse (not significant) based on high sensitivity for PTS from underwater noise for all marine mammal species (**Table 11.51**).

345. Although the potential effect significance is minor adverse (not significant), further mitigation is recommended as outlined in **Mitigation Requirements for UXO Clearance in the Offshore Development Area**, to reduce the risk of permanent auditory injury during piling works.

Table 11.51 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of PTS from the First Strike of the Piling Hammer and a Single Strike of the Maximum Piling Hammer Energy

Species	Maximum impact distance (km) and area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (permanent impact)	Sensitivity	Effect significance
First Hammer Strike (300kJ)					
Harbour porpoise	0.17 km (0.091 km^2)	0.07 harbour porpoise (0.00002% of the NS MU)	Negligible	High	Minor adverse
Bottlenose dolphin	0.013 km (0.00053 km^2)	0.000016 bottlenose dolphin (0.000007% of the CES MU; 0.0000008% of the GNS MU)	Negligible	High	Minor adverse
White-beaked dolphin		0.00013 white-beaked dolphin (0.0000003% of the CGNS MU)	Negligible	High	Minor adverse
Atlantic white-sided dolphin		0.000015 Atlantic white-sided dolphin (0.00000008% of the CGNS MU)	Negligible	High	Minor adverse
Risso's dolphin		0.000001 Risso's dolphin (0.000000008% of the CGNS MU)	Negligible	High	Minor adverse
Minke whale	0.035 km (0.0038 km^2)	0.00015 minke whale (0.0000007% of the CGNS MU)	Negligible	High	Minor adverse
Humpback whale		0.00000006 humpback whale (0.0000000002% of the reference population)	Negligible	High	Minor adverse
Grey seal	0.039 km (0.0048 km^2)	0.00023 grey seal (0.0000016% of the EaS MU; 0.0000011% of the wider reference population)	Negligible	High	Minor adverse
Harbour seal		0.000000010 harbour seal (0.0000000020% of the EaS MU; 0% of the wider reference population))	Negligible	High	Minor adverse
Maximum Hammer Strike (2,300kJ)					
Harbour porpoise	0.234 km (0.172 km^2)	0.13 harbour porpoise (0.000038% of the NS MU)	Negligible	High	Minor adverse
Bottlenose dolphin	0.018 km (0.001 km^2)	0.00003 bottlenose dolphin (0.000014% of the CES MU; 0.0000015% of the GNS MU)	Negligible	High	Minor adverse
White-beaked dolphin		0.0002 white-beaked dolphin (0.00000056% of the CGNS MU)	Negligible	High	Minor adverse
Atlantic white-sided dolphin		0.00003 Atlantic white-sided dolphin (0.00000016% of the CGNS MU)	Negligible	High	Minor adverse
Risso's dolphin		0.000002 Risso's dolphin (0.000000015% of the CGNS MU)	Negligible	High	Minor adverse
Minke whale	0.049 km (0.0075 km^2)	0.0003 minke whale (0.0000015% of the CGNS MU)	Negligible	High	Minor adverse
Humpback whale		0.0000001 humpback whale (0.00000000032% of the reference population)	Negligible	High	Minor adverse
Grey seal	0.054 km (0.0092 km^2)	0.0004 grey seal (0.0000031% of the EaS MU; 0.0000021% of the wider reference population)	Negligible	High	Minor adverse
Harbour seal		0.00000002 harbour seal (0.0000000038% of the EaS MU; 0.00000000093% of the wider reference population)	Negligible	High	Minor adverse

<u>**PTS from Cumulative Exposure of a Single Pin-Pile**</u>

346. The SEL_{cum} is a measure of the total received noise over the duration of piling, and indicates the distance from the piling location that if the receptor were to start fleeing in a straight line from the noise source starting at a range closer than the modelled range it would receive a noise exposure in excess of the criteria threshold, and if the receptor were to start fleeing from a range further than the modelled range it would receive a noise exposure below the criteria threshold (see **Appendix 9.1** for further details).

347. The piling parameters, including duration of soft-start, ramp-up procedure, strike rate, number of strikes and duration, were determined to reduce the potential impact ranges, as much as possible, for PTS from cumulative exposure (see **Appendix 9.1** and **Table 11.14** for the soft-start and ramp-up parameters used in the underwater noise modelling).

348. The maximum impact ranges for cumulative PTS exposure during one pin-pile installed in a 24 hour period for the OSP (**Table 11.50**) for each species, both without and with 15 minute ADD activation, has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.52**).

349. Without ADD activation, only harbour porpoise, minke whale, and humpback whale are at potential risk of PTS from cumulative exposure to the duration of piling for one pin-pile, and less than a single individual of each species could be at risk. The magnitude of the potential impact is assessed as negligible for these three species, with less than 0.001% of the relevant reference populations anticipated to be exposed to any permanent effect (**Table 11.52**). For all dolphin and seal species, there is no risk of PTS due to the cumulative exposure of one pin-pile being installed, even without ADD activation.

350. With 15 minute ADD Activation prior to soft-start commencing, no marine mammals would be at risk of PTS as a result of the cumulative exposure during one pin-pile being installed in a 24 hour period, as the SEL noise levels would not be high enough to breach the PTS (SEL_{cum}) thresholds (**Table 11.52**). This assessment assumes that during the 15 minute ADD activation prior to piling, marine mammals would flee directly away from the pile location, at the speeds outlined in **Table 11.40**.

351. The effect significance is minor adverse (not significant), based on high sensitivity for PTS from underwater noise for all marine mammal species (**Table 11.52**).

352. Although the potential effect significance is minor adverse (not significant), further mitigation is recommended as outlined in **Section 11.7.1.1**, to reduce the risk of permanent auditory injury in marine mammals during impact piling.

Table 11.52 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Cumulative PTS Exposure from the Installation of One Pin-Pile in 24 hour period for OSP without and with 15 minute ADD activation

Species	Maximum impact area (km^2)	Maximum number of individuals % of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Without ADD activation					
Harbour porpoise	0.227 km (0.162 km^2)	0.12 harbour porpoise (0.000035% of the NS MU)	Negligible	High	Minor adverse
Bottlenose dolphin	0	-	-	High	No impact
White-beaked dolphin	0	-	-	High	No impact
Atlantic white-sided dolphin	0	-	-	High	No impact
Risso's dolphin	0	-	-	High	No impact
Minke whale	1.085 km (3.698 km^2)	0.14 minke whale (0.00071% of the CGNS MU)	Negligible	High	Minor adverse

Species	Maximum impact area (km²)	Maximum number of individuals % of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Without ADD activation					
Humpback whale		0.00006 humpback whale (0.00000016% of the reference population)	Negligible	High	Minor adverse
Grey seal	0	-	-	High	No impact
Harbour seal	0	-	-	High	No impact
With 15 minute ADD activation					
Harbour porpoise	0	-	-	High	No impact
Bottlenose dolphin	0	-	-	High	No impact
Bottlenose dolphin	0	-	-	High	No impact
White-beaked dolphin	0	-	-	High	No impact
Atlantic white-sided dolphin	0	-	-	High	No impact
Risso's dolphin	0	-	-	High	No impact
Minke whale	0	-	-	High	No impact
Humpback whale	0	-	-	High	No impact
Grey seal	0	-	-	High	No impact
Grey seal	0	-	-	High	No impact
Harbour seal	0	-	-	High	No impact
Harbour seal	0	-	-	High	No impact

Impact Assessment for the Potential for TTS due to Piling at the Windfarm Site

353. TTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy applied during piling. TTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

354. The underwater noise modelling results for the maximum predicted ranges (and areas) for TTS in marine mammals are presented in **Table 11.49** and **Table 11.50**, and have been used to inform the assessments.

TTS from a Single Strike

355. The maximum impacted ranges for TTS due to a single hammer strike (**Table 11.49**) for each species, for both a single strike at starting hammer energy of 300 kJ and a maximum hammer energy of 2,300kJ has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.53**).

356. Less than one individual of any species could be at risk of TTS due to a single hammer strike, from either the starting or the maximum energy. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to the temporary impact (**Table 11.53**).

357. The effect significance is minor adverse (not significant) based on medium sensitivity for TTS from underwater noise for all marine mammal species (**Table 11.53**).

Table 11.53 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS from the First Strike of the Piling Hammer and for the Maximum Hammer Energy

Species	Maximum impact area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (temporary impact)	Sensitivity	Effect significance
First Hammer Strike (300kJ)					
Harbour porpoise	0.295 km (0.273 km^2)	0.2 harbour porpoise (0.00006% of the NS MU)	Negligible	Medium	Minor adverse
Bottlenose dolphin	0.022 km (0.0015 km^2)	0.00005 bottlenose dolphin (0.00002% of the CES MU; 0.0000022% of the GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin		0.0004 white-beaked dolphin (0.00000084% of the CGNS MU)	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin		0.00004 Atlantic white-sided dolphin (0.00000023% of the CGNS MU)	Negligible	Medium	Minor adverse
Risso's dolphin		0.000003 Risso's dolphin (0.000000022% of the CGNS MU)	Negligible	Medium	Minor adverse
Minke whale	0.062 km (0.012 km^2)	0.0005 minke whale (0.0000023% of the CGNS MU)	Negligible	Medium	Minor adverse
Humpback whale		0.0000002 humpback whale (0.00000000052% of the reference population)	Negligible	Medium	Minor adverse
Grey seal	0.068 km (0.0145 km^2)	0.0007 grey seal (0.0000049% of the EaS MU; 0.0000034% of the wider reference population)	Negligible	Medium	Minor adverse
Harbour seal		0.00000003 harbour seal (0.0000000061% of the EaS MU; 0.0000000015% of the wider reference population)	Negligible	Medium	Minor adverse
Maximum Hammer Strike (2,300kJ)					
Harbour porpoise	0.407 km (0.52 km^2)	0.4 harbour porpoise (0.00011% of the NS MU)	Negligible	Medium	Minor adverse
Bottlenose dolphin	0.031 km (0.0030 km^2)	0.00009 bottlenose dolphin (0.000040% of the CES MU; 0.0000044% of the GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin		0.0007 white-beaked dolphin (0.0000017% of the CGNS MU)	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin		0.00008 Atlantic white-sided dolphin (0.00000047% of the CGNS MU)	Negligible	Medium	Minor adverse
Risso's dolphin		0.000005 Risso's dolphin (0.000000044% of the CGNS MU)	Negligible	Medium	Minor adverse
Minke whale	0.085 km (0.023 km^2)	0.0009 minke whale (0.0000044% of the CGNS MU)	Negligible	Medium	Minor adverse
Humpback whale		0.0000003 humpback whale (0.0000000010% of the reference population)	Negligible	Medium	Minor adverse
Grey seal	0.093 km (0.027 km^2)	0.0013 grey seal (0.0000091% of the EaS MU; 0.0000063% of the wider reference population)	Negligible	Medium	Minor adverse
Harbour seal		0.00000005 harbour seal (0.000000011% of the EaS MU; 0.0000000028% of the wider reference population)	Negligible	Medium	Minor adverse

TTS from Cumulative Exposure During Installation of a Single Pin-Pile

358. As outlined for PTS from cumulative exposure, the ranges indicate the distance that an individual would need to be from the noise source at the start of the piling sequence to prevent a cumulative noise exposure which could lead to TTS. This is highly conservative because the assessment assumes the worst case exposure levels for an animal in the water column, and does not take account of periods where exposure will be reduced, for example in seals when their heads are out of the water;

or that the cumulative noise dose received by the marine mammal will be largely dependent on the swimming speed, and whether the animal moves away from the noise source rapidly as a flee response. The cumulative SEL dose does not take account of this and therefore is likely to overestimate the received noise levels (see **Appendix 9.1** for further details).

359. The maximum impact ranges for cumulative TTS exposure during installation of a single pin-pile for the OSP in 24 hour period installed (**Table 11.50**) for each species, both without and with 15 minute ADD activation, has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.54**).

360. Without ADD activation, harbour porpoise, minke whale, humpback whale, grey seal and harbour seal could be at potential risk of TTS from cumulative exposure during the duration of piling for one pin-pile. The magnitude of the potential impact is assessed as low for minke whale and negligible for harbour porpoise, humpback whale, grey and harbour seal (**Table 11.54**). For all dolphin species, there is no risk of TTS due to the cumulative exposure during one pin-pile being installed, even without ADD activation.

361. With ADD Activation, only harbour porpoise, minke whale and humpback whale could be at potential risk of TTS due to the cumulative exposure for one pin-pile being installed, as the SEL noise levels would not be high enough to breach the TTS (SEL_{cum}) thresholds (**Table 11.54**). This assessment assumes that during the 15 minute ADD activation prior to piling, marine mammals would flee directly away from the pile location, at the speeds outlined in **Table 11.40**.

362. The effect significance is either minor adverse (not significant), or there would be no impact, based on medium sensitivity for TTS from underwater noise for all marine mammal species (**Table 11.54**).

Table 11.54 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Cumulative TTS Exposure from the Installation of One Pin-Pile in 24 hour period for OSP without and with 15 minute ADD activation

Species	Maximum impact area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (permanent impact)	Sensitivity	Effect significance
Without ADD activation					
Harbour porpoise	3.58 km (40.264 km^2)	30.6 harbour porpoise (0.0088% of the NS MU)	Negligible	Medium	Minor adverse
Bottlenose dolphin	0	-	-	Medium	No impact
White-beaked dolphin		-	-	Medium	No impact
Atlantic white-sided dolphin		-	-	Medium	No impact
Risso's dolphin		-	-	Medium	No impact
Minke whale	41.9 km (5,515.411 km^2)	213.45 minke whale (1.06% of the CGNS MU)	Low	Medium	Minor adverse
Humpback whale		0.083 humpback whale (0.00024% of the reference population)	Negligible	Medium	Minor adverse
Grey seal	1.245 km (4.870 km^2)	0.24 grey seal (0.0016% of the EaS MU; 0.0011% of the wider reference population)	Negligible	Medium	Minor adverse
Harbour seal		0.00001 harbour seal (0.000002% of the EaS MU; 0.0000005% of the wider reference population)	Negligible	Medium	Minor adverse
With 15 minute ADD activation					
Harbour porpoise	2.19 km (15.067 km^2)	11.45 harbour porpoise (0.0033% of the NS MU)	Negligible	Medium	Minor adverse
Bottlenose dolphin	0	-	-	Medium	No impact
White-beaked dolphin		-	-	Medium	No impact

Species	Maximum impact area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (permanent impact)	Sensitivity	Effect significance
Atlantic white-sided dolphin		-	-	Medium	No impact
Risso's dolphin		-	-	Medium	No impact
Minke whale	39.8 km ($4,976.408 km^2$)	192.6 minke whale (0.96% of the CGNS MU)	Negligible	Medium	Minor adverse
Humpback whale		0.075 humpback whale (0.00021% of the reference population)	Negligible	Medium	Minor adverse
Grey seal	0	-	-	Medium	No impact
Harbour seal		-	-	Medium	No impact

Impact Assessment for the Potential for Disturbance due to Piling at the Windfarm Site

Review of Potential for Disturbance from Piling

363. During the piling campaign at Beatrice Offshore Wind Farm in 2017, an array of underwater noise recorders were deployed to determine noise levels associated with the piling campaign, alongside a separate array of acoustic recorders to monitor the presence of harbour porpoise during piling (Graham *et al.,* 2019). Piling at Beatrice comprised of four pin piles at each turbine or sub-station structure, with a 2.2 m diameter and a hammer energy of 2,400 kJ. The sound levels recorded were then used to determine the sound level at each of the acoustic recorders.

364. This study assumed that a change in the number of harbour porpoise present at each location was based on the number of positive identifications of porpoise vocalisations (Graham *et al.,* 2019). These two data sets (the harbour porpoise presence and the perceived sound level at each location) were then analysed in order to determine any disturbance impacts as a result of the piling activities and at what sound level impacts are observed. Harbour porpoise presence was measured over a period of 48 hours prior to piling being undertaken and continued following the cessation of piling to ensure that any change in porpoise detections could be observed (a total period of 96 hours was recorded for each included piling event, with a total of 17 piling events included within this analysis) (Graham *et al.,* 2019).

365. The results of the study at Beatrice Offshore Wind Farm (Graham *et al.,* 2019) found that at the start of the piling campaign, there was a 50% chance of a harbour porpoise responding to piling activity, within a distance of 7.4 km, during the 24 hours following piling. At the middle of the piling campaign, this 50% response distance had reduced to 4.0 km, and by the end of the piling had reduced further to 1.3 km. The response to audiogram-weighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 54.1 dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 60.0 dB re 1 $1\mu Pa^2s$ during the middle of the campaign, and to 70.9 dB re 1 μPa^2s by the end of the piling activities. Similarly, the response to unweighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 144.3 dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 150.0 dB re 1 $1\mu Pa^2s$ during the middle of the campaign, and to 160.4 dB re 1 μPa^2s by the end of the piling activities (Graham *et al.,* 2019).

366. Additional comparisons were made through this study (Graham *et al.,* 2019) to assess the difference in harbour porpoise presence where ADDs were used and where they were not, as well as relating to the number of vessels present within 1 km of the piling site. A significant difference was observed in the presence of harbour porpoise where ADDs were used compared to where they were not, but only in the short-term (less than 12 hours following piling), and there was no significant difference when considering a longer time period from piling. With 50% response distances for pile locations with ADD use recorded as up to 5.3 km (during 12 hours after piling), and up to 0.7 km with no ADD in use, in the 12 hours following piling. It should be noted however that only two locations used in the

analysis had ADD use, and therefore the sample number in this analysis is small (Graham *et al.,* 2019).

367. Overall, this study has shown that the response of harbour porpoise to piling activities reduces over time, suggesting a habituation effect occurred. In addition, there is some indication that the use of ADDs does reduce the presence of harbour porpoise in the short term. Also, the higher levels of vessel activity increased the potential for a response by harbour porpoise. Harbour porpoise response to piling activity was best explained by the distance from the piling location, or from the received noise levels (taking into account weighting for their hearing) (Graham *et al.,* 2019).

Assessment Based on the Underwater Noise Modelling undertaken for the Project

368. Results of the underwater noise modelling based on the 160 dB threshold for disturbance / possible strong behavioural response are provided in **Table 11.50**.

369. The disturbance range based on the SEL noise levels (**Table 11.50**) for each species has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.55**).

370. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact (**Table 11.55**).

371. The effect significance is minor adverse (not significant) based on medium sensitivity for disturbance from underwater noise for all marine mammal species (**Table 11.55**).

Table 11.55 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Disturbance from Piling at the Windfarm Site

Species	Maximum impact area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour porpoise	3.491 km (38.287 km^2)	29.1 harbour porpoise (0.008% of the NS MU)	Negligible	Medium	Minor adverse
Bottlenose dolphin		1.14 bottlenose dolphin (0.51% of the CES MU; 0.056% of the GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin		9.3 white-beaked dolphin (0.021% of the CGNS MU)	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin		1.1 Atlantic white-sided dolphin (0.0059% of the CGNS MU)	Negligible	Medium	Minor adverse
Risso's dolphin		0.07 Risso's dolphin (0.00056% of the CGNS MU)	Negligible	Medium	Minor adverse
Minke whale		1.5 minke whale (0.0074% of the CGNS MU)	Negligible	Medium	Minor adverse
Humpback whale		0.0006 humpback whale (0.0000016% of the reference population)	Negligible	Medium	Minor adverse
Grey seal		1.9 grey seal (0.013% of the EaS MU; 0.0088% of the wider reference population)	Negligible	Medium	Minor adverse
Harbour seal		0.00008 harbour seal (0.000016% of the EaS MU; 0.0000039% of the wider reference population)	Negligible	Medium	Minor adverse

372. Results of the underwater noise modelling based on the 140 dB possible mild behavioural response threshold are provided in **Table 11.50**.

373. The disturbance range based on the SEL noise levels (**Table 11.50**) for each species has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could respond (**Table 11.56**).

374. The magnitude of the potential impact is assessed as low for harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, minke whale, grey seal; and negligible for Risso's dolphin, humpback whale and harbour seal (**Table 11.56**).

375. The estimated percentage of the bottlenose dolphin reference populations that could have a possible mild behavioural response is high (**Table 11.56**). However, it is important to note, bottlenose dolphin, particularly those from the Moray Firth SAC tend to be close to the coast rather than further offshore in the Windfarm Site. Any mild behavioural response would be temporary and short-term during the active piling duration to install each of the four pin-piles for the OSP. The assessments are therefore very precautionary and worst case for bottlenose dolphin that could have a response.

376. The effect significance, based on low sensitivity for possible mild behavioural response from underwater noise for all marine mammal species (**Table 11.19**), is assessed as **minor adverse (not significant)** for harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, minke whale, grey seal; negligible for Risso's dolphin, humpback whale and harbour seal; with a worst case of **moderate adverse (significant)** for bottlenose dolphin (**Table 11.56**).

Table 11.56 Maximum Number of Individuals (and % of Reference Population) that Could have a Possible Mild Behavioural Response from Piling at the Windfarm Site

Species	Maximum impact area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour porpoise	46.705 km ($6,852.94 km^2$)	5,208.23 harbour porpoise (1.50% of the NS MU)	Low	Low	Minor adverse
Bottlenose dolphin		204.22 bottlenose dolphin (91.17% of the CES MU; 10.10% of the GNS MU)	High	Low	**Moderate adverse**
White-beaked dolphin		1,665.26 white-beaked dolphin (3.79% of the CGNS MU)	Low	Low	Minor adverse
Atlantic white-sided dolphin		191.88 Atlantic white-sided dolphin (1.06% of the CGNS MU)	Low	Low	Minor adverse
Risso's dolphin		12.34 Risso's dolphin (0.10% of the CGNS MU)	Negligible	Low	Negligible
Minke whale		265.21 minke whale (1.32% of the CGNS MU)	Low	Low	Minor adverse
Humpback whale		0.1 humpback whale (0.00029% of the reference population)	Negligible	Low	Negligible
Grey seal		335.79 grey seal (2.29% of the EaS MU; 1.58% of the wider reference population)	Low	Low	Minor adverse
Harbour seal		0.014 harbour seal (0.0029% of the EaS MU; 0.000695% of the wider reference population)	Negligible	Low	Negligible

Assessment Based the Effective Deterrence Radius Approach for Harbour Porpoise

377. The current advice from the SNCBs is that a potential disturbance range (EDR) of 15 km (potential disturbance area of up to 706.9 km^2) around piling locations for pin-piles with and without noise abatement is used to assess the area that harbour porpoise may be disturbed in within harbour porpoise designated SACs in England, Wales and Northern Ireland (JNCC *et al.,* 2020). While the Windfarm Site is not located in close proximity to these sites, the approach has been used to provide an assessment of an EDR of 15 km for the piling of pin-piles for information purposes only.

378. Not all harbour porpoise within the potential disturbance areas based on EDR will be disturbed, however as worst case scenario 100% disturbance of harbour porpoise in the area has been assumed.

379. The estimated number of harbour porpoise and percentage of the NS MU reference population that could be disturbed as a result of underwater noise during piling presented in **Table 11.57**.

380. The magnitude of the potential impact is assessed as low, with 0.15% of NS MU anticipated to be temporarily disturbed (**Table 11.57**).

Table 11.57 Maximum Number of Harbour Porpoise (and % of Reference Population) that Could be Disturbed During Piling at the Windfarm Site based on the EDR Approach

Species	Maximum impact area (km^2)	Maximum number of individuals (% of reference population)	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	15 km (706.9 km^2)	537.2 harbour porpoise (0.15% of the NS MU)	Low	Medium	Minor adverse

Dose Response Curve Assessment

381. Following current best practice guidance (Southall *et al.*, 2021), a behavioural disturbance dose-response analysis has been carried out for those species for which appropriate dose-response evidence exists within the scientific literature. For methods, see **Section 11.7.4.1**.

382. The estimated numbers (and percentage of the relevant MU) of harbour porpoise, grey seal, and harbour seal that could be disturbed as a result of underwater noise during piling of the OSP pin-piles are presented in **Table 11.58**.

383. For the species assessed, the magnitude of the potential impact is assessed as negligible, with a maximum of 0.13% of the relevant MU reference population predicted to be disturbed **Table 11.58**.

384. The effect significance is **minor adverse (not significant)** based on medium sensitivity for disturbance from underwater noise for all marine mammal species **Table 11.58**.

385. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADD which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

Table 11.58 Number of Individuals (and % of Reference Population) that Could be Disturbed During Piling at the Windfarm Site based on the Dose-Response Approach

Species	Number of individuals disturbed (% of reference population)	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	450.9 harbour porpoise (0.13% of the NS MU)	Negligible	Medium	Minor adverse
Grey seal	2.8 grey seal (0.019% of the EaS MU; 0.013% of the wider reference population)	Negligible	Medium	Minor adverse
Harbour Seal	0.0002 harbour seal (0.00004% of the EaS MU; 0.00001% of the wider reference population)	Negligible	Medium	Minor adverse

Duration of Piling and Disturbance of Marine Mammals

386. The maximum duration of piling at the Windfarm Site, based on worst case scenarios (**Table 11.14**), including soft-start and ramp-up could be:

- Average duration for piling of four foundations (including soft-start, ramp-up and ADD activation) = 17.6 hours based on average piling time of 4 hours and 39 minutes per pile (or 0.78 days), excluding ADD activation; or
- Maximum duration for piling of four foundations (including soft-start, ramp-up and ADD activation) = 40 hours based on maximum piling time of 10 hours per pile (or 1.71 days), excluding ADD activation.

387. The duration of piling is based on a worst case scenario and a very precautionary approach, and as has been shown at other offshore wind farms, the duration used in the impact assessment can be overestimated. For example, at the Beatrice Offshore Wind Farm, where within the ES it was estimated that each pin-pile would require 5 hours of active piling time. However, during construction,

the total duration of piling ranged from 19 minutes to 2 hours and 45 minutes, with an average duration of 1 hour and 15 minutes per pile (Beatrice Offshore Wind Farm Ltd, 2018).

Potential for Disturbance from ADD Activation

388. The assessments of the potential disturbance during any ADD activation is indicative only, as the final requirements for mitigation in the MMMP will be determined prior to construction. As assumed for the underwater noise modelling, the following assessment assumes an ADD activation period of 15 minutes. The maximum total ADD activation time to install all piles is one hour, based on the currently assessed 15 minutes per pile.

389. The area at which disturbance of marine mammals could occur is based on the distance of which marine mammals could be expected to flee as a result of the specific ADD time. **Table 11-58** shows the swimming speed of each marine mammal species, the distance at which they could be expected to flee (based on swimming directly away from the piling source), and the resultant area of potential disturbance. The potential disturbance ranges (and areas) have then been used to inform the assessment as presented in **Table 11.60**.

390. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact (**Table 11.60**).

391. The effect significance is **minor adverse (not significant)** based on medium sensitivity for disturbance from underwater noise for all marine mammal species (**Table 11.60**).

Table 11.59 ADD Activation Duration for Piling

Species	Swim speed (m/s)	ADD activation duration	Distance (km) from ADD / piling location after ADD activation duration	Potential area of disturbance due to ADD activation period
Harbour porpoise	1.5m/s	15 minutes	1.35 km	5.73 km^2
All dolphin species	1.52m/s	15 minutes	1.37 km	5.90 km^2
Minke whale and humpback whale	2.3m/s	15 minutes	2.07 km	13.461 km^2
Grey seal and harbour seal	1.8m/s	15 minutes	1.62 km	8.24 km^2

Table 11.60 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Disturbance from 15 Minutes of ADD Activation at the Windfarm Site

Species	Maximum number of individuals (% of reference population)	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour porpoise	4.35 harbour porpoise (0.0013% of the NS MU)	Negligible	Medium	Minor adverse
Bottlenose dolphin	0.18 bottlenose dolphin (0.078% of the CES MU; 0.0087% of the GNS MU)	Negligible	Medium	Minor adverse
White-beaked dolphin	1.43 white-beaked dolphin (0.0033% of the CGNS MU)	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin	0.17 Atlantic white-sided dolphin (0.00091% of the CGNS MU)	Negligible	Medium	Minor adverse
Risso's dolphin	0.011 Risso's dolphin (0.000087% of the CGNS MU)	Negligible	Medium	Minor adverse
Minke whale	0.52 minke whale (0.0026% of the CGNS MU)	Negligible	Medium	Minor adverse
Humpback whale	0.00020 humpback whale (0.00000058% of the reference population)	Negligible	Medium	Minor adverse
Grey seal	0.40 grey seal (0.0028% of the EaS MU; 0.0019% of the wider reference population)	Negligible	Medium	Minor adverse

Species	Maximum number of individuals (% of reference population)	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour seal	0.000016 harbour seal (0.0000035% of the EaS MU; 0.00000084% of the wider reference population)	Negligible	Medium	Minor adverse

Mitigation Requirements for Piling at the Windfarm Site

392. The MMMP for piling (**Section 11.7.1.1**) would reduce the risk of PTS from the first strike of the soft-start, single strike of the maximum hammer energy; and cumulative PTS. The MMMP for piling will be developed post-consent in consultation with Marine Scotland and NatureScot will be based on the latest information, scientific understanding and guidance and detailed project design.

393. The proposed mitigation to reduce the risk of PTS would include establishing a monitoring zone and ADD activation prior to the soft-start commencing.

394. ADDs have proven to be effective mitigation for harbour porpoise, dolphin species, minke whale, grey and harbour seal (Sparling *et al.,* 2015; McGarry *et al.,* 2017, 2020). ADDs have been widely used as mitigation to deter marine mammals during offshore wind farm piling.

395. It is also important to note that Brandt *et al.* (2018) found that at seven German offshore wind farms in the vicinity (up to 2 km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice offshore wind farm, indicate higher vessel activity within 1 km was associated with an increased probability of response in harbour porpoise (Graham *et al.,* 2019). This vessel disturbance of marine mammals from the area around the construction site prior to piling would also reduce the risk of PTS.

396. The mitigation measures in the MMMP to reduce the risk of PTS would also reduce the number of marine mammals at risk of TTS.

EPS Licence Requirements for Piling at the Windfarm Site

397. Prior to any piling being undertaken at the Windfarm Site, an EPS Licence application will be submitted. This will include an EPS RA to determine the risk of any physical or auditory injury and disturbance to cetacean (EPS) species during the piling, and from disturbance due to ADD activation, and will also take into account the duration and timing of the piling works, as well as any cumulative impacts at the time. The EPS Licence application will also include detailed MMMP for piling.

Summary of Effect significance for Piling at the Windfarm Site

Effect significance of Piling

398. For PTS, taking into account high marine mammal sensitivity and the potential magnitude of the effect (i.e. number of individuals as a percentage of the reference population), the effect significance for permanent changes in hearing sensitivity (PTS) from a single strike of the maximum or starting hammer energy without any mitigation has been assessed as minor adverse for all marine mammal species (**Table 11.61**). For PTS from cumulative exposure without ADD activation, the effect significance has been assessed as minor adverse for harbour porpoise, minke whale, and humpback whale, while there would be no impact for all other species. For PTS from cumulative exposure with ADD activation, there would be no impact to any marine mammal species assessed (**Table 11.61**).

399. For TTS, taking into account medium marine mammal sensitivity and the potential magnitude of the effect, the effect significance for temporary changes in hearing sensitivity (TTS) from a single strike of either the starting hammer energy, or the maximum hammer energy has been assessed as minor adverse for all marine mammal species (**Table 11.61**). For TTS from cumulative exposure, without ADD activation, the effect significance has been assessed as minor adverse for harbour porpoise, and all whale and seal species, and there would be no impact to dolphin species. With ADD activation, the potential for TTS from cumulative exposure has been assessed as minor adverse for harbour porpoise, minke whale and humpback whale, and there would be no impact to all dolphin and seal species (**Table 11.61**).

400. With adequate and effective mitigation, such as ADD activation and monitoring zone which will be detailed in the MMMP for piling, the residual impact would be **minor adverse (not significant).**

401. The effect significance for all marine mammal species for disturbance from recommended ADD activation prior to piling is **minor adverse (not significant)** (**Table 11.61**).

Table 11.61 Assessment of Effect significance for PTS, TTS and Disturbance for Piling

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Impact assessment for PTS						
PTS from a single strike of the starting hammer energy (300kJ)	All marine mammal species	High	Negligible	Minor adverse	**MMMP for piling (Section 11.7.1.1)**	Minor adverse
PTS from a single strike of the maximum hammer energy (2,300kJ)	All marine mammal species	High	Negligible	Minor adverse		Minor adverse
PTS due to cumulative exposure of the installation of one pin-pile without ADD activation	Harbour porpoise, minke whale, humpback whale	High	Negligible	Minor adverse		Minor adverse
	All other marine mammal species	High	No impact	No impact		No impact
PTS due to cumulative exposure of the installation of one pin-pile with 15 minutes of ADD activation	All marine mammal species	High	No impact	No impact		No impact
Impact assessment for TTS						
TTS from a single strike of the starting hammer energy (300kJ)	All marine mammal species	Medium	Negligible	Minor adverse	**MMMP for piling (see Section 11.7.1.1)**	Minor adverse
TTS from a single strike of the maximum hammer energy (2,300kJ)	All marine mammal species	Medium	Negligible	Minor adverse		Minor adverse
TTS due to cumulative exposure of the installation of one pin-pile without ADD activation	Harbour porpoise, humpback whale, grey seal, harbour seal	Medium	Negligible	Minor adverse		Minor adverse
	Minke whale	Medium	Low	Minor adverse		Minor adverse
	All dolphin species	Medium	No impact	No impact		No impact
TTS due to cumulative exposure of the installation of one pin-pile with 15 minutes of ADD activation	Harbour porpoise, minke whale, humpback whale	Medium	Negligible	Minor adverse		Minor adverse
	All other marine mammal species	Medium	No impact	No impact		No impact

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Impact assessment for Disturbance						
Disturbance / possible strong behavioural response (160 dB threshold) due to cumulative exposure of the installation of one pin-pile	All marine mammal species	Medium	Negligible	Minor adverse	None required	Minor adverse
Possible mild behavioural response (140 dB threshold) due to cumulative exposure of the installation of one pin-pile	Harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, minke whale, grey seal	Low	Low	Minor adverse		Minor adverse
	Bottlenose dolphin	Low	High	**Moderate adverse** – as worst case		Minor adverse
	Humpback whale, harbour seal	Low	Negligible	Negligible		Negligible
Disturbance based on EDR for pin-piles	Harbour porpoise	Medium	Negligible	Minor adverse		Minor adverse
Disturbance based on dose response curves	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse		Minor adverse
Disturbance due to ADD activation for 15 minutes	All marine mammal species	Medium	Negligible	Minor adverse		Minor adverse

Assessment for the Southern Trench MPA

402. The Conservation and Advice document for the Southern Trench MPA (NatureScot, 2020) states that, for any piling operations, the impacts from underwater noise should be decreased, either by using Noise Abatement Systems (NAS), or pile management strategies, such as the mitigation guidelines for piling developed by JNCC (2010b). Given the nature and scale of the piling at the Windfarm Site, that only for four pin-piles and the Windfarm site is located 50.9 km from the Southern Trench MPA, the use of NAS would not be appropriate.

403. None of the predicted impact ranges for minke whale as a result of piling would overlap with the Southern Trench MPA:

- PTS single strike of maximum hammer energy (2,300 kJ) = 0.049 km
- PTS cumulative exposure for installation of a single pin-pile, without ADD = 1.085 km
- TTS single strike of maximum hammer energy = 0.085 km
- TTS cumulative exposure for installation of a single pin-pile, without ADD = 41.9 km
- Disturbance / possible strong behavioural response (160 dB threshold) = 3.49 km
- Possible mild behavioural response (140 dB threshold) = 46.71 km

404. In total, up to 0.0003 and 0.2 minke whale may be at risk of PTS for single strike and cumulative exposure of piling, respectively. This equates to up to 0.000001% and 0.0007% of the reference population at risk of PTS, respectively (**Table 11.51** and **Table 11.52**). Up to 1.5 minke whale may be at risk of disturbance from piling (**Table 11.55**), and, due to an ADD activation period of 15 minutes, up to 0.5 minke whale may be disturbed (**Table 11.60**). Any impacts to minke whale as a result of piling would be minor adverse.

405. In order to minimise the potential for impacts to all marine mammal species, the JNCC (2010b) guidelines for piling will be followed, and a MMMP for piling will be developed, as outlined in **Section 11.7.1.1**.

406. Taking into account the mitigation that will be undertaken for piling, and the low number of minke whale at risk of either PTS or disturbance, and that a MMMP for piling will be developed, it is not expected that there would be any potential for impact to the minke whale population in relation to the Southern Trench MPA due to piling activities.

11.7.5.4 Impact C4: Other Construction Activities - Disturbance from Underwater Noise During Cable and Mooring Installation

Underwater Noise Modelling

407. Underwater noise modelling was undertaken for the following other construction noise sources:

- Cable laying; and
- Cable trenching / cutting.

408. Further information on the underwater noise modelling undertaken for these noise sources is provided in **Appendix 9.1**.

409. As outlined in **Table 11.14**, piling is not an option for turbine mooring installation. The mooring installation options being considered include drag embedment anchors, torpedo anchors, gravity-based anchors or suction piles. Underwater noise during turbine mooring installation is anticipated to be comparable or less than modelled impact ranges for cable trenching / cutting. Therefore, modelled impact ranges for cable trenching / cutting is considered worst case.

Results

410. The results of the underwater noise for construction noise sources, other than piling, are provided in **Table 11.62**. All impact ranges are based on the non-impulsive Southall *et al*. (2019) SEL_{cum} thresholds, based on 24 hours of exposure for PTS and TTS, and the NMFS (2005) Level B threshold of 120 dB re 1 µPa (rms) (for continuous noise sources) for all marine mammal species. The use of this threshold for disturbance impacts is likely to produce impact ranges that are an overestimation of the actual deterrence of mammals as a result of these activities.

411. As described within **Appendix 9.1**, the 120 dB re 1 µPa threshold is lower than the noise level at which the majority of marine mammals responded at a behavioural response level of 6, which was reported to be 140 dB re 1 µPa (as reviewed by Southall *et al*., 2007). Therefore, the underwater noise modelling results based on the 120 dB re 1 uPa threshold is likely to be an over-estimation. In addition, the impact areas used within the following assessments are based on the area of a circle, with the impact range as the radius, which is likely to cause an overestimation in the impact area, as this does not take into account the bathymetry of the surrounding area, and the absorption of sound as it travels from the source location.

Table 11.62 Estimated PTS, TTS, and Disturbance Ranges of Marine Mammals from Other Construction Noise Sources [LF = Low Frequency Cetaceans (whale species); HF = High Frequency Cetaceans (dolphin species); VHF = Very High Frequency Species (harbour porpoise); PCW = Phocid Species in Water (seal species)]

Noise source	Range (m) [0 = no exceedance of the threshold]								
	LF		HF		VHF		PCW		All
	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS	Disturbance
Cable trenching / cutting	0	0	0	0	0	55	0	40	9,284
Cable Laying	0	0	0	0	0	0	0	0	5,779

Impact Assessment for the Potential for PTS due to Other Construction Activities within the Offshore Development Area

412. Based on the results of the noise modelling (**Table 11.62**), there is no potential for PTS in any marine mammal species, as the noise sources do not exceed the relevant PTS thresholds for any species group. Therefore, there would be **no risk** of PTS in marine mammals due to other construction activities in the offshore development area.

Impact Assessment for the Potential for TTS due to Other Construction Activities within the Offshore Development Area

413. Based on the results of the noise modelling (**Table 11.62**), there is no potential for TTS in any marine mammal species as a result of cable laying, as the noise sources associated with both activities do not exceed the relevant TTS thresholds. Therefore, there would be **no risk** of TTS in marine mammals due to cable laying during construction in the offshore development area.

414. There is the potential for TTS to occur in harbour porpoise and both seal species as a result of cable trenching / cutting activities, however, the TTS thresholds are not exceeded for whale or dolphin species.

415. **Table 11.63** provides an assessment of TTS risk for harbour porpoise, grey seal, and harbour seal for cable trenching / cutting. The maximum modelled impacted ranges for TTS for each species have been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted.

416. The magnitude of the potential impact is assessed as negligible for harbour porpoise, grey seal, and harbour seal, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact during cable trenching / cutting activities (**Table 11.63**).

Table 11.63 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS from Other Construction Activities (Cable Trenching / Cutting)

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour porpoise	0.055 km (0.0095 km^2)	0.007	0.0000021% of NS MU	Negligible	Medium	Minor adverse
Grey seal – windfarm site	0.04 km (0.005 km^2)	0.00025	0.0000017% of EaS MU (0.0000012% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Grey seal - cable route	0.04 km (0.005 km^2)	0.0016	0.000011% of EaS MU (0.0000076% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - windfarm site	0.04 km (0.005 km^2)	0.00000001	0.0000000021% of EaS MU (0.00000000051% of EaS & MoF MU)	Negligible	Medium	Minor adverse
Harbour seal - cable route	0.04 km (0.005 km^2)	0.0000075	0.0000016% of EaS MU (0.00000038% of EaS & MoF MU)	Negligible	Medium	Minor adverse

Impact Assessment for the Potential for Disturbance due to Other Construction Activities in the Offshore Development Area

417. The modelled impacted ranges for disturbance for all species (**Table 11.62**) for cable trenching / cutting and cable laying has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.64**).

418. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact, except for bottlenose dolphin, with a magnitude of negligible to low (**Table 11.64**). The effect significance for all species is minor adverse.

Table 11.64 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Disturbance from Cable Trenching / Cutting and Cable Laying based on Underwater Noise Modelling

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (temporary impact)	Sensitivity	Effect significance
Cable Trenching / Cutting						
Harbour porpoise	9.284 km (270.78 km^2)	205.8	0.059% of the NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin		8.1	3.6% of the CES MU; 0.4% of the GNS MU	Low to Negligible	Medium	Minor adverse
White-beaked dolphin		65.8	0.15% of the CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin		7.6	0.042% of the CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin		0.49	0.004% of the CGNS MU	Negligible	Medium	Minor adverse
Minke whale		10.5	0.052% of the CGNS MU	Negligible	Medium	Minor adverse
Humpback whale		0.004	0.000012% of the reference population	Negligible	Medium	Minor adverse
Grey seal – windfarm site		13.3	0.091% of the EaS MU; 0.0625% of the wider reference population	Negligible	Medium	Minor adverse
Grey seal – cable corridor		86.7	0.59% of the EaS MU; 0.41% of the wider reference population	Negligible	Medium	Minor adverse
Harbour seal – windfarm site		0.0005	0.0001% of the EaS MU; 0.00003% of the wider reference population	Negligible	Medium	Minor adverse
Harbour seal – cable corridor		0.41	0.085% of the EaS MU; 0.021% of the wider reference population	Negligible	Medium	Minor adverse
Cable Laying						
Harbour porpoise	5.779 km (104.92 km^2)	79.7	0.023% of the NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin		3.1	1.4% of the CES MU; 0.15% of the GNS MU	Low to Negligible	Medium	Minor adverse
White-beaked dolphin		25.5	0.058% of the CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin		2.9	0.016% of the CGNS MU	Negligible	Medium	Minor adverse

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (temporary impact)	Sensitivity	Effect significance
Risso's dolphin		0.19	0.0015% of the CGNS MU	Negligible	Medium	Minor adverse
Minke whale		4.1	0.02% of the CGNS MU	Negligible	Medium	Minor adverse
Humpback whale		0.0016	0.0000045% of the reference population	Negligible	Medium	Minor adverse
Grey seal – windfarm site		5.1	0.035% of the EaS MU; 0.024% of the wider reference population	Negligible	Medium	Minor adverse
Grey seal – cable corridor		33.6	0.23% of the EaS MU; 0.16% of the wider reference population	Negligible	Medium	Minor adverse
Harbour seal – windfarm site		0.0002	0.000044% of the EaS MU; 0.000011% of the wider reference population	Negligible	Medium	Minor adverse
Harbour seal – cable corridor		0.16	0.033% of the EaS MU; 0.008% of the wider reference population	Negligible	Medium	Minor adverse

Duration of Other Construction Activities and Disturbance of Marine Mammals

419. Offshore construction is anticipated to take approximately 24 months from starting in Q4, 2025 and ending in Q3 2027. However, construction activities and potential disturbance of marine mammals would not be consistent throughout this period.

420. The duration of the export cable installation is estimated to take approximately 31-32 days (31.25 days) between Q1 and Q2 2027 and the array cable installation is estimated to take approximately 33-34 days (33.6 days) between Q1 and Q3 2027. Mooring installation period is anticipated to be between Q4, 2025 and Q3 2027. The duration of the mooring installation within this period will be depended on the type of mooring.

421. Any potential disturbance would be temporary while the work was being undertaken and localised to the area of work and maximum potential impact area around the activity location, therefore any disturbance is unlikely to significantly affect marine mammal populations.

EPS Licence Requirements for Other Construction Activities in the Offshore Development Area

422. Prior to any construction activities taking place, an EPS RA will be conducted to determine if the proposed activities could have the potential risk of disturbance or auditory injury to cetacean species, based on the final project design, including equipment to be used, duration of works and time of year, and any cumulative impacts at the time.

Summary of Effect significance for Other Construction Activities in the Offshore Development Area

423. For PTS in all marine mammal species, there is **no potential for impact**. For TTS in dolphin and whale species, there is also **no potential for impact.** For TTS in harbour porpoise and seal species, the effect significance is **minor (adverse)** (**Table 11.65**).

424. The effect significance for all marine mammal species for disturbance during cable trenching / cutting and cable laying or mooring installation is **minor adverse (not significant)** (**Table 11.65**).

425. There is no requirement for mitigation, and therefore the residual effect significance remains at minor adverse at worst.

Table 11.65 Assessment of Effect significance for PTS, TTS and Disturbance from Underwater Noise during Other Construction Activities in the Offshore Development Area

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
PTS due to other construction activities	All marine mammal species	High	No impact	No effect	None required.	No effect
TTS due to other construction activities	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse		Minor adverse
	Dolphin and whale species	Medium	No impact	No effect		No effect
Disturbance due to other construction activities	Bottlenose dolphin	Medium	Low to Negligible	Minor adverse		Minor adverse
	All other marine mammal species	Medium	Negligible	Minor adverse		Minor adverse

Assessment for the Southern Trench MPA

426. For minke whale, there is no potential risk for PTS or TTS due to construction activities such as cable laying or cutting being undertaken in the Offshore Development Area, as the noise levels associated with these works do not exceed the minke whale (LF cetacean) thresholds (**Table 11.62**). However, there is the potential for minke whale to be disturbed up to 9.284 km due to cabling activities, with up to 10.5 minke whale at risk of disturbance, or up to 0.052% of the reference population (see **Table 11.64**). Only cable trenching / cutting and cable laying in the Landfall Export Cable Corridor Area would be within the Southern Trench MPA.

427. Taking into account the small number of minke whale at risk of disturbance, and that this would be a temporary impact only while the activities are taking place, it is not expected that there would be any potential for impact to the minke whale population in relation to the Southern Trench MPA due to disturbance from other construction activities.

11.7.5.5 Impact C5: Vessels - Underwater Noise and Disturbance from Presence and Movements of Vessels

Underwater Noise Modelling

428. Underwater noise modelling was undertaken for the following vessel types:

- Main installation vessel (e.g. Dynamic Positioning (DP) vessel);
- Anchor handler vessel;
- Survey vessel, crew transfer vessel, and support vessel; and
- Small vessel (e.g. tugs, vessels carrying ROVs and guard vessels).

429. Further information on the modelling undertaken for these noise sources is provided in **Appendix 9.1**.

Results

430. The results of the underwater noise for vessels are provided in **Table 11.66**. All impact ranges are based on the non-impulsive Southall *et al*. (2019) SEL_{cum} thresholds, based on 24 hours of exposure for PTS and TTS, and the NMFS (2005) Level B threshold of 120 dB re 1 µPa (rms) (for continuous noise sources) for all marine mammal species.

431. There is a considerable degree of uncertainty and variability in the modelling for disturbance related impacts, and therefore the disturbance ranges presented below should be seen as over precautionary. In addition, vessel noise would be temporary and would not remain at the same location, and therefore, any underwater noise levels associated with the vessels from the Project, is unlikely to be significantly different to the noise levels of the baseline environment.

Table 11.66 Estimated PTS, TTS, and Disturbance Ranges of Marine Mammals from Vessels [LF = Low Frequency Cetaceans (whale species); HF = High Frequency Cetaceans (dolphin species); VHF = Very High Frequency Species (harbour porpoise); PCW = Phocid Species in Water (seal species)]

Noise source	Range (m) [0 = no exceedance of the threshold]								
	LF		HF		VHF		PCW		All
	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS	Disturbance
Anchor handling vessel	0	0	0	0	0	36	0	40	3,355
Main installation vessel, construction vessel (DP)	0	0	0	0	0	0	0	0	5,779
Survey vessel, crew transfer vessels and support vessels	0	0	0	0	0	55	0	40	9,284
Misc. small vessel (e.g. tugs, vessels carrying ROVs, dive boats, guard vessels and RIBs)	0	0	0	0	0	36	0	40	3,355

Impact Assessment for the Potential for PTS from Vessels in the Offshore Development Area

432. Based on the results of the noise modelling (**Table 11.66**), there is no potential for PTS in any marine mammal species, as the vessel noise does not exceed the relevant PTS thresholds for any species group. Therefore, there would be **no risk** of PTS in marine mammals due to vessels.

Impact Assessment for the Potential for TTS from Vessels in the Offshore Development Area

433. Based on the results of the noise modelling (**Table 11.66**), there is no potential for TTS in whale and dolphin species from vessels, as the noise levels do not exceed the relevant TTS thresholds. Therefore, there would be **no risk** of TTS in whale and dolphin species due to vessels.

434. There is the potential for TTS to occur in harbour porpoise and both seal species due to the presence of anchor handling vessels, support / crew transfer / survey vessels, or due to other small vessels, however, the TTS thresholds are not exceeded for main installation / construction vessel (DP).

435. **Table 11.67** provides an assessment of TTS risk for harbour porpoise, grey seal and harbour seal for survey vessel, crew transfer vessels and support vessels as these vessel types have been modelled with the largest potential impact range for TTS (**Table 11.66**). The maximum modelled impacted ranges for TTS for each species has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted.

436. The magnitude of the potential impact is assessed as negligible for harbour porpoise, grey seal, and harbour seal, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact (**Table 11.67**).

Table 11.67 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS from Vessels during Construction of the Project

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Survey / crew transport / crew support vessels						
Harbour porpoise	0.055 km (0.0095 km^2)	0.007	0.0000021% of the NS MU	Negligible	Medium	Minor adverse
Grey seal – windfarm site	0.04 km (0.005 km^2)	0.00025	0.0000017% of the EaS MU; 0.0000012% of the wider reference population	Negligible	Medium	Minor adverse
Grey seal – cable corridor		0.0016	0.000011% of the EaS MU; 0.00000761% of the wider reference population	Negligible	Medium	Minor adverse

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (permanent impact)	Sensitivity	Effect significance
Harbour seal – windfarm site		0.00000001	0.0000000021% of the EaS MU; 0.00000000051% of the wider reference population	Negligible	Medium	Minor adverse
Harbour seal – cable corridor		0.0000075	0.0000016% of the EaS MU; 0.00000038% of the wider reference population	Negligible	Medium	Minor adverse

Impact Assessment for the Potential for Disturbance from Vessels in the Offshore Development Area

437. The modelled impact ranges for disturbance of marine mammal species has been assessed based on the modelled impact range for survey vessel, crew transfer vessels and support vessels as these vessel types have the largest potential impact range. The maximum potential disturbance range has been used to estimate the maximum number of individuals and percentage of the relevant reference population that could be impacted (**Table 11.68**).

438. The magnitude of the potential impact is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact, except for bottlenose dolphin, with a magnitude of negligible to low (**Table 11.68**). The effect significance for all species is minor adverse.

439. The maximum number of construction vessels on site at any one time could be up to 16 in total. These vessels would be located in the Offshore Development Area (116.65 km^2). Therefore, the disturbance area of 270.78 km^2 (**Table 11.68**) is considered worst case for all vessels on site at the same time.

440. The area of potential disturbance for vessels (**Table 11.68**) is the same the potential disturbance for construction activities, such as cable and mooring installation (**Table 11.64**). Therefore, during these construction activities, disturbance from vessels would not be additive as they have the same footprint / area of disturbance.

441. Studies in the Moray Firth indicate that at a mean distance 2 km from construction vessels harbour porpoise occurrence decreased by up to 35.2% as vessel intensity increased. Harbour porpoise responses decreased with increasing distance to vessels, out to 4 km where no response was observed (Benhemma-Le Gall *et al.*, 2021). Therefore, the modelled disturbance range of up to 9.284 km is considered very precautionary.

442. The distance at which animals may react to vessels is difficult to predict and behavioural responses can vary a great deal depending on species, location, type and size of vessel, vessel speed, noise levels and frequency, ambient noise levels and environmental conditions.

443. Modelling by Heinänen and Skov (2015) indicates that the number of ships represents a relatively important factor determining the density of harbour porpoise in the North Sea MU, with markedly lower densities with increasing levels of traffic. A threshold level in terms of impact seems to be approximately 20,000 ships per year (approximately 80 vessels per day within a 5 km^2 area).

444. Taking into account the maximum number of vessels (up to 16) that could be in the Offshore Development Area (116.65 km^2) during construction and the displacement of other vessels from the area, the number of vessels would be approximately 0.14 vessels per km^2 (less than one (0.7) vessels per 5 km^2). This would not exceed the Heinänen and Skov (2015) threshold level of 80 vessels per day in a 5 km^2 area for harbour porpoise.

445. Studies on bottlenose dolphin found that boat physical presence, and not just noise, can result in disturbance (Pirotta *et al.*, 2015). However, disturbance and any reduction in foraging activity was

short-term. The boat effect did not persist following boat passage and was limited to the time when the boat was physically present (Pirotta *et al*., 2015).

446. Jones *et al*. (2017) produced usage maps characterising densities of grey and harbour seals and ships around the British Isles, which were used to produce risk maps of seal co-occurrence with shipping traffic. The analysis indicates that rates of co-occurrence were highest within 50 km of the coast, close to seal haul-outs. When considering exposure to shipping traffic in isolation, the study found no evidence relating to declining seal population trajectories with high levels of co-occurrence between seals and vessels. For example, in areas where the harbour seal population was increasing there were high intensities of vessels (Duck and Morris, 2016; Jones *et al*., 2017).

447. The number of vessel trips to Peterhead port is estimated to be up to 227 during the three construction period. This equates to an average of approximately 6-7 trips per month, resulting in a daily average of approximately 0.25 vessel movements. Peterhead is located approximately 53.7 km (29 nm) to the southwest of the Windfarm Site and between the two landfall options of the Offshore Export Cable Corridor.

448. As outlined in **Chapter 14: Shipping and Navigation**, the area around the Windfarm Site already has a high number of vessel movements, with an average of 22 vessels per day during summer (August 2021) and average of 14 vessel per day during winter (January 2022). Therefore, the vessel movements during the construction period would not significantly increase the number of vessels already moving in the area. As such vessel movements during the construction period would not result an in increased disturbance of marine mammals.

449. If the behavioural response is displacement from the area, it is predicted that marine mammals will return once the vessel has left the area and therefore any disturbance from construction vessels will be both localised and temporary.

Table 11.68 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of Disturbance from Vessels

Species	Maximum impact range (km) and area (km^2)	Maximum number of individuals	% of reference population	Magnitude (temporary impact)	Sensitivity	Effect significance
Survey / crew transport / crew support vessels						
Harbour porpoise	9.284 km (270.78 km^2)	205.8	0.059% of the NS MU	Negligible	Medium	Minor adverse
Bottlenose dolphin		8.1	3.6% of the CES MU; 0.4% of the GNS MU	Low to Negligible	Medium	Minor adverse
White-beaked dolphin		65.8	0.15% of the CGNS MU	Negligible	Medium	Minor adverse
Atlantic white-sided dolphin		7.6	0.042% of the CGNS MU	Negligible	Medium	Minor adverse
Risso's dolphin		0.49	0.004% of the CGNS MU	Negligible	Medium	Minor adverse
Minke whale		10.5	0.052% of the CGNS MU	Negligible	Medium	Minor adverse
Humpback whale		0.0041	0.000012% of the reference population	Negligible	Medium	Minor adverse
Grey seal – windfarm site		13.3	0.091% of the EaS MU; 0.0626% of the wider reference population	Negligible	Medium	Minor adverse
Grey seal – cable corridor		86.7	0.59% of the EaS MU; 0.41% of the wider reference population	Negligible	Medium	Minor adverse
Harbour seal – windfarm site		0.00054	0.00011% of the EaS MU; 0.000027% of the wider reference population	Negligible	Medium	Minor adverse

Species	Maximum impact range (km) and area (km²)	Maximum number of individuals	% of reference population	Magnitude (temporary impact)	Sensitivity	Effect significance
Harbour seal – cable corridor		0.41	0.085% of the EaS MU; 0.021% of the wider reference population	Negligible	Medium	Minor adverse

Duration of Construction Vessels and Disturbance of Marine Mammals

450. As outlined above, offshore construction is anticipated to take approximately 24 months. However, construction vessels and potential disturbance of marine mammals would not be consistent throughout this period. Most construction vessels would be in the Offshore Development Area prior and during construction activities, such as turbine installation, cable installation and installation of OSP.

451. Any potential disturbance would be temporary while the vessels are in the Offshore Development Area and the work was being undertaken, localised to the area of work and maximum potential impact area around the vessel / activity location, therefore any disturbance is unlikely to significantly affect marine mammal populations.

EPS Licence Requirements from Vessels in the Offshore Development Area

452. Prior to any construction activities taking place, an EPS RA will be conducted to determine if the proposed activities could have the potential risk of disturbance or auditory injury to cetacean species, based on the final project design, including vessels to be used, duration of works and time of year, and any cumulative impacts at the time.

Summary of Effect significance for Vessels in the Offshore Development Area

453. For PTS from vessels in all species, there is **no potential risk**. For TTS in dolphin and whale species, there is also **no potential risk**. For TTS in harbour porpoise and seal species, the effect significance is **minor (adverse)** (**Table 11.69**).

454. The effect significance for all marine mammal species for disturbance from vessels is minor adverse (not significant) (Table 11.69).

455. There is no requirement for mitigation, and therefore the residual effect significance remains at minor adverse at worse.

Table 11.69 Assessment of Effect significance for PTS, TTS and Disturbance from Vessels during Construction of the Project

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
PTS due to construction vessels	All marine mammal species	High	No impact	No effect	None required.	No effect
TTS due to construction vessels	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse		Minor adverse
	Dolphin and whale species	Medium	No impact	No effect		No effect
Disturbance due to construction vessels	Bottlenose dolphin	Medium	Low to Negligible	Minor adverse		Minor adverse
	All other marine mammal species	Medium	Negligible	Minor adverse		Minor adverse

Assessment for the Southern Trench MPA

456. For minke whale, there is no potential for PTS or TTS due underwater noise from vessels during construction, as the noise levels do not breach the minke whale thresholds (**Table 11.66**). However, there is the potential for minke whale to be disturbed up to 9.284 km due to vessel presence, with up to 10.5 minke whale at risk of disturbance, or up to 0.052% of the reference population (see **Table 11.68**). Only vessels in the Landfall Export Cable Corridor Area would be within the Southern Trench MPA.

457. Taking into account the small number of minke whale at risk of disturbance, and that this would be a temporary impact only while the vessels are in transit, it is not expected that there would be any potential for impact to the minke whale population in relation to the Southern Trench MPA due to disturbance from vessels.

11.7.5.6 Impact C6: Vessel Interaction – Increased Collision Risk with Vessels

458. During the offshore construction phase of the Project, there will be an increase in vessel traffic within the Windfarm Site and both Export Cable Corridors. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area.

Sensitivity of Marine Mammals to an Increase in Vessel Collision Risk

459. Marine mammals in and around the Offshore Development Area and in the wider North Sea area would typically be habituated to the presence of vessels (given the existing levels of marine traffic, see **Chapter 14: Shipping and Navigation**) and would be able to detect and avoid vessels. However, as a precautionary approach the sensitivity of marine mammals to collision risk with vessels during construction is considered to be high. As if an individual receptor collides with a vessel there is the potential for a very limited capacity to recover from the worst case impact (**Table 11.3**), although they have the potential to avoid.

460. Marine mammals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al.,* 2007). Therefore, increased vessel movements, especially those outwith recognised vessel routes, can pose an increased risk of vessel collision to marine mammals.

461. Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80 m in length causing the most damage to marine mammals (Laist *et al.,* 2001). Vessels travelling at high speeds are considered to be more likely to collide with marine mammals, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al.,* 2001).

462. Harbour porpoise are small and highly mobile, and, given their responses to vessel noise (e.g. Thomsen *et al.,* 2006; Polacheck and Thorpe, 1990), are expected to largely avoid vessel collisions. The Heinänen and Skov (2015) report indicates a negative relationship between the number of ships and the distribution of harbour porpoise in the North Sea, suggesting that the species could exhibit avoidance behaviour which reduces the risk of strikes.

463. Both the Scottish Marine Animal Stranding Scheme (SMASS) and Cetacean Strandings Investigation Programme (CSIP) record strandings of marine mammals and undertake investigations to determine causes of fatalities wherever possible. SMASS record and investigate all marine mammal strandings reported to them in Scotland, and the CSIP record and investigate all recorded strandings of cetacean species in the UK. **Table 11.70** summarises the data for the relevant species, for the most recent available data from both schemes, and details the number of deaths caused by either vessel strike, or physical trauma with an unknown cause (which could be attributed to vessel strike).

Magnitude of impact for an Increase in Vessel Collision Risk

464. The approximate number of vessels on site at any one time during construction is estimated to be 16 vessels in the Offshore Development Area. There will be an average of approximately 76 trips per year (or up to seven per month), resulting in a daily average of approximately 0.25 vessel movements, based on 227 vessel trips over three year construction period (**Table 11.14**). The number of annual vessel transits to and from the Windfarm Site during construction is an estimated 151 (based on 454 total vessel transits over the three year construction period).

465. To estimate the potential collision risk of those vessels associated during construction, the potential risk rate per vessel has been calculated for all relevant species (**Table 11.70**), which is then used to calculate the total risk to marine mammal species due to the presence of an additional 16 construction vessels (**Table 11.71**). To inform this assessment, the total number of each marine mammal species in UK waters has been compared against the total vessels presence in UK waters, as well as the potential collision risk rate of each species based on the SMASS and CSIP data. The total UK populations are taken from IAMMWG (2022) for all cetacean species (with the exception of humpback whale, as a UK estimate is not available for that species), and the total UK populations for seal species are taken from SCOS (2021). The total presence of vessels in UK waters is taken from the total vessel transits within the 2015 Automatic Identification System (AIS) data, which is the latest publicly available[5].

466. The number of marine mammals at risk of collision, per vessel, in UK waters has been calculated and has been used to calculate the number of each marine mammal species at risk of collision from the 16 construction vessels on site at any one time. For all species, there is less than 0.001% at risk of the permanent impact, and therefore a negligible magnitude of impact, with the exception of bottlenose dolphin from the CES MU and harbour seal, which could have a low magnitude of impact (**Table 11.71**).

Table 11.70 Summary of UK Cetacean Strandings and Causes of Death from Physical Trauma of Unknown Cause and Physical Trauma Following Probable Impact from a Vessel

Species	Number of strandings (SMASS 2009 – 2020[6] & CSIP 2003 – 2015[7])	Number of necropsies where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from a ship or boat	Collision risk rate (number attributed to vessels strike / other physical trauma as proportion of total number necropsied)[8]
Harbour porpoise	SMASS = 1,198 CSIP = 3,598 **Total = 4,796**	SMASS = 350 CSIP = 815 **Total = 1,165**	SMASS = 4 CSIP = 45 **Total = 49**	SMASS = 2 CSIP = 17 **Total = 19**	0.0584 at risk of collision
Bottlenose dolphin	SMASS = 38 CSIP = 102 **Total = 140**	SMASS = 13 CSIP = 27 **Total = 10**	SMASS = 0 CSIP = 1 **Total = 1**	SMASS = 0 CSIP = 0 **Total = 0**	0.0250 at risk of collision
White-beaked dolphin	SMASS = 111 CSIP = 149 **Total = 260**	SMASS = 43 CSIP = 52 **Total = 95**	SMASS = 1 CSIP = 2 **Total = 3**	SMASS = 0 CSIP = 0 **Total = 0**	0.0316 at risk of collision
Atlantic white-sided dolphin	SMASS = 36 CSIP = 105 **Total = 141**	SMASS = 8 CSIP = 37 **Total = 45**	SMASS = 1 CSIP = 0 **Total = 1**	SMASS = 0 CSIP = 0 **Total = 0**	0.0222 at risk of collision
Risso's dolphin	SMASS = 59 CSIP = 77 **Total = 136**	SMASS = 9 CSIP = 15 **Total = 582**	SMASS = 0 CSIP = 0 **Total = 0**	SMASS = 0 CSIP = 1 **Total = 1**	0.0417 at risk of collision
All dolphin species	*SMASS = 797* *CSIP = 1,797* ***Total = 2,594***	*SMASS = 226* *CSIP = 356* ***Total = 582***	*SMASS = 3* *CSIP = 9* ***Total = 12***	*SMASS = 0* *CSIP = 6* ***Total = 6***	*0.0309 at risk of collision*

[5] https://www.data.gov.uk/dataset/963c1a7b-5b72-4cce-93f5-3f1e223fd575/anonymised-ais-derived-track-lines-2015
[6] *SMASS (2009); SMASS (2010); SMASS (2011); SMASS (2012); SMASS (2013); SMASS (2014); SMASS (2015); SMASS (2016); SMASS (2017); SMASS (2018); SMASS (2019); SMASS (2020) [available from: https://strandings.org/publications/]*
[7] *CSIP (2004); CSIP (2005); CSIP (2006); CSIP (2011); CSIP (2016) [available from: https://ukstrandings.org/csip-reports/]*
[8] *Where species specific data is not available, the species group data is used*

Species	Number of strandings (SMASS 2009 – 2020[6] & CSIP 2003 – 2015[7])	Number of necropsies where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from a ship or boat	Collision risk rate (number attributed to vessels strike / other physical trauma as proportion of total number necropsied)[8]
Minke whale	SMASS = 137 CSIP = 162 **Total = 299**	SMASS = 45 CSIP = 25 **Total = 70**	SMASS = 0 CSIP = 0 **Total = 0**	SMASS = 2 CSIP = 2 **Total = 4**	0.0571 at risk of collision
Humpback whale	SMASS = 10 CSIP = 13 **Total = 23**	SMASS = 6 CSIP = 3 **Total = 9**	SMASS = 0 CSIP = 0 **Total = 0**	SMASS = 0 CSIP = 0 **Total = 0**	0 at risk of collision
All large whale species	*SMASS = 225* *CSIP = 233* ***Total = 458***	*SMASS = 69* *CSIP = 30* ***Total = 99***	*SMASS = 0* *CSIP = 0* ***Total = 0***	*SMASS = 1* *CSIP = 3* ***Total = 4***	*0.0404 at risk of collision*
Grey seal	SMASS = 1,909	SMASS = 470	SMASS = 0	SMASS = 4	0.0085 at risk of collision
Harbour seal	SMASS = 624	SMASS = 180	SMASS = 5	SMASS = 0	0.0278 at risk of collision
All seal species	*SMASS = 3,869*	*SMASS = 791*	*SMASS = 13*	*SMASS = 4*	*0.0215 at risk of collision*

Table 11.71 Predicted Number of Marine Mammals at Risk of Collision with Construction Vessels, based on Current UK Collision Rates and Vessel Presence

Species	Collision risk rate (number attributed to vessels strike / other physical trauma as proportion of total number necropsied)[9]	Estimated total number of individuals in UK waters[10]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[11]	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Additional marine mammals at risk due to increase in vessel number (collision rate * proportion vessel increase)	Magnitude of impact
Harbour porpoise	0.0584 at risk of collision	200,714	11,715 harbour porpoise at risk within UK waters	3,852,030	0.00304 harbour porpoise at risk per vessel within UK waters	151	0.4592 harbour porpoise (0.00013% of NS MU) estimated to be at risk for all Project construction vessels	Negligible
Bottlenose dolphin	0.0250 at risk of collision	7,545	189 bottlenose dolphin within UK waters	3,852,030	0.00005 bottlenose dolphin at risk per vessel within UK waters	151	0.0074 bottlenose dolphin (0.0033% of CES MU; 0.00037% of GNS MU) estimated to be at risk for all Project construction vessels	Low to Negligible
White-beaked dolphin	0.0316 at risk of collision	34,025	1,074.5 white-beaked dolphin at risk within UK waters	3,852,030	0.00028 white-beaked dolphin at risk per vessel within UK waters	151	0.0421 white-beaked dolphin (0.000096% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible
Atlantic white-sided dolphin	0.0222 at risk of collision	12,293	273 Atlantic white-sided dolphin at risk within UK waters	3,852,030	0.00007 Atlantic white- sided dolphin at risk per vessel within UK waters	151	0.0107 Atlantic white-sided dolphin (0.000059% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible
Risso's dolphin	0.0417 at risk of collision	8,687	362 Risso's dolphin at risk within UK waters	3,852,030	0.00009 Risso's dolphin at risk per vessel within UK waters	151	0.0142 Risso's dolphin (0.00012% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible
Minke whale	0.0571 at risk of collision	10,288	588 minke whale at risk within UK waters	3,852,030	0.00015 minke whale at risk per vessel within UK waters	151	0.023 minke whale (0.00012% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible

[9] *Where species specific data is not available, the species group data is used*
[10] *Based on the IAMMWG (2022) UK population estimates for cetacean species, SCOS (2021) UK population estimates for seal species*
[11] *Latest publicly available data*

Species	Collision risk rate (number attributed to vessels strike / other physical trauma as proportion of total number necropsied)[9]	Estimated total number of individuals in UK waters[10]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[11]	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Additional marine mammals at risk due to increase in vessel number (collision rate * proportion vessel increase)	Magnitude of impact
Humpback whale	0.0404 at risk of collision (based on large whale risk)	35,000	1,414 humpback / large whale at risk within UK waters	3,852,030	0.00037 humpback whale at risk per vessel within UK waters	151	0.0554 humpback whale (0.00016% of reference population) estimated to be at risk for all Project construction vessels	Negligible
Grey seal	0.0085 at risk of collision	157,300	1,339 grey seal at risk within UK waters	3,852,030	0.00035 grey seal at risk per vessel within UK waters	151	0.0525 grey seal (0.00006% of reference population; 0.00036% of EaS MU) estimated to be at risk for all Project construction vessels	Negligible
Harbour seal	0.0278 at risk of collision	43,750	1,215 harbour seal at risk within UK waters	3,852,030	0.00032 harbour seal at risk per vessel within UK waters	151	0.0476 harbour seal (0.0024% of reference population; 0.010% of EaS) estimated to be at risk for all Project construction vessels	Low

Effect significance of Increased Collision Risk with Vessels

467. Taking into account the high marine mammal sensitivity and the potential negligible magnitude of the impact, as assessed in **Table 11.71**, the effect significance for any potential increased collision risk as a result of construction vessels has been assessed as minor adverse (not significant) for all marine mammal species. With the exception of bottlenose dolphin from the CES MU and harbour seal which could have a moderate adverse effect, without Best Practice Measures (**Table 11.72**).

468. The residual effect, taking into account best practice to reduce any risk of collisions with marine mammals, would be **minor adverse (not significant)** or **Negligible** in the Offshore Development Area. There have been no known reported incidents of marine mammal collisions with offshore wind farm vessels.

Table 11.72 Effect significance for Risk of Vessel Collision to Marine Mammals due to Construction Vessels in the Offshore Development Area

Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Increased collision risk from construction vessels	Harbour porpoise	High	Negligible	Minor adverse	**Best Practice Measures in CEMP (see below).**	Minor adverse
	Bottlenose dolphin		Low to Negligible	**Moderate to Minor adverse**		Minor adverse
	White-beaked dolphin		Negligible	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Negligible	Minor adverse		Minor adverse
	Risso's dolphin		Negligible	Minor adverse		Minor adverse
	Minke whale		Negligible	Minor adverse		Minor adverse
	Humpback whale		Negligible	Minor adverse		Minor adverse
	Grey seal		Negligible	Minor adverse		Minor adverse
	Harbour seal		Low	**Moderate adverse**		Minor adverse

Best Practice Measures

469. Vessel movements, where possible, will be incorporated into recognised vessel routes, and therefore to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk. Additionally, all vessel operators will use good practice to reduce any risk of collisions with marine mammals, this includes following the Scottish Marine Wildlife Watching Code (Scottish Natural Heritage, 2017), where appropriate, during all construction activities, including while transiting to and from site. This will be detailed within the CEMP.

Assessment for the Southern Trench MPA

470. The Conservation Advice for the Southern Trench MPA (NatureScot, 2020) notes that minke whale are sensitive to collision. As noted above, out of 299 stranded minke whale around the UK from 2003 to 2020, 70 were investigated through necropsies, and four were fatally injured through vessel collision (a collision rate of 0.0571 when taking into account minke whale necropsies). This was one of the highest of all the species summarised in **Table 11.70**, suggesting that minke whale could be at increased collision risk compared to other marine mammal species.

471. The Conservation Advice for the Southern Trench MPA, to reduce or limit the potential for collision, is to follow the Scottish Marine Wildlife Watching Code. As noted above and in **Table 11.72**, this best practice has been applied as a form of mitigation, and all vessels associated with the construction of the Project will follow the code.

472. Less than one minke whale (0.023; **Table 11.71**) could be at risk of collision with construction vessels, and, when taken into consideration with the best practice measures as outlined above, it is not

expected that there would be any potential for impact to the minke whale population of the Southern Trench MPA. Only vessels in the Landfall Export Cable Corridor Area would be within the Southern Trench MPA.

11.7.5.7 Impact C7: Barrier Effects as a Result of Underwater Noise

473. Underwater noise during construction could have the potential to create a barrier effect, preventing movement or migration of marine mammals between important feeding and / or breeding areas, or potentially increasing swimming distances if marine mammals avoid the area and go around it.

474. Bottlenose dolphin are known to travel down the east Scotland coast, with individuals from the Moray Firth population being frequently reported along the coast between Montrose and Aberdeen, and as far south as Berwickshire (Arso Civil *et al*., 2021). Where bottlenose dolphin are seen along the east coast, the majority are within 2 km of the coastline, and in waters that are less than 30 m deep (Quick *et al.,* 2014). It has been estimated that more than 60% of the Moray Firth bottlenose dolphin population use the area between Aberdeen and the Firth of Forth (Quick *et al.,* 2014). Therefore, there is likely to be bottlenose dolphin transiting past the landfall area options, and through the Landfall Export Cable Corridor. Bottlenose dolphin are present in the area year-round, with May to September being important periods for breeding and calving (Arso Civil *et al*., 2021).

475. Telemetry studies for grey seal show usage of the Offshore Development Area (**Figure 11.15**), with relatively high densities close to the coastline (**Figure 11.16**). For harbour seal, the telemetry studies show no presence within the Offshore Development Area (**Figure 11.15**), or along the nearby coastline, and there is relatively low densities of harbour seal present in the area (**Figure 11.16;** Carter *et al.,* 2020).

476. In 2012, 25 harbour seal from The Wash were tagged, as well as a further 10 from the Thames (Russell, 2016). Of those, 24 of the tags were in place for sufficient time to allow for activity budget analysis, in order to determine key foraging areas of harbour seal in the southern North Sea. The results of this study show foraging activity of harbour seal off the coast off Norfolk, and at offshore wind farms (**Figure 11.20**; Russell, 2016). The results of this tagging study show foraging activity (in red) within a number of offshore wind farm sites, including Sheringham Shoal, Dudgeon, with a relatively lower level of activity at Hornsea Projects One, Two, and Four, as well as Dogger Bank A. While the majority of these wind farm projects at the time of tagging had not commenced (in 2012), Sheringham Shoal was undergoing construction, with turbine installation undertaken from 2011 to 2012, and cabling works from 2010 to 2012. This indicates that harbour seal will still undertake foraging activity during wind farm construction activities.

477. The Windfarm Site is located 80 km from the coast. The nearest major (and protected) haul-out sites are located approximately 19 km (at the Ythan River mouth) and approximately 116 km (at Findhorn) from the landfall location, for grey seal and harbour seal, respectively.

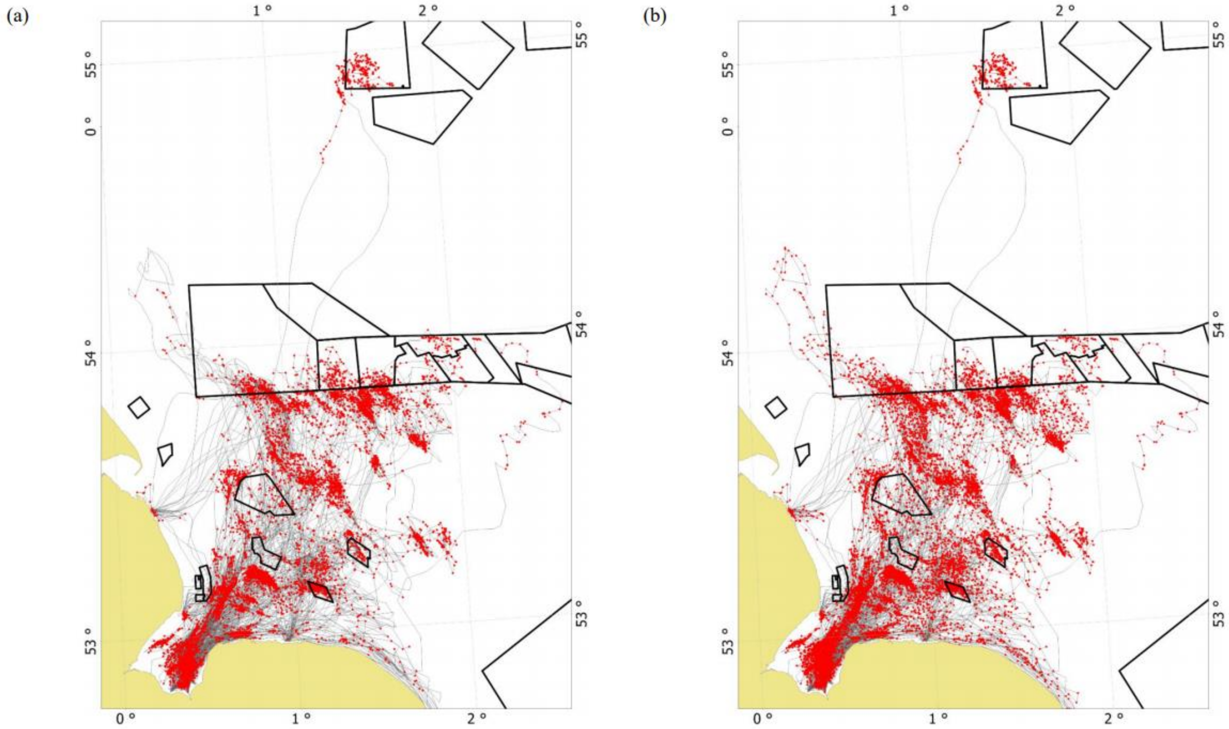

Figure 11.20 The tracks (grey) and estimated foraging locations (red) of tagged harbour seals in geo- (a) and hydro- (b) space (Russell, 2016).

Duration of Barrier Effects from Underwater Noise during Construction

478. Offshore construction is anticipated to take approximately 24 months. However, any barrier effects as a result of underwater noise would not be consistent throughout this period.

479. Piling for the OSP is anticipated to occur in Q1, Q2 2027. The maximum duration of piling at the Windfarm Site, based on worst case scenarios (**Table 11.14**), including soft-start, ramp-up and ADD activation would be:

- Piling of four foundations (including soft-start, ramp-up and ADD activation) = 18.6 hours based on average piling time of 4 hours and 39 minutes per pile (or 0.78 days), including 15 minute ADD activation; or
- Piling of four foundations (including soft-start, ramp-up and ADD activation) = 41 hours based on maximum piling time of 10 hours per pile (or 1.71 days), including 15 minute ADD activation.

480. The duration of the export cable installation is estimated to take approximately 31-32 days (31.25 days) between Q1 and Q2 2027 and the array cable installation is estimated to take approximately 33-34 days (33.6 days) between Q1 and Q3 2027. Mooring installation period is anticipated to be between Q5 2025 and Q3 2027. The duration of the mooring installation within this period will be depended on the type of mooring. Most construction vessels would be associated with construction activities, such as turbine installation, cable installation and installation of OSP.

481. There is the potential, as a worst case, for mooring installation, export cable installation, array cable installation and piling for the OSP to occur at the same time. However, the maximum duration for this worst case scenario would be the maximum duration for the pile installation and ADD activation of up to 41 hours, as outlined above. If mooring installation, export cable installation and array cable installation were to occur at the same time, the maximum duration would be up to 34 days.

482. Any potential barrier effects would be temporary while the work was being undertaken, therefore the duration of any potential barrier effects is unlikely to significantly affect marine mammal populations.

Impact Assessment for Barrier Effects due to Underwater Noise

483. The maximum area for any potential barrier effects during the worst case, for mooring installation, export cable installation, array cable installation and piling for the OSP to occur at the same time, would be the maximum impact disturbance range for piling (3.5 km; **Table 11.55**), plus maximum disturbance range around vessels, mooring installation, export cable installation and array cable installation locations (9.284 km^2; **Table 11.64**).

484. Taking into account the disturbance impact ranges for cable installation and vessels in the Export Cable Corridor, and mooring installation, array cable installation and piling for the OSP in the Windfarm Site, there would be no potential for any barrier effects between the Windfarm Site and the coast (80 km) as a result of underwater noise during construction.

485. It is anticipated that marine mammals will return once the activity has been completed and therefore any potential barrier effects from underwater noise as a result of construction activities will be both localised and temporary. Therefore, there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of marine mammals.

486. Bottlenose dolphin are known to transit along the coastline, and past both the Landfall Export Cable Corridor and landfall location, the impacts close to shore (within 2 km) would be minor and temporary, and unlikely to cause any significant barrier to movement along the coastline. However, to ensure that bottlenose dolphin maintain the ability to transit along the coastline, given their preference for remaining within close proximity to the coastline, the Scottish Marine Wildlife Watching Code[12], where applicable, would be followed at all times when working within 3 km of the coastline. This will be detailed within the CEMP.

487. There is unlikely to be any significant long-term impacts from any barrier effects, as any areas affected would be relatively small in comparison to the range of marine mammals and would not be continuous throughout the offshore construction period. The magnitude of impact for any potential temporary barrier effects, based on worst case, is assessed as negligible for harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11.73**).

488. Taking into account the medium marine mammal sensitivity and the potential magnitude of the impact, the effect significance for any potential barrier effects in the Offshore Development Area as a result of underwater noise during construction has been assessed as **minor adverse (not significant**) for all marine mammal species (**Table 11.73**).

Table 11.73 Assessment of Effect significance for Any Potential Barrier Effects from Underwater Noise during Construction of the Project

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Barrier effect due to underwater noise during construction	Harbour porpoise	Medium	Negligible	Minor adverse	None required. However, the Scottish Marine Wildlife Watching Code, where applicable, would be followed within 3 km of the coastline.	Minor adverse
	Bottlenose dolphin	Medium	Negligible	Minor adverse		Minor adverse
	White-beaked dolphin	Medium	Negligible	Minor adverse		Minor adverse
	Atlantic white-sided dolphin	Medium	Negligible	Minor adverse		Minor adverse
	Risso's dolphin	Medium	Negligible	Minor adverse		Minor adverse
	Minke whale	Medium	Negligible	Minor adverse		Minor adverse
	Humpback whale	Medium	Negligible	Minor adverse		Minor adverse

[12] *https://www.nature.scot/doc/scottish-marine-wildlife-watching-code-smwwc*

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
	Grey seal	Medium	Negligible	Minor adverse		Minor adverse
	Harbour seal	Medium	Negligible	Minor adverse		Minor adverse

Assessment for the Southern Trench MPA

489. The potential for any barrier effects from underwater noise during the construction to minke whale within the Southern Trench MPA would be due to UXO clearance and cable installation in the Landfall Export Cable Corridor. Neither of these activities would be constant, with significant periods of no noise occurring between activities taking place. There is unlikely to be any significant long-term barrier effect during construction, as any areas impacted would be small in comparison to the range of minke whale and would be intermittent. Therefore, is not expected that there would be any potential barrier effects to impact the minke whale population in relation to the Southern Trench MPA due to underwater noise during construction.

11.7.5.8 Impact C8: Changes to Prey Resources

490. As outlined in **Chapter 10: Fish and Shellfish Ecology**, the potential impacts on fish species during construction can result from:

- Physical seabed disturbance
- Increased SSCs and sediment re-deposition
- Re-mobilisation of contaminated sediments and sediment redistribution
- Underwater noise and vibration

491. Any impacts on prey species have the potential to affect marine mammals.

Sensitivity of Marine Mammals to Changes in Prey Resource

492. The diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Analysis of 188 stranded harbour porpoise around Scotland (from 1992 to 2003) showed that whiting *Merlangius merlangus* and sandeels are the main prey species, accounting for 80% of their diet (Santos *et al.,* 2004). Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the environmental conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.*, 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

493. Bottlenose dolphin and white-beaked dolphin are opportunistic feeders with a broad diet, feeding on a wide range of prey species. Analysis of stranded bottlenose dolphin around Scotland found that gadoid species are the main prey species (Santos *et al.,* 2001).

494. White-beaked dolphin prey upon similar species, with gadoids, sandeels, herring *Clupea harengus* and octopus forming part of their diet. On the east coast of Scotland, haddock *Melanogrammus aeglefinus* and whiting were the key prey species (Canning *et al.,* 2008).

495. The diet of Atlantic white-sided dolphin in the UK is not currently understood, however, in other parts of the Atlantic, the species has been reported to prey upon herring, mackerel *Scomber scombrus*, horse mackerel *Trachurus trachurus*, silvery pout *Gadiculus argenteus* and squid (Reeves *et al.,* 1999).

496. Risso's dolphin prey mainly upon cephalopods, with stomach content analysis of individuals stranded in Scotland (from 1992 to 2004) indicating that cephalopods make up 98% of Risso's dolphin total prey (by both weight and number) (MacLeod *et al*., 2014).

497. Dolphin species are considered to have large foraging ranges, and a broad range of prey species, and are therefore considered to have low sensitivity to changes in prey resources.

498. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level. In Scotland, minke whale were found to prey upon mainly sandeels, with sprat *Sprattus sprattus*, herring, mackerel, and Norway pout *Trisopterus esmarkii* making up a small proportion of prey species (Pierce *et al.,* 2004).

499. Humpback whale are baleen whales and are therefore filter feeders; they prey upon plankton and small schooling fish. In the Celtic Sea, juvenile sprat and herring formed a large proportion of humpback whale diet, with older sprat (1 to 2 years) and herring (2 to 4 years) also making up part of their diet (Ryan *et al*., 2014).

500. Therefore, minke whale and humpback whale are considered to have a low to medium sensitivity to changes in prey resource.

501. Grey and harbour seal feed on a variety of prey species, both are considered to be opportunistic feeders, feeding on a wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges. Grey seal are often found offshore in gravel or sandy areas, which are ideal habitats for sandeels, a key prey species (McConnell *et al.,* 1999). As well as sandeels, grey seal prey upon gadids (e.g. cod *Gadus morhua*), saithe *Pollachius virens*, and ling *Molva molva* (Hammond and Wilson, 2016). Harbour seal are also generalist feeders, and their prey species include sandeels, gadoids, herring, sprat, and flatfish, octopus and squid (DECC, 2016).

502. Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

Magnitude of Potential Changes in Prey Resources

Physical Seabed Disturbance

503. During construction, the maximum total area of seabed habitat that could be disturbed is 4.55 km^2. As outlined in **Table 11.14**, this area includes worst case for total substructure moorings (based on catenary system), disturbance of seabed from inter-array and export cable installation, rock protection for non-buried cables and any crossings of inter-array and export cables, and OSP foundations (based on worst case for suction bucket foundation including scour protection). The total area of seabed disturbance (4.55 km^2) represents 3.9% of the total Offshore Development Area (116.65 km^2).

504. The magnitude of impact of physical disturbance to seabed habitat during construction has been assessed as low in **Chapter 9: Benthic Ecology**. In **Chapter 10: Fish and Shellfish Ecology**, the magnitude is considered to be negligible for all species (apart from molluscs which has a magnitude of negligible / minor), due to species being able to use similar, adjacent habitats and there not being a major effect at a population level.

505. Therefore, the magnitude of any potential changes to prey resources as a result of physical seabed disturbance is assessed as low for marine mammals.

Increased Suspended Sediment Concentrations (SSCs) and Sediment Re-Deposition

506. Construction activities such as seabed preparation, OSP foundation installation, mooring system installation and cable installation may lead to the potential for increased SSC in the water column and subsequent sediment re-deposition. Activities such as seabed disturbances from placement of cable protection are not expected to increase the SSCs to the extent to which it would cause an impact to benthic or fish receptors.

507. Increases in suspended sediment are expected to cause localised and short-term increases in SSC at the point of discharge. Released sediment may then be transported by tidal currents in suspension in the water column. Due to the small quantities of fine-sediment released, the fine-sediment is likely to be widely and rapidly dispersed. This would result in only low SSCs and low changes in seabed level when the sediments are deposited. In **Chapter 9: Benthic Ecology**, the impact magnitude is

considered to be low. The magnitude of impact in **Chapter 10: Fish and Shellfish Ecology** is assessed as negligible to no impact for all species. The effect significance for fish species is assessed as minor adverse to no impact.

508. Therefore, any potential changes to prey resources as a result of increased SSCs and sediment deposition is assessed as negligible for marine mammals.

Re-mobilisation of Contaminated Sediments and Sediment Redistribution

509. The data and analysis in **Chapter 8: Marine Sediment and Water Quality** indicates that levels of contaminants are very low and do not contain elevated levels to cause concern, therefore the magnitude of the effect is negligible.

510. Therefore, any potential changes to prey resource as a result of re-mobilisation of contaminated sediments is assessed as being of negligible significance for marine mammals.

Underwater Noise and Vibration

511. High levels of underwater noise can cause physiological (mortality, permanent injury or temporary injury), behavioural (startled movements, swimming away from noise source, change migratory patterns or cease reproductive activities) and environmental (changes to prey species or feeding behaviours) impacts on fish species.

512. Potential sources of underwater noise during construction include UXO clearing, piling, cable installation and vessels. A summary of the underwater noise modelling for fish is provided in **Table 11.74** (see **Appendix 9.1** for further information).

Table 11.74 Summary of Underwater Noise Impact Ranges for Fish Species

Fish Species Group	Mortality Impact Range (m)			TTS Impact Range (km)	Recoverable Injury Range (and TTS range) (m)		
	Low-order UXO clearance	High-order UXO clearance	Piling (SPL_{peak})	Piling (SEL_{cum})	Cable laying	Cable trenching / cutting	Vessels
Group 1 Fish: no swim bladder (particle motion detection)	30-45m	410-680m	85m	4.5 km	-	-	-
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	30-45m	410-680m	147m	4.5 km	-	-	-
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	30-45m	410-680m	147m	4.5 km	16m (66m)	10m 51m)	16m (66m)

513. The data and analysis in **Chapter 10: Fish and Shellfish Ecology** indicates that the magnitude of impacts from underwater noise and vibration is negligible and the significance is negligible adverse for all fish species.

514. As a precautionary approach the potential changes to prey resource as a result of underwater noise is assessed as being of low to negligible significance for all marine mammal species.

515. It is important to note that there is unlikely to be any additional displacement of marine mammals as a result of any changes in prey availability during piling as marine mammals would be disturbed from the area (**Section 11.7.5.3**).

Effect Significance for Changes to Prey Resources

516. Taking into account the marine mammal sensitivity and the potential magnitude of the impact, the effect significance for any potential changes in prey resource has been assessed as **negligible to minor adverse (not significant)** for all marine mammal species (**Table 11.75**).

Table 11.75 Assessment of Effect significance for Any Potential Change in Prey Resource during Construction

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Change in prey resource	Harbour porpoise	Low to medium	Negligible to low	Negligible to minor adverse	None required. Mitigation in MMMP would reduce underwater noise impacts on fish.	Negligible to minor adverse
	Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin	Low	Negligible to low	Negligible to minor adverse		Negligible to minor adverse
	Minke whale, and humpback whale	Low to medium	Negligible to low	Negligible to minor adverse		Negligible to minor adverse
	Grey seal, and harbour seal	Low	Negligible to low	Negligible to minor adverse		Negligible to minor adverse

Mitigation

517. Mitigation to reduce the potential impacts of underwater noise for marine mammals in the MMMPs for UXO clearance and piling would also reduce the potential impacts on prey species. No further mitigation is required or proposed in relation to any changes in prey availability.

Assessment for the Southern Trench MPA

518. The Conservation Advice for the Southern Trench MPA (NatureScot, 2020) notes that a key prey species for minke whale is sandeels, and any impacts to the habitats of this species should be reduced in order to protect the prey resource for minke whale. As assessed above, any changes to prey species habitats are expected to be negligible or minor due to species being able to use similar adjacent habitats, the small scale of impact, temporary and localised nature. Therefore, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA due to a change in prey availability.

11.7.6 Potential Impacts during Operation and Maintenance

519. The potential impacts during operation and maintenance assessed for marine mammals are:

- Impact 1: Underwater noise and disturbance from operational turbines
- Impact 2: Underwater noise and disturbance during maintenance activities and from vessels
- Impact 3: Barrier effects from underwater noise
- Impact 4: Vessel interaction – increased collision risk with vessels
- Impact 5: Entanglement
- Impact 6: Electromagnetic Fields (EMF)
- Impact 7: Barrier effects from physical presence of windfarm
- Impact 8: Changes to prey resource (including habitat loss and EMF)

11.7.6.1 Impact O1: Underwater Noise and Disturbance from Operational Turbines

520. There are few studies into the sound levels associated with floating wind farms, with most research and monitoring undertaken to date being for fixed foundations. **Appendix 9.1** summarises the information gathered to date on the monitored noise levels of operational wind turbines with fixed foundations. The studies present a range of values, but the majority found that within a few hundred

metres of the source, sound levels would be audible, but not high enough to cause injury or behavioural impact. Norro *et al.* (2011) reviewed a number of studies of operational turbine noise with fixed foundations within the North Sea and found that the highest noise levels were between 20 and 25 dB re 1 µPa above ambient noise levels. The review concluded that these noise levels are unlikely to cause a significant impact, however it is important to note, that underwater noise from operational turbines would be for the duration of the operational lifespan of the wind farm, and that little is known of the long-term impacts to aquatic life (**Appendix 9.1**).

521. There is ongoing research into floating wind (e.g. Offshore Renewable Energy (ORE) Catapult and Xodus Group, 2022). For example, the FORTUNE (Floating Offshore Wind Turbine Noise) project aims to obtain systematic, long-term measurements of underwater noise generated by floating turbines; where relevant and possible, this analysis would be supported by in-situ monitoring during both construction and operation within pilot scale and early commercial floating farms (ORE Catapult and Xodus Group, 2022).

522. Given that sound is more readily transmitted from structures which are coupled together, the case of operational noise from piled foundation turbines is considered a worst case (**Appendix 9.1**).

Impact Assessment for the Potential for Disturbance from Operational Wind Turbines at the Windfarm Site

523. All marine mammal species have a sensitivity of medium for disturbance due to operational underwater noise.

524. Currently available data indicates that there is no lasting disturbance or exclusion of harbour porpoise or seals around wind farm sites with fixed foundations during operation (Diederichs *et al.,* 2008; Lindeboom *et al.,* 2011; Marine Scotland, 2012; McConnell *et al.,* 2012; Russell *et al.,* 2014; Scheidat *et al.,* 2011; Teilmann *et al.,* 2006; Tougaard *et al.,* 2005, 2009a, 2009b). Data collected suggests that any behavioural responses for harbour porpoise and seal may only occur up to a few hundred metres away (Touggard *et al.,* 2009b; McConnell *et al.,* 2012).

525. Monitoring was carried out at the Horns Rev and Nysted wind farms (fixed foundations) in Denmark during the operation between 1999 and 2006 (Diederichs *et al.,* 2008). Numbers of harbour porpoise within Horns Rev were slightly reduced compared to the wider area during the first two years of operation, however, it was not possible to conclude that the wind farm was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard *et al.,* 2009a). Later studies by Diederichs *et al.* (2008) recorded no noticeable effect on the abundances of harbour porpoise at varying wind velocities at both of the offshore wind farms studied, following two years of operation.

526. Monitoring studies at Nysted and Rødsand (fixed foundations) have also indicated that operational activities have had no impact on regional seal populations (Teilmann *et al.,* 2006; McConnell *et al.,* 2012). Tagged harbour seals have been recorded within two operational wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around wind turbine fixed foundation structures (Russell *et al.,* 2014).

527. Both harbour porpoise and seals have been shown to forage within operational wind farm sites (e.g. Lindeboom *et al.,* 2011; Russell *et al.,* 2014), indicating no restriction to movements in operational offshore wind farm sites with fixed foundations. There is currently limited information for other marine mammal species, however, bottlenose dolphin are frequently observed in and around the Aberdeen Offshore Wind Farm (European Offshore Wind Deployment Centre; pers. comm.).

528. Modelling of noise effects of operational offshore wind turbines with fixed foundations suggest that harbour seal, grey seal and bottlenose dolphin are not considered to be at risk of displacement by the operational wind farms (Marmo *et al.,* 2013).

529. Based on the review of marine mammals and operational wind farms, the noise levels associated with currently operational wind turbines with fixed foundations, and taking into account the duration, a precautionary magnitude of low has been given to all marine mammal species.

Summary of Effect Significance from Operational Wind Turbines at the Windfarm Site

530. The effect significance for all marine mammal species for disturbance due to underwater noise from operational wind turbines is **minor adverse (not significant)** (**Table 11.76**).

531. There is no requirement for mitigation, and therefore the residual effect significance remains at **minor adverse** at worse.

Table 11.76 Assessment of Effect significance for Disturbance from Underwater Noise from Operational Wind Turbines at the Windfarm Site

Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Disturbance from underwater noise from operational wind turbines	Harbour porpoise	Medium	Low	Minor adverse	None required.	Minor adverse
	Bottlenose dolphin		Low	Minor adverse		Minor adverse
	White-beaked dolphin		Low	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Low	Minor adverse		Minor adverse
	Risso's dolphin		Low	Minor adverse		Minor adverse
	Minke whale		Low	Minor adverse		Minor adverse
	Humpback whale		Low	Minor adverse		Minor adverse
	Grey seal		Low	Minor adverse		Minor adverse
	Harbour seal		Low	Minor adverse		Minor adverse

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532. For minke whale, there is no potential for PTS or disturbance due to operational turbine underwater noise, as the noise levels associated with them do not exceed the minke whale thresholds. Therefore, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA due to disturbance from underwater noise from operational turbines.

11.7.6.2 Impact O2: Underwater Noise and Disturbance during Maintenance Activities and from Vessels

533. The requirements for any potential maintenance work, such as cable re-burial, are currently unknown, however the work required, and associated impacts would be less than those during construction.

534. As outlined in **Sections 11.7.5.4** and **11.7.5.5**, there is no potential for PTS in any marine mammal species, and the potential for TTS is only present for harbour porpoise and seal species, while all marine mammals could be disturbed from maintenance activities and vessels.

535. The impacts from additional cable laying and protection, including the vessels associated with them, are temporary in nature and will be limited to relatively short periods during the operation and maintenance phase. The number of vessels in the Offshore Development Area and vessel movements during operation and maintenance would be less than during the construction phase (**Table 11.14**). Any disturbance would be temporary and localised and is likely to be limited to the area in and around the vessel or where the activity is taking place for the duration of the activity or presence of the vessels.

536. Therefore, TTS or disturbance from underwater noise from maintenance activities and vessels are considered to be the same or less than those assessed for underwater noise from other construction activities (including trenching and cable laying) (**Section 11.7.5.4**; **Table 11.63**; **Table 11.64**) and construction vessels (**Section 11.7.5.5**; **Table 11.67**; **Table 11.68**).

537. Based on the assessments for the construction phase, the magnitude for the potential risk of TTS from maintenance activities and vessels is assessed as negligible for harbour porpoise, grey seal and harbour seal with no impact for dolphin and whale species (**Table 11.63**; **Table 11.67**).

538. The magnitude of the potential disturbance from maintenance activities and vessels is assessed as negligible for all marine mammal species, with less than 1% of the relevant reference populations anticipated to be exposed to any temporary impact, except for bottlenose dolphin, with a magnitude of negligible to low (**Table 11.64**; **Table 11.68**).

Summary of Effect Significance for Maintenance Activities and Vessels in the Offshore Development Area

539. For PTS in all species, there is **no potential for impact**. For TTS in dolphin and whale species, there is also **no potential for impact**. For TTS in harbour porpoise and seal species, the effect significance is **minor (adverse)** (**Table 11.77**).

540. The effect significance for all marine mammal species for disturbance during geophysical surveys is **minor adverse (not significant)** (**Table 11.77**).

541. There is no requirement for mitigation, and therefore the residual effect significance remains at **minor adverse** at worst.

Table 11.77 Assessment of Effect significance for PTS, TTS and Disturbance from Underwater Noise during Operational and Maintenance Activities including vessels in the Offshore Development Area

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
PTS due to operational and maintenance activities including vessels	All marine mammal species	High	No impact	No effect	None required.	No effect
TTS due to operational and maintenance activities including vessels	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse		Minor adverse
	Dolphin and whale species	Medium	No impact	No effect		No effect
Disturbance due to operational and maintenance activities including vessels	Bottlenose dolphin	Medium	Negligible to low	Minor adverse		Minor adverse
	All other marine mammal species	Medium	Negligible	Minor adverse		Minor adverse

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542. For minke whale, there is no potential for PTS or TTS due to other maintenance activities (such as cable laying or cutting) and vessels in the Offshore Development Area, as the noise levels associated with these works do not breach the minke whale PTS thresholds (**Table 11.62**; **Table 11.66**). However, there is the potential for minke whale to be disturbed up to 9.284 km due to these cabling activities or vessels, with up to 11 minke whale at risk of disturbance, or up to 0.052% of the reference population (see **Table 11.64**; **Table 11.68**).

543. Taking into account the small number of minke whale at risk of disturbance, and that this would be a temporary impact only while the activities are taking place or the vessels are present in the Offshore Development Area, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA due to disturbance from maintenance activities and vessels.

11.7.6.3 Impact O3: Barrier Effects from Underwater Noise

544. No barrier effects as a result of underwater noise during operation and maintenance are anticipated. As outlined in **Section 11.7.6.1**, currently available information indicates that there is no lasting disturbance or exclusion of harbour porpoise, bottlenose dolphin or seals in and around wind farm sites with fixed foundations (worst case) during operation.

545. Any behavioural responses or disturbance as a result of the mooring chains on the seabed would be limited to the close vicinity of the mooring locations and is likely to be similar to the area of seabed disturbance (up to 0.00195 km^2 for each turbine, up to 0.06825 km^2 for 35 turbines).

546. Taking into account the relatively small impact areas for underwater noise around operational turbines, including any underwater noise from the movements of mooring chains on the seabed, and the spacing between mooring locations, there is unlikely to be the potential for barrier effects to marine mammals as a result of operational noise.

547. As assessed in **Section 11.7.6.1**, the magnitude for displacement or disturbance as a result of underwater noise from operational turbines has been assessed as low for all marine mammal species, with an effect significance of minor adverse (not significant).

548. As assessed in **Section 11.7.6.2**, the magnitude for disturbance from underwater noise from maintenance activities and vessels is assessed as negligible to low for all marine mammal species based on maximum impact areas for all activities, with a minor adverse effect significance.

549. Therefore, any potential barrier effects as a result of underwater noise during operation and maintenance has not been assessed further.

11.7.6.4 Impact O4: Vessel Interaction – Increased Collision Risk with Vessels

Sensitivity of Marine Mammals to an Increase in Vessel Collision Risk

550. As outlined in **Section 11.7.5.6**, marine mammals are considered to have a high sensitivity to the risk of a vessel strike. As if an individual receptor collides with a vessel there is the potential for a very limited capacity to recover from the worst case impact (**Table 11.3**), although they have the potential to avoid.

Magnitude of Impact for an Increase in Vessel Collision Risk

551. It is estimated that the maximum number of vessel trips each year, through the operation and maintenance phase, is up to eight (or 16 transits). An assessment of the potential increase in risk to marine mammals as a result of the 16 vessel transits per year has been undertaken following the same approach as undertaken for the construction phase (see **Section 11.7.5.6**).

552. The number of marine mammals at risk of collision, per vessel, in UK waters has been calculated, and has been used to calculate the number of each marine mammal species at risk of collision from the 16 yearly vessel transits associated with the operation and maintenance phase of the Project. For all species, there is less than 0.001% at risk of the permanent impact, and therefore a negligible magnitude of impact, with the exception of harbour seal from the EaS MU which has been assessed as a low magnitude (**Table 11.78**).

Table 11.78 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels, based on Current UK Collision Rates and Vessel Presence

Species	Collision risk rate (number attributed to vessels strike / other physical trauma as proportion of total number necropsied)[13]	Estimated total number of individuals in UK waters[14]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[15]	Number of marine mammals at risk of collision per vessel in UK waters	Number vessel transits associated with operation and maintenance	Additional marine mammals at risk due to increase in vessel number (collision rate * proportion vessel increase)	Magnitude of impact
Harbour porpoise	0.0584 at risk of collision	200,714	11,715 harbour porpoise at risk within UK waters	3,852,030	0.00304 harbour porpoise at risk per vessel within UK waters	16	0.0487 harbour porpoise (0.000014% of NS MU) estimated to be at risk for all Project construction vessels	Negligible
Bottlenose dolphin	0.0250 at risk of collision	7,545	189 bottlenose dolphin within UK waters	3,852,030	0.00005 bottlenose dolphin at risk per vessel within UK waters	16	0.0008 bottlenose dolphin (0.0003% of CES MU; 0.00004% of GNS MU) estimated to be at risk for all Project construction vessels	Negligible
White-beaked dolphin	0.0316 at risk of collision	34,025	1074.5 white-beaked dolphin at risk within UK waters	3,852,030	0.00028 white-beaked dolphin at risk per vessel within UK waters	16	0.0045 white-beaked dolphin (0.00001% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible
Atlantic white-sided dolphin	0.0222 at risk of collision	12,293	273 Atlantic white-sided dolphin at risk within UK waters	3,852,030	0.00007 Atlantic white- sided dolphin at risk per vessel within UK waters	16	0.0011 Atlantic white-sided dolphin (0.000006% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible
Risso's dolphin	0.0417 at risk of collision	8,687	362 Risso's dolphin at risk within UK waters	3,852,030	0.00009 Risso's dolphin at risk per vessel within UK waters	16	0.0015 Risso's dolphin (0.00001% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible
Minke whale	0.0571 at risk of collision	10,288	588 minke whale at risk within UK waters	3,852,030	0.00015 minke whale at risk per vessel within UK waters	16	0.0024 minke whale (0.000012% of CGNS MU) estimated to be at risk for all Project construction vessels	Negligible

[13] Where species specific data is not available, the species group data is used
[14] Based on the IAMMWG (2022) UK population estimates for cetacean species, SCOS (2021) UK population estimates for seal species
[15] Latest publicly available data

Species	Collision risk rate (number attributed to vessels strike / other physical trauma as proportion of total number necropsied)[13]	Estimated total number of individuals in UK waters[14]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[15]	Number of marine mammals at risk of collision per vessel in UK waters	Number vessel transits associated with operation and maintenance	Additional marine mammals at risk due to increase in vessel number (collision rate * proportion vessel increase)	Magnitude of impact
Humpback whale	0.0404 at risk of collision (based on large whale risk)	35,000	1,414 humpback whale / large whale at risk within UK waters	3,852,030	0.00037 humpback whale at risk per vessel within UK waters	16	0.0059 humpback whale (0.00002% of reference population) estimated to be at risk for all Project construction vessels	Negligible
Grey seal	0.0085 at risk of collision	157,300	1,339 grey seal at risk within UK waters	3,852,030	0.00035 grey seal at risk per vessel within UK waters	16	0.0056 grey seal (0.00003% of reference population; 0.00004% of EaS MU) estimated to be at risk for all Project construction vessels	Negligible
Harbour seal	0.0278 at risk of collision	43,750	1,215 harbour seal at risk within UK waters	3,852,030	0.00032 harbour seal at risk per vessel within UK waters	16	0.005 harbour seal (0.0003% of reference population; 0.0011% of EaS MU) estimated to be at risk for all Project construction vessels	Negligible to Low

Effect Significance of Increased Collision Risk with Vessels

553. Taking into account the high marine mammal sensitivity and the potential negligible magnitude of the impact, as assessed in **Table 11.78**, the effect significance for any potential increased collision risk as a result of vessels during operation and maintenance has been assessed as minor for all species, with the exception of harbour seal from the Eas MU which could have a moderate adverse effect, without Best Practice Measures (**Table 11.79**).

554. The residual impact, taking into account best practice to reduce any risk of collisions with marine mammals, would be **minor adverse (not significant)** for vessels during operation and maintenance. There have been no known reported incidents of marine mammal collisions with offshore wind farm vessels.

Table 11.79 Effect significance for Risk of Vessel Collision to Marine Mammals due to Operation and Maintenance Vessels

Potential Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Increased collision risk with operation and maintenance vessels	Harbour porpoise	High	Negligible	Minor adverse	Best practice measures.	Minor adverse
	Bottlenose dolphin		Negligible	Minor adverse		Minor adverse
	White-beaked dolphin		Negligible	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Negligible	Minor adverse		Minor adverse
	Risso's dolphin		Negligible	Minor adverse		Minor adverse
	Minke whale		Negligible	Minor adverse		Minor adverse
	Humpback whale		Negligible	Minor adverse		Minor adverse
	Grey seal		Negligible	Minor adverse		Minor adverse
	Harbour seal		Negligible	Minor adverse		Minor adverse

Best Practice Measures

555. As outlined in **Section 11.7.5.6**, vessel movements, where possible, will be incorporated into recognised vessel routes, and therefore to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk. Additionally, all vessel operators will use good practice to reduce any risk of collisions with marine mammals, this includes following the Scottish Marine Wildlife Watching Code, where appropriate, during all operation and maintenance activities, including transiting to and from site. This will be detailed within the CEMP.

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556. The Conservation Advice for the Southern Trench MPA (NatureScot, 2020) notes that minke whale are sensitive to collision. As outlined in **Section 11.7.5.6**, out of 299 stranded minke whale around the UK from 2003 to 2020, 70 were investigated through necropsies, and four were fatally injured through vessel collision (a collision rate of 0.0571 when taking into account the number of minke whale necropsies). This was one of the highest of all the species summarised in **Table 11.70**, supporting that minke whale are one of the more sensitive marine mammals to collision with vessels.

557. The Conservation Advice for the Southern Trench MPA, to reduce or limit the potential for collision, is to follow the Scottish Marine Wildlife Watching Code. As noted above and in **Table 11.79**, this best practice has been applied as a form of mitigation, and all vessels associated with the operation and maintenance of the Project will follow the code.

558. Less than one minke whale (0.0024; **Table 11.78**) are at risk of collision with vessels associated with the operation and maintenance of the Project, and, when taken into consideration with the best

practice measures as outlined above, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA. Only vessels in the Landfall Export Cable Corridor Area would be within the Southern Trench MPA.

11.7.6.5 Impact O5: Marine Mammal Entanglement

559. Depending on the method used, there is the perceived potential for entanglement in the mooring systems for floating offshore wind turbines. To date, there have been no recorded instances of marine mammal entanglement from mooring systems of renewable devices (Sparling *et al.,* 2013; Isaacman and Daborn, 2011, Harnois *et al.,* 2015), or for anchored Floating Production, Storage and Offloading (FPSO) vessels in the oil and gas industry (Benjamins *et al*., 2014), with similar mooring lines as proposed for floating turbine structures. However, entanglement in fishing gear is known to occur in Scottish waters, and there is therefore the potential for a risk of secondary entanglement.

560. For the Project, there will be a maximum of 210 mooring lines (6 per WTG Unit) with two cables per turbine. The mooring lines will be made of anchor chain, mooring cables or polyester mooring line and extend out to between 650 m (catenary system) and 100 m (TLP system) from the WTG. It is expected that the full length of each mooring line will be suspended in the water column by one buoy per anchor, with temporary surface buoys used during construction. Permanent submersible buoys at the seabed will also be used. There will also be 70 cables, with two cables per turbine between the turbine and seabed, supported by distributed buoyancy (**Figures 5.5, 5.6, 5.7 and 5.15**).

Sensitivity of Marine Mammals to Entanglement

561. Impacts to marine mammals due to entanglement are fatalities due to drowning, infection and tissue damage if the animal escapes, emaciation if entanglement stops the animal from feeding effectively, increased drag and energy use if the animal is entangled but able to move freely.

562. Marine mammal entanglement risk will likely be influenced by the type of mooring system employed (slack or taut-moored systems), mooring characteristics, and turbine array configuration (Farr *et al*., 2021).

563. Benjamins *et al*. (2014) provided an in-depth qualitative assessment of relative entanglement risk, taking into consideration both biological risk parameters (e.g. body size, flexibility, and ability to detect moorings) and physical risk parameters of mooring elements (e.g., tension characteristics, swept volume, and mooring curvature).

564. Results of a risk assessment on different mooring types by Benjamins *et al.* (2014) indicated a higher risk of entanglement based on mooring stiffness for the most compliant mooring arrangements, specifically catenary with chain and nylon, catenary with accessory buoys and taut with accessory buoys. The risk was reduced for the catenary configuration with chain, and catenary configuration with chain and polyester. The risk was lowest for the stiffer taut configuration.

565. Benjamins *et al*. (2014) provides a qualitative assessment of relative entanglement risk across different marine megafauna groups, taking into account both biological risk factors such as animal size, sensory capabilities and foraging methods, and physical risk factors such as mooring flexibility, pre-tension and footprint. **Table 11.80** summarises the results of this assessment. Baleen whales appear to be at greatest risk, due to their size and distinctive foraging techniques (i.e. rapidly engulfing dense prey aggregations). Lunge feeding baleen whales are thought to be more susceptible when feeding and exposing themselves to entanglement (Johnson *et al.,* 2005). Mooring systems can also attract marine mammals due to potential increases in prey species around the mooring lines and devices. Small toothed cetaceans incur the least risk, primarily due to their small size and manoeuvrability. Seal species have a similar risk level to small toothed cetaceans, with an increase in manoeuvrability.

Table 11.80 Relative Risk Assessment for Marine Mammals and Mooring Scenarios relevant to the Offshore Development Area (based on Biological and Physical Risk Parameters; Benjamins et al., 2014)

Species	Catenary & chain	Taut & accessory buoy
Harbour porpoise	Low	Low
Bottlenose dolphin	Low	Low
Risso's dolphin	Low	Low
Common dolphin	Low	Low
White beaked dolphin	Low	Low
Atlantic white sided dolphin	Low	Low
Minke whale	High	High
Humpback whale	High	High
Grey seal	Low	Low
Harbour seal	Low	Low

566. However, given the size and physical characteristics of the mooring systems required for floating OWF, it is unlikely that upon encountering them, a marine mammal of any size would become directly entangled in the moorings themselves (note that the mooring system will remain under tension at all times and no loops, as seen in fishing gear, will ever be formed to allow entanglement with the mooring system). Mooring systems in the offshore renewables industry typically have greater diameter (Benjamins *et al.,* 2014), compared to fishing gear, which has been identified as a major entanglement risk for whales (NMFS, 2018).

567. SMASS reported on entanglements of marine mammal species with fishing gear, as part of the strandings scheme. In total, from 2009 to 2020, a total of 29 minke whale and four humpback whale were reported with a cause of death attributed to entanglements, out of a total 70 known causes of death for minke whale, and nine for humpback whale[16]. Therefore, entanglement with fishing gear can be attributed to an estimated 41.4% and 44.4% of minke whale and humpback whale deaths, respectively. In addition, 17 grey seal (out of 470 known causes of death), and four harbour seal (of 180 known causes of death) were found stranded, with entanglement as the cause of death. This equates to entanglement causing an estimated 3.6% of grey seal deaths, and 2.2% of harbour seal deaths. One harbour porpoise and one short-beaked common dolphin were also reported to have been entangled. The above reported entanglements are all with fishing gear.

568. Whale species were the most commonly reports species to become entangled, further supporting that they are the most sensitive species to the risk of entanglement. It should be noted that there have been no reports of marine mammal entanglements with mooring systems or cables associated with either floating wind farm infrastructure, or FPSOs, despite both being present in Scottish waters for the same period as the SMASS scheme has been in place. Indicating, as noted above, that the risk of entanglement with floating turbines is from that of secondary entanglement, where fishing gear becomes caught in the mooring system or cables associated with the floating turbine infrastructure, and marine mammals would be at risk of entangling with the caught fishing gear, rather than the mooring system or cables themselves.

569. Therefore, the greatest risk is most likely to be from indirect (or secondary) entanglement in anthropogenic debris, such as the lost, abandoned or discarded fishing gear and other marine debris, caught in the mooring system or cables, known as 'ghost fishing' (Benjamins *et al.,* 2014). Tertiary entanglement is also a potential risk (although is considered to be unlikely unless in areas of high fishing and high whale presence), and refers to the potential for marine animals, who are trailing

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[16] SMASS (2009); SMASS (2010); SMASS (2011); SMASS (2012); SMASS (2013); SMASS (2014); SMASS (2015); SMASS (2016); SMASS (2017); SMASS (2018); SMASS (2019); SMASS (2020) [available from: https://strandings.org/publications/]

fishing gear, to swim in close proximity to mooring lines, allowing the trailing gear to become entangled.

570. The entanglement risk of marine megafauna (marine mammals, sharks, and marine turtles), with floating wind systems is relatively unknown, mainly due to the lack of focused studies and monitoring (including on the potential for ghost fishing gear to become entangled in the mooring lines). However, it is expected that the highest risk would come from catenary mooring systems.

571. Taking into account that there have been no recorded instances of marine mammal entanglement from mooring systems of marine renewable devices or similar mooring lines, and the mooring lines and cables do not have loose ends or sufficient slack (Copping and Hemery*,* 2020) the sensitivity of marine mammals to potential entanglement at the Windfarm Site is assessed to be negligible for all species due to direct entanglement. All marine mammal species, due to the increased risk and sensitivity of secondary (or tertiary) entanglement, have a sensitivity of medium, with the exception of both minke whale and humpback whale, which have a sensitivity of high to secondary (and tertiary) entanglement.

Magnitude of Impact for Marine Mammal Entanglement

572. As a precautionary approach, the potential magnitude of impact has been based on the relative risk assessment for marine mammals by Benjamins *et al.* (2014) for the catenary and chain mooring system. However, it should also be noted that the potential for avoidance of fishing gear is likely to be higher at the Windfarm Site, due to the infrastructure that would be present, which would have the likely effect of providing marine mammals with a higher ability to detect the presence of structures in the water column, and therefore increase their ability to avoid it.

573. It is difficult to determine whether marine mammals will be deterred from the WTGs by the operational noise, or potentially attracted if fish aggregations develop around the devices. However, given the relatively low density of marine mammals, including minke and humpback whale, in and around the Windfarm Site (**Table 11.11**), the low risk of entanglement based on the information in Benjamins *et al.* (2014), and the potentially increased opportunity for avoidance of fishing gear, the magnitude of impact is predicted to be negligible for all species, except minke whale and humpback whale, for which magnitude of impact is considered to be low, due to their increased rates of entanglement with fishing gear.

Effect Significance of Entanglement

574. The effect significance for the possible entanglement with mooring system and cables has been assessed as **negligible to minor adverse** for harbour porpoise, bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, grey seal and harbour seal, and **negligible to moderate adverse** for minke whale and humpback whale.

575. There is a medium to high level of confidence in this assessment based on the data which support the low occurrence of marine mammals in the vicinity of the Windfarm Site, which is used in determination of the magnitude of impact, and the evidence used to assess the sensitivity of marine mammals to this type of impact.

576. The residual impact, taking into account management measures (as outlined below) to reduce any risk of entanglements, would be **negligible to minor adverse (not significant)** for all marine mammal species in the Windfarm Site.

577. Any entanglement risk during construction or decommissioning would be less than assessed for operational phase of the Project.

Table 11.81 Effect significance for Risk of Marine Mammal Entanglement during Operation of the Project

Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Entanglement risk for marine mammals during operation	Harbour porpoise	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to minor adverse	**Monitoring measures in PEMP (see below).**	Negligible
	Bottlenose dolphin		Negligible	Negligible to minor adverse		Negligible
	White-beaked dolphin		Negligible	Negligible to minor adverse		Negligible
	Atlantic white-sided dolphin		Negligible	Negligible to minor adverse		Negligible
	Risso's dolphin		Negligible	Negligible to minor adverse		Negligible
	Minke whale	Negligible (direct entanglement) High (secondary entanglement)	Low	**Negligible to moderate adverse**		Negligible to minor adverse
	Humpback whale		Low	**Negligible to moderate adverse**		Negligible to minor adverse
	Grey seal	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to minor adverse		Negligible
	Harbour seal		Negligible	Negligible to minor adverse		Negligible

Monitoring for the Risk of Entanglement

578. The Project Environmental Monitoring Plan (PEMP) will include for monitoring for entanglement risk. This will include:

- Monitoring for large strains on mooring lines:
  - On Kincardine Offshore Windfarm this has to date been undertaken by load cells attached to the mooring devices and subsea cables, designed to alert if there is unexpected load on the devices which can then be examined. The monitoring method is in the process of changing to using position monitoring system, which will identify the associated drag function on the structures outside the normal operating range.
- Surveys: the turbines and mooring systems would be regular checked by ROV (during both planned and unplanned maintenance activities):
  - This would ensure that there was no material such as discarded nets, ropes or other debris which could increase the risk of entanglement for marine mammals, or interfere with the optimal operation of the turbines. Surveys would be carried out according to American Bureau of Shipping (ABS) rules and standards. This technique is currently being used on Kincardine Offshore Windfarm, which has not found any entanglement events to date.

579. The monitoring required will be agreed with Marine Scotland and NatureScot, and take account results of the methods being used at Kincardine Offshore Windfarm and other floating wind farms to inform the most appropriate technique at the time of deployment of the Project.

580. The monitoring measures will be developed to reduce the potential for an entanglement event to occur. Any entanglement event that does occur through the lifetime of the project will be reported, and full information of the incident will be recorded.

581. In the event that any entanglement of a marine mammal does occur during the operation of the Project, additional mitigation and monitoring measures may be required to ensure it does not happen again.

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582. Minke whale are sensitive to entanglement, with entanglement in fishing gear representing the most frequently reported cause of death for minke whale in Scottish waters (as outlined above). Minke whale are more sensitive than other species given their larger size and reduced flexibility, and feeding technique. However, the design of the mooring system are such that the direct entanglement of minke whale within the cables is highly unlikely. The remaining risk is therefore of secondary entanglement of minke whale with fishing gear that has become entangled in the mooring system or cables.

583. While there is a risk of secondary entanglement, it is not well understood. However, it is expected that the risk of secondary entanglement of minke whale with the mooring system and cables is reduced in comparison to entanglement with fishing gear, as the presence of the wind turbines and mooring system themselves may act as a visual cue as to the presence of infrastructure (and therefore any fishing gear) in order to better avoid it. In addition, monitoring measures will be put in place to ensure that no fishing gear is caught on the mooring system and cables, and therefore there would be no opportunity for a secondary entanglement event to occur (see above for more detail). Therefore, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA.

11.7.6.6 Impact O6: Electromagnetic Fields (EMF)

584. The Project will be developed using high voltage alternative current (HVAC) cable circuits operating at 50 Hz, which are extremely low frequency (ELF) alternating EMFs. An earthed magnetic shield applied over the insulation that ensures the electric field is entirely contained. The offshore cables will consist of two 3-cored cables. The cables will produce two fields, a magnetic field which in turn causes an induced electric field in organisms passing through this field (**Appendix 9.2**; National Grid, 2022).

585. Many marine organisms have evolved sensory abilities to use electric and magnetic cues in essential aspects of life history, such as prey detection, predatory behaviour, and navigation and these behaviours may be impacted by EMF in the water column (Hutchinson *et al*., 2020).

586. The review of EMF marine impacts by Normandeau et al. (2011) concluded: “Most marine species may not sense very low intensity electric or magnetic fields at Alternating Current (AC) power transmission frequencies, AC magnetic fields at intensities below 5 microtesla (μT) may not be sensed by magnetite-based systems (e.g., mammals, turtles, fish, invertebrates), although this AC threshold is theoretical and remains to be confirmed experimentally. Low intensity AC electric fields induced by power cables may not be sensed directly at distances of more than a few meters by the low-frequency-sensitive ampullary systems of electrosensitive fishes.”

587. As outline above, the earthed metallic shield that is applied over the insulation of HVAC cables ensures that the electric field will be contained entirely within the insulation, and no external electric field will be emitted. Magnetic fields are not shielded in the same way as electric fields and will be produced outside the cables, and this has been assessed for each cable route (**Appendix 9.2**).

588. The magnetic field produced by the cables will in turn induce electric fields in organisms passing through the field. This will be proportional to the magnetic field and the size of the organism. Magnetic field intensities reduce as a function of distance from the source and are highly localised.

589. The assessments by National Grid (2022) in **Appendix 9.2**, were performed assuming maximum load, minimum circuit separation and minimum burial depth, giving a worst case scenario (see **Appendix 9.2**) for the two offshore routes:

- Offshore route 1: 66 kV between Ettrick and Blackbird field to the Buzzard Platform. Consists of two 66 kV single 3-phase 1000 mm^2 export cable circuits installed with a 50 m separation. The maximum current capacity of each circuit is 825 A. Each circuit will have a minimum burial depth of 0.6 m.

- Offshore route 2: 275 kV between Ettrick and Blackbird field to Landfall. Consists of two 275 kV single 3-phase 2000 mm^2 export cable circuits, each with a maximum circuit rating of 1024 A. Each circuit will have a minimum circuit separation of 50 m and a minimum burial depth of 0.6 m.

590. **Table 11.82** summarises the magnetic fields with increased distance from the seabed for the buried export cable options (National Grid, 2022) conducted an EMF assessment for the Project.

*Table 11.82 Calculated Maximum Magnetic Fields for Offshore Export Cable Circuits Options. Cables are buried with the top of the cable 0.6 m below the seabed (**Appendix 9.2**)*

Offshore Cable Route Option	**Magnetic Field (µT)** Distance above seabed (m)						
	Seabed	0.5m	1m	2m	5m	10m	20m
Offshore route 1 - 66 kV	35.1 µT	12.3 µT	6.17 µT	2.47 µT	0.55 µT	0.15 µT	0.04 µT
Offshore route 2 - 275 kV	54.1 µT	19.5 µT	9.90 µT	3.99 µT	0.90 µT	0.25 µT	0.06 µT

591. The predicted magnetic fields for the Project are greatest on the seabed and reduce rapidly with vertical and horizontal distance from the buried cables. The magnetic fields for both cable route options are reduced to very low levels within a few metres from the buried cables. The magnetic fields halved in value 0.8 m from the seabed and reduced to below 1 µT at 5 m from the seabed (**Table 11.82**). It is important to note that these levels do not take account of shielding factors of the cable sheath which would further reduce the fields.

592. The induced electric field within an organism, such as a marine mammal is directly related to the size of the magnetic field, the size of the organism and, for large organisms, orientation over the cables (see **Appendix 9.2**). The modelled induced electric field was assessed for three marine mammal species. **Table 11.83** summaries the results for cable route 2: 275 kV cable circuits.

593. The induced electric field would also only persist whilst the organism is within the magnetic field. For comparison, the public exposure limit for induced electric fields in humans is 20 mV/m in the head and 400 mV/m for the whole body.

594. The modelled results indicate that at 5 m from the cables, the induced electric field had reduced significantly. These reductions at vertical and horizontal distance were observed in all species. The smaller the species the smaller the predicted induced electric field. The modelling indicates very little potential risk to marine mammals, unless they are in very close proximity to the cables.

*Table 11.83 Modelled Maximum Induced Electric Fields for Offshore Export Cable Circuit Option 2: 275 kV. Cables are buried with the top of the cable 0.6 m below the seabed (**Appendix 9.2**)*

Species (worst case orientation)	**Electric Field (µV/m)** Distance above seabed (m)						
	Seabed	0.5m	1m	2m	5m	10m	20m
Harbour porpoise	1,996 µV/m	812 µV/m	439 µV/m	188 µV/m	45.2 µV/m	12.9 µV/m	3.3 µV/m
Bottlenose dolphin	2,958 µV/m	1,366 µV/m	788 µV/m	361 µV/m	92.6 µV/m	27.3 µV/m	7.1 µV/m
Minke whale	2,946 µV/m	1,884 µV/m	1,327 µV/m	769 µV/m	265 µV/m	92.0 µV/m	27.0 µV/m

595. The significance of EMF effects on the surrounding environment depends on the voltage and current passing through the cables, and as voltage increases the electric field increases. The export cables

and inter-array cable for the Project will be buried at a minimum depth of 0.6 m, significantly reducing the levels of detectable EMF, and are not expected to have any impact on marine mammals.

596. There will be two dynamic cables from each turbine to the seabed which will not be buried. However, as outlined in **Section 11.7.6.5**, it is anticipated that marine mammals would be able to detect and avoid the moorings systems, therefore it is highly unlikely that marine mammals would be in close proximity to the dynamic cables in the water column.

Sensitivity of Marine Mammals to EMF

597. Some marine mammals, such as cetaceans, are believed to use geomagnetic cues as a navigational tool (Ferrari, 2016). However, this aspect of their physiology is not well understood and much of the literature dealing with EMF effects on marine mammals is inconclusive (Dhanak *et al*., 2016). Whilst other marine mammals including pinnipeds may be able to sense EMF in their environment, it is not considered a primary system for foraging or navigation. The overall sensitivity of marine mammals to EMF is therefore considered to be low.

Magnitude of Impact of EMF for Marine Mammals

598. Current information on the effects of EMF on marine mammals is limited, however, there is no evidence to date that marine mammal activity will change as a result of the presence of any increased EMF in the environment from export cable, inter-array cables or dynamic cables in the water column between the turbine and seabed. The use of single 3-core cables ensures magnetic fields reduce quickly with distance. The magnetic field intensities reduce as a function of distance from the source and are highly localised, reducing levels well below a detectable level for magneto-receptive marine mammal species (5 µT; Normandeau *et al*., 2011). The expected magnetic field levels would be less than 5 µT at 5 m from the buried cables and are therefore unlikely to be detectable to marine mammals. Similarly, electric fields would be significantly lower than the public exposure limit for induced electric fields in humans of 20 mV/m in the head and 400 mV/m for the whole body. EMF from buried export cables, buried inter-array cables and dynamic cables in the water column between the turbine and seabed are therefore unlikely to have a direct impact on marine mammals.

599. A magnitude of low is given for all marine mammal species, as while it is not expected that the EMF would impact marine mammal species (which would result in a magnitude of negligible), there remain some unknowns of this potential effect.

Effect Significance of EMF form Marine Mammals

600. The effect significance for EMF related to the Project has been assessed as a precautionary **minor adverse (not significant)** for all marine mammal species.

601. No mitigation is proposed (or required) for EMF effects, and therefore the residual impact would be **minor adverse (not significant)** for all marine mammal species in the Offshore Development Area.

Table 11.84 Effect significance for Effect of EMF on Marine Mammals

Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Effect of EMF on marine mammals	Harbour porpoise	Low	Low	Minor adverse	None required.	Minor adverse
	Bottlenose dolphin		Low	Minor adverse		Minor adverse
	White-beaked dolphin		Low	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Low	Minor adverse		Minor adverse
	Risso's dolphin		Low	Minor adverse		Minor adverse
	Minke whale		Low	Minor adverse		Minor adverse
	Humpback whale		Low	Minor adverse		Minor adverse

Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
	Grey seal		Low	Minor adverse		Minor adverse
	Harbour seal		Low	Minor adverse		Minor adverse

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602. As outlined above, while the information on the effects of EMF on marine mammals is limited, there is also no evidence that marine mammal activity will change due to the presence of increased EMF in the environment. Marine mammals have been reported to be able to detect EMF at a level of 5 µT (Normandeau *et al*., 2011). The Landfall Export Cable Corridor Area (offshore cable route 2: 275 kV cable circuits) is within the Southern Trench MPA. The expected magnetic field levels would be less than 5 µT at 5 m from the buried cables and are therefore unlikely to be detectable to minke whale. Electric fields would be significantly lower than the public exposure limit for induced electric fields in humans. Therefore, it is not expected that minke whale would be directly affected, and therefore it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA.

11.7.6.7 Impact O7: Barrier Effects from Physical Presence of the Wind Farm

Sensitivity of Marine Mammals to Barrier Effects due to Physical Presence of the WindFarm

603. The presence of a wind farm could be perceived as having the potential to create a physical barrier, preventing movement or migration of marine mammals between important feeding and / or breeding areas, or potentially increasing swimming distances if marine mammals avoid the site and go round it. The Windfarm Site is not located on any known migration routes for marine mammals. It is known that bottlenose dolphin regularly transit from the Moray Firth SAC to the southeast coast of Scotland and northeast England, however the Windfarm Site is located 80 km offshore, and the bottlenose dolphin population generally remains within 2 km of the coastline (as described in **Section 11.6.2.2**; Quick *et al*., 2014).

604. As outlined in **Section 11.7.6.1**, information from operational (fixed foundation) windfarms show no evidence of exclusion of harbour porpoise or seals (for example, Diederichs *et al*., 2008; Lindeboom *et al*., 2011; Marine Scotland, 2012; McConnell *et al*., 2012; Russell *et al*., 2014; Scheidat *et al*., 2011; Teilmann *et al*., 2006; Tougaard *et al*., 2005, 2009a, 2009b). Based on the review of marine mammal presence within operational wind farms, the sensitivity of all marine mammal species to a barrier to movement due to the physical presence of the windfarm is negligible.

Magnitude of Barrier Effects due to Physical Presence of the Wind Farm

605. The spacing between wind turbines will be approximately 2 km. The mooring line radius around each turbine would be either 100 m or 650 m, depending on mooring system. Therefore, there would be approximately 1.8 km or 700 m between the mooring line configurations, depending on mooring system. It is therefore expected that marine mammals would move between turbines and mooring systems and through the operational Windfarm Site, irrespective of layout.

606. Maximum footprint of turbine moorings and OSP foundations is approximately 0.0755 km^2 (based on total area for substructure moorings of 0.06825 km^2 (for worst case catenary system) and area for OSP foundations of 0.00724 km^2 (for worst case suction bucket foundation) (**Table 11.14**). Therefore, the physical footprint of structures that could present a physical barrier is a very small area (0.065%) of the total Windfarm Site area (116 km^2).

607. There is currently no information on the potential for the physical presence of a floating offshore wind farm site to cause a barrier to movement for marine mammal species, however, it is assumed to cause a similar level of effect to that of fixed foundation wind farms. It is not expected that the locations of the turbines and infrastructure themselves will be positioned in a location to cause a barrier to movement, with room for marine mammal transit through the Windfarm Site. Therefore, the magnitude of impact for all marine mammals is negligible.

Effect Significance of Barrier Effects due to Physical Presence of the Wind Farm

608. The effect significance for the potential for a barrier to movement from the physical presence of the wind farm has been assessed as **negligible** for all marine mammal species.

609. There is a medium to high level of confidence in this assessment based on the data which support the continued presence of marine mammals in the vicinity of the Windfarm Site during operation, and the evidence used to assess the sensitivity of marine mammals to this type of impact.

610. No mitigation is proposed (or require) for physical barrier effects, and therefore the residual impact would be **negligible** for all marine mammal species at the Windfarm Site.

Table 11.85 Effect significance for Barrier Effect due to the Physical Presence of the Project

Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Barrier effect due to physical presence of the Project	Harbour porpoise	Negligible	Negligible	Negligible	None required.	Negligible
	Bottlenose dolphin		Negligible	Negligible		Negligible
	White-beaked dolphin		Negligible	Negligible		Negligible
	Atlantic white-sided dolphin		Negligible	Negligible		Negligible
	Risso's dolphin		Negligible	Negligible		Negligible
	Minke whale		Negligible	Negligible		Negligible
	Humpback whale		Negligible	Negligible		Negligible
	Grey seal		Negligible	Negligible		Negligible
	Harbour seal		Negligible	Negligible		Negligible

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611. It is not expected that the locations of the turbines, mooring systems and OSP foundations will cause a barrier to movements of minke whale to or from the Southern Trench MPA, with room for marine mammals transit through the wind farm, based on spacings between all turbines and mooring systems. The Windfarm Site is located 50.9 km from the Southern Trench MPA. As outlined above, a number of studies have shown that there is no exclusion of marine mammals from an operational wind farm. Therefore, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA due to barrier effect from the physical presence of the Wind Farm during operation.

11.7.6.8 Impact O8: Changes to Prey Resource

612. As outlined in **Chapter 10: Fish and Shellfish Ecology**, the potential impacts on fish species during operation and maintenance can result from:

- Temporary habitat loss / disturbance
- Permanent habitat loss (introduction of wind turbine moorings / anchors, OSP foundations, scour protection and rock protection for cables)
- Re-mobilisation of contaminated sediments, increased suspended sediments and sediment re-deposition
- Underwater noise
- EMF

613. Any impacts on prey species have the potential to affect marine mammals.

Sensitivity of Marine Mammals to a Change in Prey Resource

614. As outlined in **Section 11.7.5.8**, harbour porpoise are considered to have low to medium sensitivity to changes in prey resources, bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin have low sensitivity, minke whale and humpback whale have low to medium sensitivity, and grey seal and harbour seal have low sensitivity.

Magnitude of impact due to a Change in Prey Resource

Temporary Habitat Loss / Disturbance

615. Activities during operation and maintenance will result in the temporary disturbance of the seabed and consequent impacts on prey species. This includes any requirement for cable reburial and/or repairs.

616. Temporary habitat loss has not been assessed as a direct impact on marine mammals, as any impacts of habitat loss would only cause an indirect effect in terms of changes in prey availability.

617. Impacts on prey will be on a considerably smaller scale and at a much lower frequency than those assessed in relation to construction. The effect significance for fish species is assessed as negligible to minor adverse (**Chapter 10: Fish and Shellfish Ecology**) for the operation and maintenance phase of the Project.

618. Due to the considerably smaller scale to any potential changes to prey resource compared to the construction phase, the magnitude for the effects of temporary habitat loss of prey species during operation and maintenance is assessed as negligible for marine mammals.

Permanent Habitat Loss

619. Habitat loss will occur during the lifetime of the Project as a result of wind turbine moorings / anchors, OSP foundations, rock protection for cables and scour protection. The introduction of these structures, scour and rock protection will alter the benthic substrate, from soft circalittoral fine mud to hard substrate. This will lead to a permanent loss of soft substrate habitat during the operational phase and will impact the benthic and fish communities reliant upon this habitat type. As outlined in **Table 11.14**, the total permanent habitat loss would be up to small, but long-term for the duration of the operation of the Project.

620. In **Chapter 9: Benthic Ecology**, the permanent habitat loss and introduction of hard substrate during the lifespan of the Project the magnitude is negligible in relation to the surrounding habitat available and the highly localised nature of the impact. Resulting in an effect significance of minor adverse (not significant). The impacts of scour on benthic communities arising from the mooring chains and anchors has also been assessed to have negligible magnitude and an effect significance of minor adverse (not significant).

621. In **Chapter 10: Fish and Shellfish Ecology** this is considered not significant in the context of the amount of similar available habitat in the wider area. Overall, due to the presence of comparable habitats identified throughout the offshore sites and the wider region, and the localised spatial extent of impacts, the magnitude of impact of permanent habitat loss during operation is assessed to be negligible, with a minor adverse to negligible effect significance for fish and shellfish species. The introduction of foundations, scour protection, hard substrate and habitats has been determined to have no impact or negligible impacts on fish and shellfish species.

622. Taking into account the small area of impact and the assessments for benthic and fish ecology, the magnitude is negligible for marine mammals for any changes to prey resources from permanent habitat loss and the introduction of hard substrate for the duration of the operational phase of the Project.

623. Permanent habitat loss has not been assessed as a direct impact on marine mammals, as any impacts of habitat loss would only cause an indirect effect in terms of changes in prey resource.

624. The introduction of various man-made structures can change to the type of habitat available, resulting in locally altered biodiversity as species are able to establish and thrive new habitats (Birchenough and Degraer, 2020). The colonisation of introduced structures may cause indirect effects on fish and shellfish populations, if the structures act as artificial reefs, with the potential of foundations acting as fish aggregation devices (FAD).

625. Studies show that the effect of a FAD results in an increase of the biomass of fish species around foundations compared to areas where there was no FAD present. Fish are attracted and aggregate from the surrounding areas as they are attracted to the new habitat by increased feeding opportunities.

626. The potential effects of increased the biomass of fish species through introduction of structures and substrates could be beneficial to marine mammals, although have been assessed as negligible as a precautionary approach.

Re-Mobilisation of Contaminated Sediments, Increased Suspended Sediments and Sediment Re-Deposition

627. Maintenance activities and cable repairs could disturb the seabed resulting in remobilisation of contaminated sediments, increases in SSC within the water column and subsequent sediment re-deposition onto the seabed. However, the volumes of sediment disturbed from maintenance activities, as well as the overall duration of the disturbance, would be significantly less compared to construction.

628. Contaminants in the area have not been reported at significantly elevated levels that would be a cause for concern. Any effects from the remobilisation of contaminated sediments and sediment redeposition are likely to be less than during the construction stage (**Chapter 8: Marine Sediment and Water Quality**). In **Chapter 10: Fish and Shellfish Ecology**, the magnitude for remobilisation of contaminated sediments and sediment redistribution is assessed as negligible / no impact, with an effect significance of negligible to minor adverse for prey species. As such the magnitude for changes in prey resources as a result of remobilisation of contaminated sediments and sediment redeposition during operation has been assessed as negligible for marine mammals.

629. Any increases in SSCs are expected to be localised and short-term at the point of discharge. Cable repairs or replacements will be infrequent and in small area compared to construction.

630. Therefore, the magnitude for any changes in prey resource as a result of any increase in SSC during the operational phase is considered to be negligible for marine mammals.

Underwater Noise

631. Sources of underwater noise that could impact prey resources during operation and maintenance include operational turbines, maintenance activities, such as cable repairs, replacement and protection, and vessels.

632. As outlined in **Section 11.7.6.1**, as sound is more readily transmitted from structures which are coupled together, operational noise from piled (fixed) foundation turbines is considered a worst case (**Appendix 9.1**). Fixed foundation turbine operational noise falls below the threshold for negative impacts on fish (**Chapter 10: Fish and Shellfish Ecology**).

633. Underwater noise for maintenance activities and vessels during operation and maintenance would be less than during construction (**Section 11.7.6.2**). The maximum impact ranges for recoverable injury and TTS to the most sensitive fish species (Group 3 and 4) is 16 m and 66 m, respectively, for both cable lying and vessels (**Table 11.74**; **Appendix 9.1**). However, it should be noted that this impact assumes a stationary fish and a stationary vessel for a period of 48 hours and 24 hours for recoverable injury and TTS to occur respectively. Overall, operational noise is conservatively assessed to have a negligible magnitude, with a negligible adverse effect significance for all receptors in **Chapter 10: Fish and Shellfish Ecology**.

634. There would be no additional impact on marine mammals as a result of any impacts on fish species from underwater noise during operation and maintenance. The magnitude of any potential impact would be negligible for marine mammals.

EMF

635. As outlined in **Section 11.7.6.6**, EMF will result from the operation of inter-array cables, offshore export cables and dynamic cables from the turbines to the seabed. EMF could potentially affect the sensory mechanisms of some species of fish and shellfish, particularly electrosensitive species (including elasmobranchs) and migratory fish species (Hutchison *et al*., 2020; **Chapter 10: Fish and Shellfish Ecology**).

636. National Grid (2022) conducted an EMF assessment for the Project (**Appendix 9.2**). The predicted magnetic fields for the Project are greatest on the seabed and reduce rapidly with vertical and horizontal distance from the buried cables. The magnetic fields for both cable route options are reduced to very low levels within a few metres from the buried cables. The magnetic fields halved in value 0.8 m from the seabed and reduced to below 1 μT at 5 m from the seabed (**Table 11.82**). It is important to note that these levels do not take account of shielding factors of the cable sheath which would further reduce the fields.

637. Similarly, the modelled results for electric fields indicate that at 5 m from the cables, the induced electric field had reduced significantly (**Table 11.83**). These reductions at vertical and horizontal distance were observed in all species. The smaller the species the smaller the predicted induced electric field. The modelling indicates very little potential risk to marine species, unless they are in very close proximity to the cables.

638. The overall magnitude of impact of EMF on fish and shellfish receptors is considered to be low to negligible in **Chapter 10: Fish and Shellfish Ecology**. EMF effects on marine mammal prey species, taking into consideration their sensitivities, are assessed to result in an overall effect significance of negligible adverse during the operation of the Project.

639. The magnitude of the effect on marine mammals as a result of any changes to prey from EMF is assessed as negligible.

Effect Significance of a Change in Prey Resource

640. Taking into account the marine mammal sensitivity (low to medium) and the potential magnitude of the impacts (negligible), the effect significance for any potential changes in prey resource during operation and maintenance has been assessed as negligible adverse or negligible to minor adverse (not significant) for all marine mammal species (**Table 11.86**).

641. As assessed in **Chapter 10: Fish and Shellfish Ecology** any potential impacts to fish species in the Offshore Development Area during operation and maintenance would be negligible to low.

642. No mitigation is required or proposed for any potential impacts on prey species during the operation and maintenance phase.

Table 11.86: Assessment of Effect significance for Any Potential Changes in Prey Resource during Operation and Maintenance

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Change in prey resource	Harbour porpoise	Low to medium	Negligible	Negligible to minor adverse	None required.	Negligible to minor adverse
	Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin	Low	Negligible	Negligible adverse		Negligible adverse
	Minke whale, and humpback whale	Low to medium	Negligible	Negligible to minor adverse		Negligible to minor adverse
	Grey seal, and harbour seal	Low	Negligible	Negligible adverse		Negligible adverse

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643. The Conservation Advice for the Southern Trench MPA (NatureScot, 2020) notes that a key prey species for minke whale is sandeels, and any impacts to the habitats of this species should be reduced in order to protect the prey resource for minke whale. As assessed above, any changes to prey species habitats are expected to be negligible or minor due to species being able to use similar adjacent habitats. All other impacts to fish species are assessed as negligible or minor adverse given their small scale of impact, and localised nature. Therefore, it is not expected that there would be any potential impact to the minke whale population in relation to the Southern Trench MPA due to a change in prey availability during operation of the Project.

11.7.7 Potential Impacts during Decommissioning

644. At the Project at end-of-life, the Project will consider the options that delivers the most benefit or least damage to the environment, at an acceptable cost. As outlined in **Chapter 5: Project Description**, prior to decommissioning, the Project will develop a Decommissioning Programme.

645. During decommissioning, the potential impacts are anticipated to be similar or less (as no piling or UXO clearance) than the worst case for the construction phase, depending on the methods used.

646. The potential impacts during decommissioning for marine mammals include:

- Underwater noise during turbine anchor and mooring substructure removal.
- Underwater noise during OSP foundation removal (depended on type of foundation and method used).
- Underwater noise and disturbance from other decommissioning activities, such as cable removal, rock protection removal or scour protection removal, if required.
- Underwater noise and disturbance from vessels.
- Barrier effects as a result of underwater noise.
- Increased collision risk with vessels.
- Changes to prey resources.

647. Potential impacts on marine mammals associated with decommissioning have not been assessed in detail, as further assessments will be carried out ahead of any decommissioning works to be undertaken taking account of known information at that time, including relevant guidelines and requirements. A detailed decommissioning programme will be provided details of the techniques to be employed and any relevant mitigation measures required.

648. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise which would not occur).

649. The potential impacts on marine mammals during decommissioning would be expected to be the same or less than those assessed for construction. **Table 11.87** provides an indicative assessment of the potential impacts during decommissioning, based on the worst case for construction.

Table 11.87 Indicative Assessment of Effect significance for Potential Impacts during Decommissioning, based on Construction

Impact	Species	Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
PTS from underwater noise: - Cutting of OSP foundations (dependent on method) – based on piling	All marine mammal species	High	Negligible	Minor adverse	MMMP, if required	Minor adverse
TTS and Disturbance from underwater noise: - Turbine anchor and mooring substructure removal - OSP foundation removal - Other decommissioning activities - Vessels	All marine mammal species	Medium	Negligible to Low	Minor adverse	None required	Minor adverse
Barrier effects from underwater noise	All marine mammal species	Medium	Negligible to Low	Minor adverse	None required	Minor adverse
Increased collision risk with vessels	Bottlenose dolphin	High	Negligible to Low	**Moderate to Minor adverse**	**Best practice measures in CEMP** (see **Section 11.7.5.6**).	Minor adverse
	Harbour seal	High	Low	**Moderate adverse**		Minor adverse
	All marine mammal species	High	Negligible	Minor adverse		Minor adverse
Changes to prey resources	All marine mammal species	Low to Medium	Negligible to Low	Negligible to Minor adverse	None required.	Negligible to Minor adverse

11.8 Cumulative Impacts

650. The cumulative impacts that have screened in for assessment are:

- Impact CIA1: Disturbance due to underwater noise during construction and piling of the Project
- Impact CIA2: Cumulative barrier effects from underwater noise or physical presence during construction or operation of the Project
- Impact CIA3: Increased collision risk with vessels during construction and operation of the Project
- Impact CIA4: Entanglement during operation of the Project
- Impact CIA5: Changes to prey resources during construction or operation of the Project

651. All potential cumulative impacts are detailed in **Table 11.88**, and a rationale for either screening in or out to the cumulative assessment is provided.

Table 11.88 Potential Cumulative Impacts with the Project

Impact	Potential for cumulative impact	Data confidence	Rationale
The risk of permanent change in hearing sensitivity (PTS) from underwater noise	No	Medium	PTS could occur as a result of pile driving during offshore wind farm installation, pile driving during oil and gas platform installation, underwater explosives (used occasionally during the removal of underwater structures and UXO clearance) and seismic surveys (JNCC, 2010a, 2017). However, if there is the potential for any PTS, from any project, suitable mitigation would be put in place to reduce any risk to marine mammals. Other activities such as dredging, rock placement, vessel activity, operational windfarms, oil and gas installations or wave and tidal sites will emit broadband noise in lower frequencies and PTS from these activities is very unlikely. **Therefore, the potential risk of PTS in marine mammals from cumulative impacts has been screened out from further consideration in the CIA.**
The risk of temporary change in hearing sensitivity (TTS) from underwater noise	No	Medium	Where there is little information on the potential disturbance ranges for marine mammals, TTS has been used to indicate possible fleeing response (see **Section 11.7.5.3**). It is acknowledged that disturbance is likely to have greater impact ranges than for TTS. The risk of TTS will be within disturbance ranges for marine mammals. The effects of TTS in marine mammals are temporary. **TTS / fleeing response has been screened out of the CIA, but is used to inform the assessment of disturbance impacts where there is a lack of further relevant information for disturbance.**
Disturbance from underwater noise	Yes	High	The potential for the disturbance to marine mammals from underwater noise has been screened into the CIA. See **Section 11.8.1**.
Barrier effects due to disturbance and physical presence of the wind farm	Yes	High	The potential for cumulative projects to cause a barrier effect has been considered further in **Section 11.8.2**.
Vessel collision risk	Yes	High	The potential for cumulative projects to cause an increase in vessels collision risk has been considered further in **Section 11.8.3**.
Entanglement	Yes		The potential for cumulative projects to cause risk of entanglement has been considered further in **Section 11.8.4**.
Changes to prey resource	Yes	High	The potential for cumulative projects to cause a change to prey resource from has been considered further in **Section 11.8.5**.

11.8.1 Impact 1: CIA for Disturbance Due to Underwater Noise During Construction of the Project

11.8.1.1 Summary of CIA Screening and Approach to Assessment for Disturbance

652. The full CIA screening process for marine mammals is provided in **Appendix 11.1**. **Table 11.89** summarises the activities, plans and projects screened into the CIA with the potential for disturbance effects from underwater noise during construction of the Project. A long list of potential projects to be screened into cumulative impact assessment is provided in **Appendix 20.1**, however, this long list excludes some projects for which impacts are identified for marine mammals only. All projects where there is potential for cumulative impact on marine mammals are included in the assessment and described in **Appendix 11.1**.

653. It was not considered that any cumulative impacts would arise with the decommissioning of O&G facilities, and therefore, Decommissioning Plans have not been screened in.

Table 11.89 Summary of Activities, Plans and Projects Screened into the CIA for Disturbance Effects

Impact	Potential for Cumulative Impact	Projects
Disturbance from underwater noise	Piling at other OWFs	The OWFs that could be piling at the same time as the Project, and therefore screened into the CIA for further assessment are: • Berwick Bank (Seagreen Charlie Delta Echo) • Dogger Bank South (East and West) • Dunkerque • Hornsea Project Four • Hornsea Project Three[17] • Norfolk Boreas • Norfolk Vanguard[17] • Outer Dowsing • Stora Middelgrund • Thor
	Other construction activities at OWFs (other than piling) including vessels, cable installation works, dredging, seabed preparation and rock placement	The OWFs screened in for other construction activities that could have cumulative impacts with other construction activities at the Project are: • Aspen (floating) • Beech North (floating) • Beech South (floating) • Dieppe - Le Treport • Dolphyn Project - pre-commercial (floating) • Dudgeon Extension • East Anglia ONE North • East Anglia THREE • East Anglia TWO • Inch Cape • Ossian • Pentland Floating Demo (formerly Dounreay Tri) • Salamander (floating) • Sheringham Shoal Extension • Sofia (formerly Dogger Bank Teesside B)
	Geophysical surveys at OWFs	Unknown It is therefore assumed, as a worst case scenario, that there could potentially be up to two geophysical surveys at OWFs in the North Sea at any one time, during construction of the Project.
	Marine Renewable Energy (MRE) projects (wave and tidal) – construction phase only	All MRE projects screened out as no potential overlapping construction windows with the Project.
	Aggregate extraction and dredging	Aggregate extraction and dredging projects screened in for the potential for cumulative impact with the Project are: • East Orford Ness • EEC 5 South • EEC 5 South • Lowestoft Extension • West Bassurelle Extension • Goodwin Sands • Off Great Yarmouth • Median Deep • West Wight • Greenwich Light East • Greenwich Light East • Greenwich Light East • Greenwich Light East

[17] *Where projects have the same developer, it is assumed (unless further information is known), that only one will be piled at a time, and therefore additional projects with the same developer and similar construction windows are screened out of assessment of concurrent piling, and assessed as undergoing construction at the same time as the Project*

Impact	Potential for Cumulative Impact	Projects
	Oil and gas installation projects	Oil and gas installation projects screened in for the potential for cumulative impact with the Project are: • Rosebank Field Development • Teal West Development
	Oil and gas seismic surveys	Unknown It is therefore assumed, as a worst case scenario, that there could potentially be up to one seismic surveys in the North Sea at any one time, during construction of the Project.
	Subsea cable and pipelines	Installation of pipeline project screened in: • Hewett Depleted Gas
	Other marine projects (gas storage, offshore mines and carbon capture)	None screened in as no potential overlapping construction windows with the Project.
	UXO clearance	Unknown It is assumed UXO clearance would use low-order technique. However, as a worst case scenario, CIA includes potential for one UXO high-order detonation (no mitigation) and one low-order detonation in the North Sea at the same time as construction of the Project.

654. **Table 11.90** summarises the activities and types of projects screened out of the CIA. Further details and justification is provided in **Appendix 11.1**.

Table 11.90 Summary of Activities and Types of Projects Screened out of the CIA

Impact	Potential for Cumulative Impact	Activities and types of projects screened out
Disturbance from underwater noise	No	The activities and types of projects screened out of the CIA, as no potential for significant contribution to underwater noise cumulative impacts during construction, are: • Operational OWFs • Maintenance of operational OWFs • Decommissioning of OWFs • Marine renewable (wave and tidal) developments – operation and decommissioning phases • Licensed disposal sites • Shipping • Oil and gas decommissioning projects • Commercial fisheries

655. The CIA screening identified that there is the potential for cumulative impacts on marine mammals as a result of disturbance from underwater noise during piling and other construction activities. Other potential impacts, including PTS from underwater noise, TTS from underwater noise, were screened out of the CIA (see **Appendix 11.1**). All operational impacts have also been screened out of assessment.

656. The approach to the assessment for cumulative disturbance from underwater noise for harbour porpoise has been based on the worst case approach for the assessment of disturbance in **Section 11.7.5.3**, including the current advice from the SNCBs (JNCC *et al.*, 2020) on the assessment of impacts on the harbour porpoise designated SACs.

657. The potential disturbance from underwater noise during piling for other marine mammal species has been assessed based on the worst case maximum area modelled for the Project for each species, using TTS / fleeing response as a proxy for disturbance, where no further information on potential disturbance impact ranges are available.

658. The potential disturbance from offshore wind farms during non-piling construction activities, such as vessel noise and cable installation, has been based on the worst case area modelled for the Project for other construction activities, including vessels (see **Sections 11.7.5.4** and **11.7.5.5**).

659. Where a quantitative assessment has been possible, the potential magnitude of disturbance has been based on the number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, and minke whale in the potential impact areas using the latest SCANS-III density estimates (Hammond *et al*., 2021). For humpback whale, only the projects within Scottish waters have been included in the cumulative assessments, as their presence is rare in the southern North Sea, and in the absence of available density estimates for humpback whale, the estimate for the Project has been used in all relevant cumulative assessments.

660. For bottlenose dolphin, only those projects within the CES MU have been assessed within that MU, and those within the GNS MU, have been assessed as being a part of that MU.

661. The number of grey and harbour seal in the potential impact areas has been estimated based on the seal at sea usage maps (Carter *et al*., 2020).

662. It is intended that this approach to assessing the potential cumulative impacts of disturbance from underwater noise will reduce some of the uncertainties and complications in using the different assessments from EIAs, based on different noise models, thresholds and criteria, as well as different approaches to density estimates.

663. It should be noted that a large amount of uncertainty is inherent in the CIA. At the project level, uncertainty in the assessment process has been expressed as a level of the confidence in the data used in the assessment. This relates to confidence in both the understanding of the consequences of the potential impacts on marine mammals, but also the information used to inform the predicted magnitude and significance of project impacts on marine mammals. As outlined in the tier approach, there is more information and certainty for lower tiers, compared to higher tiers (JNCC and Natural England, 2013).

664. In the CIA, the potential for impacts over wider spatial and temporal scales means that the uncertainty arising from the consideration of a large number of plans or projects leads to a lower confidence in the information used in the assessment, but also the conclusions of the assessment itself. To take this uncertainty into account, where possible, a precautionary approach has been taken at multiple stages of the assessment process.

665. The approach to dealing with uncertainty has led to a highly precautionary assessment of the cumulative impacts, especially for pile driving, as the CIA is based on the worst case scenarios for all projects included. It should therefore be noted that building precaution on precaution can lead to unrealistic worst case scenarios within the assessment.

666. Therefore, the assessment is based on the most realistic worst case scenario to reduce any uncertainty and avoid presentation of highly unrealistic worst case scenarios, while still providing a conservative assessment. Careful consideration has been given to determine the most realistic worst case scenario for the CIA.

11.8.1.2 Impact 1a: Assessment of Disturbance from Underwater Noise for Piling at Offshore Wind Farms

667. Following the initial screening of UK and European OWFs, the next stage of the screening exercise was undertaken on those projects that have been identified as having the potential for cumulative construction impacts. This stage of the screening is based on known construction periods of UK and European OWF projects, including known piling and /or construction timings, in order to determine a more realistic, but still worst case, list of UK and European OWF projects that may the potential for overlapping piling with the Project (**Appendix 11.1**).

668. Within this stage of the screening, it is assumed that, where OWF developers have more than one offshore wind farm, they are unlikely to develop more than one site at a time, unless further information is available (for example, in the case of the East Anglia Hub where two sites could be developed at the same time).

669. Of the UK and European OWFs screened in for having a construction period that could potentially overlap with the construction of the Project, ten UK OWFs could be piling at the same time as the Project, which is estimated to take place in 2027:

- Berwick Bank (Seagreen Charlie Delta Echo) (for all species)
- Dogger Bank South (East and West) (for all cetacean species, except humpback whale)
- Dunkerque (for all cetacean species, except humpback whale)
- Hornsea Project Four (for all cetacean species, except humpback whale)
- Norfolk Boreas (for all cetacean species, except humpback whale)
- Outer Dowsing (for all cetacean species, except humpback whale)
- Stora Middelgrund (for all cetacean species, except harbour porpoise and humpback whale)
- Thor (for all cetacean species, except humpback whale)

670. This more realistic short list of OWF projects that could be piling at the same time as the Project could change as projects develop, but this is the best available information at the time of writing, and more accurately reflects the limitations and constraints to project delivery.

671. The commitment to the mitigation measures agreed through the MMMP for piling (**Section 11.7.1.1**) would reduce the risk of physical injury or permanent auditory injury (PTS) for all marine mammals. As such, the Project would not contribute to any cumulative impacts for physical injury or permanent auditory injury (PTS) from piling activities, and therefore the following assessment only considers potential disturbance effects to marine mammals.

Sensitivity to Disturbance

672. As outlined in **Section 11.7.4.4**, all marine mammal species are assessed as having medium sensitivity to disturbance from underwater noise sources.

Magnitude of Potential Disturbance from Piling at other Offshore Wind Farms

673. The magnitude of the potential disturbance from piling activities has been estimated for each individual project screened in for assessment, based on the following disturbance ranges for each marine mammal species:

- Harbour porpoise (Table 11.91)
  - The potential impact area during single pile installation, based on the EDR of 26 km for monopile (as worst case) at the other OWFs (2,123.7 km^2 per project) and 15 km EDR for the OSP pin-piles (as worst case) at the Project (706.86 km^2) (see **Section 11.7.5.3**).
- Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin (**Table 11.92**)
  - The potential impact area during single pile installation, based on maximum impact range and area for the worst case modelled for the Project for a strong behavioural response of 3.491 km from each piling location (38.29 km^2 per project) (see **Section 11.7.5.3**).
- Minke whale and humpback whale (Table 11.93)
  - The potential impact area during single pile installation, based on maximum impact range and area for the worst case modelled for the Project for a TTS of 39.8 km from each piling location (4,976.41 km^2 per project). While the potential for a behavioural reaction was modelled for whale species, the range is considerably smaller than as modelled for TTS, and therefore the ranges for TTS are assessed as the worst case (see **Section 11.7.5.3**).
- Grey seal and harbour seal (Table 11.94)
  - The potential impact area during single pile installation, based on maximum impact range and area for the worst case modelled for the Project for a strong behavioural response of 3.491 km from each piling location (38.29 km^2 per project) (see **Section 11.7.5.3**).

674. It should be noted that the potential areas of disturbance assume that there is no overlap in the areas of disturbance between different projects and are therefore highly conservative.

675. Piling of the OSP foundations (four pin-piles) at the Windfarm Site has been included in the CIA as a worst case scenario. It is also assumed that all OWF projects would be 100% piled, as a worst case if piled foundations is an option for turbines.

676. The approach to the CIA for piling at OWFs is based on the potential for single piling at each wind farm at the same time as piling at the Windfarm Site. This approach allows for some of the offshore wind farms not to be piling at the same time, while others could be simultaneously piling (further information is available in **Appendix 11.1**). This is considered to be the most realistic worst-case scenario, as it is highly unlikely that all other wind farms would be simultaneously piling at exactly the same time as piling at the Project, especially given the limited active piling time.

677. It is important to note the actual duration for active piling time (a maximum of 41 hours) which could disturb marine mammals is only a very small proportion of the potential construction period for the Project, based on the estimated maximum duration to install individual piles (**Table 11.14**). This means that there is a limited window for any cumulative impact to occur.

678. For harbour porpoise, the potential worst-case scenario for piling at OWFs including the Project is assessed in (**Table 11.91**). The potential magnitude of the temporary impact is assessed as low, however, this is very precautionary, as it is unlikely that all projects could be simultaneously piling at exactly the same time as piling at the Project and all other offshore wind farm projects.

679. In practice, the potential temporary impacts would be less than those predicted in this assessment as there is likely to be a great deal of variation in timing, duration, and hammer energies used throughout the various offshore wind farm project construction periods. In addition, not all individuals would be displaced over the entire potential disturbance range (26 km) used within the assessments. For example, the study of harbour porpoise at Horns Rev (Brandt *et al*., 2011), indicated that at closer distances (2.5 to 4.8 km) there was 100% avoidance, however, this proportion decreased significantly moving away from the pile driving activity and at distances of 10 km to 18 km avoidance was 32% to 49% and at 21 km the abundance was reduced by just 2%.

Table 11.91 Quantified CIA for the Potential Disturbance of Harbour Porpoise During Single Piling at the Offshore Wind Farm Projects Which Could be Piling at the Same Time as the Project

Harbour porpoise				
Project	**SCANS-III Block**	**Harbour porpoise density (/km^2)**	**Impact area (km^2) (26 km EDR)**	**Maximum number of individuals potentially disturbed during single piling**
Green Volt	R	0.599	706.86	423.4
Berwick Bank (Seagreen Charlie Delta Echo)	R	0.599	2123.7	1,272.1
Dogger Bank South (East and West)	O	0.888	2123.7	1,885.8
Dunkerque	L	0.607	2123.7	1,289.1
Hornsea Project Four	O	0.888	2123.7	1,885.8
Norfolk Boreas	O	0.888	2123.7	1,885.8
Outer Dowsing	O	0.888	2123.7	1,885.8
Thor	M	0.277	2123.7	588.3
Total number of harbour porpoise ***(without Green Volt)***				**11,116** ***(10,693)***
Percentage of NS MU ***(without Green Volt)***				**3.21%** ***(3.09%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Low** ***(Low)***

680. The CIA for bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin for OWFs that could be piling at the same time as the Project is provided in **Table 11.92**. The

potential magnitude for the cumulative impacts of piling is assessed as negligible to low for bottlenose dolphin, with less than 1% or 1% to 5% of the reference population that could be temporarily disturbed, depending on the reference population assessed. For white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin, the magnitude is assessed as negligible.

Table 11.92 Quantified CIA for the Potential Disturbance for Dolphin Species During Single Piling at the Offshore Wind Farm Projects Which Could be Piling at the Same Time as the Project

Project	SCANS-III Block	Dolphin species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed during single piling
Bottlenose dolphin*				
Green Volt	R	0.0298	38.3	1.1
Berwick Bank (Seagreen Charlie Delta Echo)	R	0.0298	38.3	1.1
Dogger Bank South (East and West)	O	-	38.3	0
Dunkerque	L	-	38.3	0
Hornsea Project Four	O	-	38.3	0
Norfolk Boreas	O	-	38.3	0
Outer Dowsing	O	-	38.3	0
Stora Middelgrund	2	-	38.3	0
Thor	M	-	38.3	0
Total number of bottlenose dolphin ***(without Green Volt)***				**2.3** ***(1.1)***
Percentage of CES MU (only projects within the CES MU) ***(without Green Volt)***				**1.02%** ***(0.51%)***
Percentage of GNS MU (only projects within the GNS MU) ***(without Green Volt)***				**0.11%** ***(0.06%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible to Low** ***(Negligible)***
White-beaked dolphin				
Green Volt	R	0.243	38.3	9.3
Berwick Bank (Seagreen Charlie Delta Echo)	R	0.243	38.3	9.3
Dogger Bank South (East and West)	O	0.002	38.3	0.1
Dunkerque	L	-	38.3	0
Hornsea Project Four	O	0.002	38.3	0.1
Norfolk Boreas	O	0.002	38.3	0.1
Outer Dowsing	O	0.002	38.3	0.1
Stora Middelgrund	2	-	38.3	0
Thor	M	-	38.3	0
Total number of white-beaked dolphin ***(without Green Volt)***				**18.9** ***(9.6)***
Percentage of CGNS MU ***(without Green Volt)***				**0.04%** ***(0.02%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***
Atlantic white-sided dolphin				
Green Volt	N/A	0.028	38.3	1.1
Berwick Bank (Seagreen Charlie Delta Echo)	R	0.01	38.3	0.4

Project	SCANS-III Block	Dolphin species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Dogger Bank South (East and West)	O	-	38.3	0
Dunkerque	L	-	38.3	0
Hornsea Project Four	O	-	38.3	0
Norfolk Boreas	O	-	38.3	0
Outer Dowsing	O	-	38.3	0
Stora Middelgrund	2	-	38.3	0
Thor	M	-	38.3	0
Total number of Atlantic white-sided dolphin ***(without Green Volt)***				**1.5** ***(0.4)***
Percentage of CGNS MU ***(without Green Volt)***				**0.01%** ***(0.002%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***
Risso's Dolphin				
Green Volt	N/A	0.0018	38.3	0.1
Berwick Bank (Seagreen Charlie Delta Echo)	R	-	38.3	0
Dogger Bank South (East and West)	O	-	38.3	0
Dunkerque	L	-	38.3	0
Hornsea Project Four	O	-	38.3	0
Norfolk Boreas	O	-	38.3	0
Outer Dowsing	O	-	38.3	0
Stora Middelgrund	2	-	38.3	0
Thor	M	-	38.3	0
Total number of Risso's Dolphin ***(without Green Volt)***				**0.1** ***(0)***
Percentage of CGNS MU ***(without Green Volt)***				**0.0004%** ***(0%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***

**Note - some projects are within both MUs and are included in both MU assessments.*

681. For minke whale, the potential magnitude of the temporary impact is assessed as low, with between 1% and 5% of the reference population likely to be exposed to the temporary impact, and for humpback whale, the magnitude of temporary impact is negligible, with less than 1% of the reference population potentially temporary impacted (**Table 11.93**).

Table 11.93 Quantified CIA for the Potential Disturbance of Whale Species During Single Piling at the Offshore Wind Farm Projects Which Could be Piling at the Same Time as the Project

Project	SCANS-III Block	Whale species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Minke whale				
Green Volt	R	0.0387	4,976.4	192.6
Berwick Bank (Seagreen Charlie Delta Echo)	R	0.0387	4,976.4	192.6
Dogger Bank South (East and West)	O	0.01	4,976.4	49.8

Project	SCANS-III Block	Whale species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Minke whale				
Dunkerque	L	-	4,976.4	0
Hornsea Project Four	O	0.01	4,976.4	49.8
Norfolk Boreas	O	0.01	4,976.4	49.8
Outer Dowsing	O	0.01	4,976.4	49.8
Stora Middelgrund	2	-	4,976.4	0
Thor	M	-	4,976.4	0
Total number of minke whale *(without Green Volt)*				**584.2 *(391.6)***
Percentage of CGNS MU *(without Green Volt)*				**2.90% *(1.95%)***
Magnitude of cumulative impact *(without Green Volt)*				**Low *(Low)***
Humpback whale*				
Green Volt		0.000015	4,976.4	0.0746
Berwick Bank (Seagreen Charlie Delta Echo)		0.000015	4,976.4	0.0746
Total number of humpback whale *(without Green Volt)*				**0.1493 *(0.0746)***
Percentage of reference population *(without Green Volt)*				**0.000427% *(0.000213%)***
Magnitude of cumulative impact *(without Green Volt)*				**Negligible *(Negligible)***

** Based on the density at Green Volts (for SCANS-III Block T). Projects in Scotland, only given rarity of species in southern North Sea*

682. For grey and harbour seal, based on a single pile installation at each of the offshore wind farms during piling at the Project, the potential magnitude for the cumulative impacts of piling is assessed as negligible for both species with less than 1% of the reference population with the potential to be temporarily impacted (**Table 11.94**).

Table 11.94 Quantified CIA for the Potential Disturbance of Seal Species During Single Piling at the Offshore Wind Farm Projects Which Could be Piling at the Same Time as the Project

Project	Seal species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Grey seal			
Green Volt	0.049	38.3	1.9
Berwick Bank (Seagreen Charlie Delta Echo)	0.993	38.3	38.0
Total number of grey seal *(without Green Volt)*			**39.9 *(38.0)***
Percentage of wider reference population *(without Green Volt)*			**0.19% *(0.18%)***
Magnitude of cumulative impact *(without Green Volt)*			**Negligible *(Negligible)***
Harbour seal			
Green Volt	0.000002	38.3	0.0001

Project	Seal species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Berwick Bank (Seagreen Charlie Delta Echo)	0.00001	38.3	0.0005
Total number of harbour seal ***(without Green Volt)***			**0.001** ***(0.0005)***
Percentage of wider reference population ***(without Green Volt)***			**0.00003%** ***(0.00002%)***
Magnitude of cumulative impact ***(without Green Volt)***			**Negligible** ***(Negligible)***

Effect significance of Potential Disturbance during Offshore Wind Farm Piling

683. If all included offshore wind farms were piling at the same time as the Project, there is the potential for a low to negligible magnitude of impact (dependent on species), however, as outlined above, it is highly unlikely that all offshore wind farms could be simultaneously piling at exactly the same time as the short duration of piling of the OSP pin-piles in the Windfarm Site.

684. Taking into account the medium receptor sensitivity for all marine mammal species, the overall cumulative impact assessment for disturbance to marine mammals from piling at offshore wind farms including the Project is **minor adverse (not significant)** for all species. This is deemed to be a conservative assessment based on the worst case scenario for offshore wind farms piling at the same time as the Project.

685. No further mitigation measures are required or proposed for the Project to reduce the potential for cumulative disturbance due to other OWFs piling at the same time as the Project.

686. The confidence in this impact assessment is relatively high as it is deemed precautionary enough to comfortably encompass the likely uncertainty and variability. Throughout the assessment it has been made clear where multiple and compounding precautionary assumptions have been made. Additionally, where possible, the uncertainty in the data typically used to inform CIAs and the quantification of impacts when based on published ESs, has been removed by using a standard impact range for disturbance and the same source for density estimates (e.g. SCANS-III or Waggitt *et al*. (2019) and Carter *et al*. (2020) seal-at sea density estimates) for all offshore wind farm sites.

Table 11.95 Cumulative Effect significance for Disturbance to Marine Mammals from Piling at Offshore Wind Farms including the Project

Cumulative Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Disturbance from underwater noise during piling at OWFs including the Project	Harbour porpoise	Medium	Low	Minor adverse	None required.	Minor adverse
	Bottlenose dolphin		Negligible for GNS MU (Low for CES MU)	Minor adverse		Minor adverse
	White-beaked dolphin		Negligible	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Negligible	Minor adverse		Minor adverse
	Risso's dolphin		Negligible	Minor adverse		Minor adverse
	Minke whale		Low	Minor adverse		Minor adverse
	Humpback whale		Negligible	Minor adverse		Minor adverse
	Grey seal		Negligible	Minor adverse		Minor adverse

Cumulative Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
	Harbour seal		Negligible	Minor adverse		Minor adverse

11.8.1.3 Impact 1b: Assessment of Disturbance from Underwater Noise for Construction Activities (Other than Piling) at Offshore Wind Farms

687. All OWFs with construction dates that have the potential to overlap with the construction dates for the Project, have the potential for other construction activities (such as seabed preparation, mooring installation, cable installation and vessels) to occur at the same time as other construction activities at the Project.

688. OWFs screened in for other construction activities that could have potential cumulative impacts with other construction activities at the Project are (**Appendix 11.1**):

- Aspen (floating) (for all cetacean species)
- Beech North (floating) (for all marine mammal species)
- Beech South (floating) (for all marine mammal species)
- Dieppe - Le Treport (for all cetacean species except bottlenose dolphin and humpback whale)
- Dolphyn Project - pre-commercial (floating) (for all marine mammal species
- Dudgeon Extension (for all cetacean species except humpback whale)
- East Anglia ONE North (for all cetacean species except humpback whale)
- East Anglia THREE (for all cetacean species except humpback whale)
- East Anglia TWO (for all cetacean species except humpback whale)
- Hornsea Project Three (for all cetacean species except humpback whale)
- Inch Cape (for all marine mammal species)
- Norfolk Vanguard (for all cetacean species except humpback whale)
- Ossian (for all marine mammal species)
- Pentland (floating) (for all cetacean species)
- Salamander (floating) (for all marine mammal species)
- Sheringham Extension (for all cetacean species except humpback whale)
- Sofia (formerly Dogger Bank Teesside B) (for all cetacean species except humpback whale)

Sensitivity to Disturbance

689. As outlined in **Section 11.7.4.4**, all marine mammal species are assessed as having medium sensitivity to disturbance from underwater noise sources.

Magnitude of Potential Disturbance

690. During the construction of the Project, there is the potential for overlap with impacts from the non-piling construction activities at other offshore wind farms. Noise sources which could cause potential disturbance impacts during offshore wind farm construction activities, other than pile driving, can include vessels, mooring installation, seabed preparation, cable installation works and rock placement.

691. The CIA includes all projects that could have non-piling construction activities during the Project construction period. The approach to the CIA is the same as for piling.

692. The potential disturbance from offshore wind farms during non-piling construction activities, such as vessel noise, seabed preparation, rock placement and cable installation, has been based on the worst case area modelled for the Project for cable trenching / cutting or vessels (see **Sections 11.7.5.4** and **11.7.5.5**):

- All marine mammal species

- The potential impact area, based on the worst case disturbance range of 9.284 km for cable trenching / cutting or for a survey, crew transfer, or support vessel, with an area of 270.8 km^2 per project, including the Project (see **Sections 11.7.5.4** and **11.7.5.5**).

693. For harbour porpoise, based on the worst-case scenario, for all offshore wind farms that could be constructing at the same time as the Project, the potential magnitude of the temporary impact is assessed as negligible, with less than 1% of the reference population potentially temporarily disturbed (**Table 11.96**).

Table 11.96 Quantified CIA for the Potential Disturbance of Harbour Porpoise During the Construction (other than Piling) at Offshore Wind Farm Projects at the Same Time as Construction at the Project

Harbour porpoise				
Project	**SCANS-III Block**	**Harbour porpoise density (/km^2)**	**Impact area (km^2)**	**Maximum number of individuals potentially disturbed**
Green Volt	R	0.599	270.8	162.2
Aspen (floating)	S & T	0.402	270.8	108.9
Beech North (floating)	T	0.402	270.8	108.9
Beech South (floating)	R	0.599	270.8	162.2
Dieppe - Le Treport	C	0.213	270.8	57.7
Dolphyn Project - pre-commercial (floating)	S & T	0.402	270.8	108.9
Dudgeon Extension	O	0.888	270.8	240.5
East Anglia ONE North	L	0.607	270.8	164.4
East Anglia THREE	O & L	0.888	270.8	240.5
East Anglia TWO	L	0.607	270.8	164.4
Inch Cape	R	0.599	270.8	162.2
Ossian	R	0.599	270.8	162.2
Pentland (floating)	S	0.152	270.8	41.2
Salamander (floating)	R	0.599	270.8	162.2
Sheringham Extension	O	0.888	270.8	240.5
Sofia (formerly Dogger Bank Teesside B)	O	0.888	270.8	240.5
Hornsea Project Three	O	0.888	270.8	240.5
Norfolk Vanguard	O & L	0.888	270.8	240.5
Total number of harbour porpoise ***(without Green Volt)***				**3,008** ***(2,846)***
Percentage of NS MU ***(without Green Volt)***				**0.87%** ***(0.82%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***

694. Based on all offshore wind farms with the potential for overlapping construction periods with the Project, the magnitude of impact for bottlenose dolphin is assessed as low to medium, depending on the reference population assessment, with between 1% and 5% or between 5% and 10% of the reference population, for the GNS and CES MUs, respectively (**Table 11.97**).

695. For white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin the potential magnitude of the temporary impact is assessed as negligible, with less than 1% of the reference population potentially temporarily disturbed (**Table 11.97**).

Table 11.97 Quantified CIA for the Potential Disturbance of Dolphin Species During Construction (other than Piling) at Offshore Wind Farm Projects at the Same Time as Construction at the Project

Project	SCANS-III Block	Dolphin species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Bottlenose dolphin*				
Green Volt	R	0.0298	270.8	8.1
Aspen (floating)	S & T	0.0037	270.8	1.0
Beech North (floating)	T	-	270.8	0.0
Beech South (floating)	R	0.0298	270.8	8.1
Dolphyn Project - pre-commercial (floating)	S & T	0.0037	270.8	1.0
Dudgeon Extension	O	-	270.8	0.0
East Anglia ONE North	L	-	270.8	0.0
East Anglia THREE	O & L	-	270.8	0.0
East Anglia TWO	L	-	270.8	0.0
Inch Cape	R	0.0298	270.8	8.1
Ossian	R	0.0298	270.8	8.1
Pentland (floating)	S	0.0037	270.8	1.0
Salamander (floating)	R	0.0298	270.8	8.1
Sheringham Extension	O	-	270.8	0.0
Sofia (formerly Dogger Bank Teesside B)	O	-	270.8	0.0
Hornsea Project Three	O	-	270.8	0.0
Norfolk Vanguard	O & L	-	270.8	0.0
Total number of bottlenose dolphin ***(without Green Volt)***				**43.4** ***(35.3)***
Percentage of CES MU ***(without Green Volt)***				**7.65%** ***(4.05%)***
Percentage of GNS MU ***(without Green Volt)***				**2.14%** ***(1.75%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Low to Medium** ***(Low)***
White-beaked dolphin				
Green Volt	R	0.243	270.8	65.8
Aspen (floating)	S & T	0.037	270.8	10.0
Beech North (floating)	T	0.037	270.8	10.0
Beech South (floating)	R	0.243	270.8	65.8
Dieppe - Le Treport	C	-	270.8	0.0
Dolphyn Project - pre-commercial (floating)	S & T	0.037	270.8	10.0
Dudgeon Extension	O	0.002	270.8	0.5
East Anglia ONE North	L	-	270.8	0.0
East Anglia THREE	O & L	0.002	270.8	0.5
East Anglia TWO	L	-	270.8	0.0
Inch Cape	R	0.243	270.8	65.8
Ossian	R	0.243	270.8	65.8
Pentland (floating)	S	0.021	270.8	5.7
Salamander (floating)	R	0.243	270.8	65.8
Sheringham Extension	O	0.002	270.8	0.5

Project	SCANS-III Block	Dolphin species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Sofia (formerly Dogger Bank Teesside B)	O	0.002	270.8	0.5
Hornsea Project Three	O	0.002	270.8	0.5
Norfolk Vanguard	O & L	0.002	270.8	0.5
Total number of white-beaked dolphin ***(without Green Volt)***				**368** **(302)**
Percentage of CGNS MU ***(without Green Volt)***				**0.84%** ***(0.69%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** **(*Negligible*)**
Atlantic white-sided dolphin				
Green Volt	N/A	0.028	270.8	7.6
Aspen (floating)	S & T	0.0209	270.8	5.7
Beech North (floating)	T	0.0209	270.8	5.7
Beech South (floating)	R	0.01	270.8	2.7
Dieppe - Le Treport	C	-	270.8	0.0
Dolphyn Project - pre-commercial (floating)	S & T	0.0209	270.8	5.7
Dudgeon Extension	O	-	270.8	0.0
East Anglia ONE North	L	-	270.8	0.0
East Anglia THREE	O & L	-	270.8	0.0
East Anglia TWO	L	-	270.8	0.0
Inch Cape	R	0.01	270.8	2.7
Ossian	R	0.01	270.8	2.7
Pentland (floating)	S	-	270.8	0.0
Salamander (floating)	R	0.01	270.8	2.7
Sheringham Extension	O	-	270.8	0.0
Sofia (formerly Dogger Bank Teesside B)	O	-	270.8	0.0
Hornsea Project Three	O	-	270.8	0.0
Norfolk Vanguard	O & L	-	270.8	0.0
Total number of Atlantic white-sided dolphin ***(without Green Volt)***				**35.4** ***(27.8)***
Percentage of CGNS MU ***(without Green Volt)***				**0.20%** ***(0.15%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** **(*Negligible*)**
Risso's Dolphin				
Green Volt	N/A	0.0018	270.8	0.5
Aspen (floating)	S & T	-	270.8	0
Beech North (floating)	T	-	270.8	0
Beech South (floating)	R	-	270.8	0
Dieppe - Le Treport	C	-	270.8	0
Dolphyn Project - pre-commercial (floating)	S & T	-	270.8	0
Dudgeon Extension	O	-	270.8	0

Project	SCANS-III Block	Dolphin species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
East Anglia ONE North	L	-	270.8	0
East Anglia THREE	O & L	-	270.8	0
East Anglia TWO	L	-	270.8	0
Inch Cape	R	-	270.8	0
Ossian	R	-	270.8	0
Pentland (floating)	S	-	270.8	0
Salamander (floating)	R	-	270.8	0
Sheringham Extension	O	-	270.8	0
Sofia (formerly Dogger Bank Teesside B)	O	-	270.8	0
Hornsea Project Three	O	-	270.8	0
Norfolk Vanguard	O & L	-	270.8	0
Total number of Risso's Dolphin ***(without Green Volt)***				**0.5** ***(0)***
Percentage of CGNS MU ***(without Green Volt)***				**0.0027%** ***(0)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***

**Note - some projects are within both MUs and are included in both MU assessments.*

696. Based on the offshore wind farms that could be undergoing construction at the same time as the Project, the magnitude of the temporary impact is assessed as negligible for minke whale and humpback whale (**Table 11.98**).

Table 11.98 Quantified CIA for the Potential Disturbance of Whale Species During Construction (other than Piling) at Offshore Wind Farm Projects at the Same Time as Construction at the Project

Project	SCANS-III Block	Whale species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Minke whale				
Green Volt	R	0.0387	270.8	10.5
Aspen (floating)	S & T	0.0316	270.8	8.6
Beech North (floating)	T	0.0316	270.8	8.6
Beech South (floating)	R	0.0387	270.8	10.5
Dieppe - Le Treport	C	0.0023	270.8	0.6
Dolphyn Project - pre-commercial (floating)	S & T	0.0316	270.8	8.6
Dudgeon Extension	O	0.01	270.8	2.7
East Anglia ONE North	L	-	270.8	0.0
East Anglia THREE	O & L	0.01	270.8	2.7
East Anglia TWO	L	-	270.8	0.0
Inch Cape	R	0.0387	270.8	10.5
Ossian	R	0.0387	270.8	10.5
Pentland (floating)	S	0.0095	270.8	0
Salamander (floating)	R	0.0387	270.8	10.5
Sheringham Extension	O	0.01	270.8	2.7
Sofia (formerly Dogger Bank Teesside B)	O	0.01	270.8	2.7

Project	SCANS-III Block	Whale species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Hornsea Project Three	O	0.01	270.8	0
Norfolk Vanguard	O & L	0.01	270.8	0
Total number of minke whale ***(without Green Volt)***				**89.5** ***(79)***
Percentage of CGNS MU ***(without Green Volt)***				**0.44%** ***(039%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***
Humpback whale*				
Green Volt		0.000015	270.8	0.0041
Aspen (floating)		0.000015	270.8	0.0041
Beech North (floating)		0.000015	270.8	0.0041
Beech South (floating)		0.000015	270.8	0.0041
Dolphyn Project - pre-commercial (floating)		0.000015	270.8	0.0041
Inch Cape		0.000015	270.8	0.0041
Ossian		0.000015	270.8	0.0041
Pentland (floating)		0.000015	270.8	0.0041
Salamander (floating)		0.000015	270.8	0.0041
Total number of humpback whale ***(without Green Volt)***				**0.04** ***(0.03)***
Percentage of reference population ***(without Green Volt)***				**0.00010%** ***(0.00009%)***
Magnitude of cumulative impact ***(without Green Volt)***				**Negligible** ***(Negligible)***

** Based on the density at Green Volts (for SCANS-III Block T). Projects in Scotland, only given rarity of species in southern North Sea*

697. Based on the projects that could have construction overlapping with the Project, the potential magnitude for the cumulative impacts is assessed as low for grey seal and negligible for harbour seal, with between 1% and 5% of the reference population and less than 1% of the reference population that could be temporarily disturbed, respectively (**Table 11.99**).

Table 11.99 Quantified CIA for the Potential Disturbance of Seal Species During Construction (other than Piling) at Offshore Wind Farm Projects at the Same Time as Construction at the Project

Project	Seal species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Grey seal			
Green Volt	0.43	270.8	116.4
Beech North (floating)	0.268	270.8	72.6
Beech South (floating)	0.268	270.8	72.6
Dolphyn Project - pre-commercial (floating)	0.268	270.8	72.6
Inch Cape	1.075	270.8	291.1
Ossian	0.268	270.8	72.6
Pentland (floating)	0.511	270.8	138.4
Salamander (floating)	0.268	270.8	72.6

Project	Seal species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Total number of grey seal ***(without Green Volt)***			**908.7** ***(792.3)***
Percentage of wider reference population ***(without Green Volt)***			**4.28%** ***(3.73%)***
Magnitude of cumulative impact ***(without Green Volt)***			**Low** ***(Low)***
Harbour seal			
Green Volt	0.000002	270.8	0.0005
Beech North (floating)	0.00600	270.8	1.62
Beech South (floating)	0.00600	270.8	1.62
Dolphyn Project - pre-commercial (floating)	0.00600	270.8	1.62
Inch Cape	0.00300	270.8	0.81
Ossian	0.00600	270.8	1.62
Pentland (floating)	0.02600	270.8	7.04
Salamander (floating)	0.00600	270.8	1.62
Total number of harbour seal ***(without Green Volt)***			**15.98** **(15.98)**
Percentage of wider reference population ***(without Green Volt)***			**0.81%** ***(0.81%)***
Magnitude of cumulative impact ***(without Green Volt)***			**Negligible** ***(Negligible)***

Effect Significance of Potential Disturbance during Offshore Wind Farm Construction

698. If all included offshore wind farms were constructing at the same time as the Project, there is the potential for a negligible, low or medium magnitude of impact (dependent on species and MU; **Table 11.100**).

699. Therefore, taking into account the medium receptor sensitivity for all marine mammal species, the overall cumulative impact assessment for disturbance to marine mammals from construction activities at offshore wind farms including the Project is minor adverse (not significant) for all species (**Table 11.100**). This is deemed to be a conservative assessment based on the worst case scenario for offshore wind farms constructing at the same time as the Project.

700. It should be noted that while the projects included within the cumulative assessment for disturbance from other offshore wind farms constructing at the same time as the Project are based on the current knowledge of their possible construction or activity windows. However, it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the marine mammals that could be at risk of disturbance during the offshore construction aspects of the Project.

701. In addition, this assessment for other construction activities uses the results of the underwater noise modelling for the Project (**Appendix 9.1**), which, as noted in **Section 11.7.5.4**, is likely to be an over-estimation in terms of impact range, uses the area of a circle to generate the impact area, and would occur for only a short duration of the activity, further increasing the over-estimation of this impact area. Therefore, the likely number of marine mammals at risk of disturbance would be less than has been assessed.

702. For bottlenose dolphin, while the assessment presented in **Table 11.97** indicates that there could be a magnitude of medium for the CES MU, it is likely that the assessment against the GNS MU is more realistic, taking into consideration the location of the projects included in the CIA, and the location of

the Project. This, in addition to the over-precautionary nature of this assessment, indicates that a magnitude level of low would be more appropriate for bottlenose dolphin, and the final impact assessment has been undertaken on that conclusion (**Table 11.100**).

703. The confidence in this impact assessment is relatively high as it is deemed precautionary enough to comfortably encompass the likely uncertainty and variability. Throughout the assessment it has been made clear where multiple and compounding precautionary assumptions have been made. Additionally, where possible, the uncertainty in the data typically used to inform CIAs and the quantification of impacts when based on published ESs has been removed by using a standard impact range for disturbance and the SCANS-III and seal-at sea density estimates for all offshore wind farm sites.

Table 11.100 Cumulative Effect significance for Disturbance to Marine Mammals from Offshore Wind Farms Constructing (other than piling) at the same time as the Project

Cumulative Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Disturbance from underwater noise during construction (other than piling) of OWFs including the Project	Harbour porpoise	Medium	Negligible	Minor adverse	None required.	Minor adverse
	Bottlenose dolphin		Low for GNS MU	Minor adverse		Minor adverse
	White-beaked dolphin		Negligible	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Negligible	Minor adverse		Minor adverse
	Risso's dolphin		Negligible	Minor adverse		Minor adverse
	Minke whale		Negligible	Minor adverse		Minor adverse
	Humpback whale		Negligible	Minor adverse		Minor adverse
	Grey seal		Low	Minor adverse		Minor adverse
	Harbour seal		Negligible	Minor adverse		Minor adverse

11.8.1.4 Impact 1c: Assessment of Disturbance from Underwater Noise for Other Noise Sources

704. During the construction period for the Project, the other potential noise sources that could also disturb marine mammals are:

- Geophysical surveys for offshore wind farms
- Aggregate extraction and dredging
- Oil and gas installation projects
- Oil and gas seismic surveys
- Installation of pipeline
- UXO clearance

705. Further information on the CIA screening is provided in **Appendix 11.1**.

706. As outlined in **Section 11.7.4.4**, all marine mammal species are assessed as having medium sensitivity to disturbance from underwater noise sources.

Potential for Disturbance from Geophysical Surveys

707. It is currently not possible to estimate the number of potential offshore wind farm geophysical surveys that could be undertaken at the same time as construction and potential piling activity for the Project.

708. As outlined in **Section 11.7.5.1**, offshore wind farm geophysical surveys using SBP and USBL systems have the potential to disturb marine mammals and have therefore been screened into the CIA, as a precautionary approach.

709. The potential disturbance range used in the cumulative assessment is based on that modelled for the Project, with a worst case impact range of 1.425 km, and disturbance area of 6.4 km^2 per survey, for all marine mammal species (see **Section 11.7.5.1**).

710. For geophysical surveys with SBP, it is realistic and appropriate to base the assessments on the potential impact area around the vessel, as the potential for disturbance would be around the vessel at any one time. Marine mammals would not be at risk throughout the entire area surveyed in a day, as animals would return once the vessel had passed, and the disturbance had ceased.

711. It is currently not possible to estimate the location or number of potential OWF geophysical surveys that could be undertaken at the same time as construction and potential piling activity for the Project. It is therefore assumed, as a worst case scenario, that there could potentially be up to two geophysical surveys (12.8 km^2) in the North Sea at any one time, during construction of the Project.

712. Without knowing the actual location for offshore wind farm geophysical surveys, the following density estimates have been used to estimate the potential number of individuals that could potentially be disturbed:

- For harbour porpoise, the SCANS-III density estimate for the North Sea MU of 0.52/km^2
- For bottlenose dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0185/km^2
- For white-beaked dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0202/km^2
- For Atlantic white-sided dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0076/km^2
- For Risso's dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0202/km^2
- For minke whale, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0082/km^2
- For humpback whale, the same density estimate as for the Project has been used, due to a lack of available density data for the species
- For grey and harbour seal, densities were calculated for the entire area of the Moray Firth and East Scotland MUs, based on the grid squares that overlap with the area, and using the most recent grey and harbour seal population estimates to convert the Carter *et al.* (2020) relative densities to absolute densities. This is 0.332 grey seal per km^2 and 0.021 harbour seal per km^2.

713. For geophysical surveys alone, with no other cumulative activities, the magnitude of impact would be negligible for all marine mammal species (**Table 11.101** to **Table 11.104**).

Potential for Disturbance from Aggregate Extraction and Dredging

714. Taking into account the small potential impact ranges, distances of the aggregate extraction and dredging projects from the Offshore Development Area, the potential for contribution to cumulative impacts is very small. However, as a precautionary approach, a total of 13 aggregate extraction and dredging projects are included in the CIA for the potential cumulative disturbance effects from underwater noise.

715. As outlined in the BEIS (2020) RoC HRA for the SNS SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600 m of the activities (Diederichs *et al.,* 2010). As a worst case assessment, a buffer of 600 m has been applied to all aggregate and dredging projects screened to the relevant study area, for each marine mammal species.

716. The densities for each marine mammal species are as outlined for the geophysical surveys assessment.

717. For aggregate and dredging projects alone, with no other cumulative activities, the magnitude of impact would be negligible for all marine mammal species (**Table 11.101** to **Table 11.104**).

Potential for Disturbance from Oil and Gas Installation Projects

718. Two oil and gas installation projects have been screened in with the potential for overlapping construction phases with the Project. The reported disturbance ranges and assessments have been reviewed and used to provide the information needed to assess them. This information is taken from the ESs for both projects[18].Grey seal and harbour seal densities are based on the relevant MU for the location of the projects.

719. For oil and gas installation projects alone, with no other cumulative activities, the magnitude of impact would be negligible for all marine mammal species (**Table 11.101** to **Table 11.104**).

Potential for Disturbance from Oil and Gas Seismic Surveys

720. It is currently not possible to estimate the number of potential oil and gas seismic surveys that could be undertaken at the same time as construction and potential piling activity for the Project. Therefore, it has been assumed that at any one time, one seismic survey could be taking place at the same time as the construction of the Project.

721. This assessment for the potential disturbance due to oil and gas seismic surveys is based on the following for each marine mammal species:

- Harbour porpoise
  - The potential impact area during seismic surveys, based on a radius of 12 km (452.4 km^2), following the current SNCB guidance for the assessment of impact on harbour porpoise in the SNS SAC.
- Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin
  - Strong avoidance of bottlenose dolphin from a 2D seismic survey (with 470 cubic inch airguns, and a peak sound source level of 243 dB re 1 µPa @1m) was modelled at between 1.8 km and 11 km (based on site-specific underwater noise modelling using the dB_{ht} method) (DECC, 2011). This equates to an area of 380.13 km^2, assuming the largest potential disturbance range of 11 km. A potential disturbance range of 11 km (disturbance area of 380.13 km^2) has therefore been used in the assessment for each seismic survey.
- Minke whale and humpback whale
  - As for dolphin species, there is little available information on the potential for disturbance from seismic surveys, however, observations of behavioural changes in other baleen whale species have shown avoidance reactions in up to 10 km for a seismic survey (Macdonald *et al.,* 1995). A potential disturbance range of 10 km (314.1 km^2) has therefore be applied to minke whale and humpback whale as a precautionary approach, due to a lack of species-specific information.
- Grey seal and harbour seal
  - As for both dolphin species and minke whale, there is little available information on the potential for disturbance from seismic surveys for either grey seal or harbour seal, however, observations of behavioural changes in other seal species have shown avoidance reactions up to 3.6 km from the source for a seismic survey (Harris *et al.,* 2001). A more recent assessment of potential for disturbance to seal species, as a result of seismic surveys, shows potential disturbance ranges from 13.3 km to 17.0 km from source (BEIS, 2020). These ranges are based on modelled impact ranges, using the NMFS Level B harassment

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[18] *Disturbance range taken from Rosebank Environmental Statement - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1097880/Rosebank_Environmental_Statement_-_Final_for_Submission_To_OPRED_Equinor_3rd_August_2022.pdf*
Disturbance range taken from Teal West Environmental Statement - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1099286/Teal_West_Environmental_Statement_1_Redacted.pdf

threshold of 160 dB, for a noise source of 3,070 cubic inches, 4,240 cubic inches, or 8,000 cubic inches.
    - A potential disturbance range of 17.0 km (907.9 km^2) is therefore be applied to both grey seal and harbour seal due to a lack of species-specific information.

722. The densities for each marine mammal species are as outlined for the geophysical surveys assessment.

723. For oil and gas seismic surveys alone, with no other cumulative activities, the magnitude is negligible for all marine mammal species, except grey seal, which have a low magnitude (**Table 11.101** to **Table 11.104**).

Potential for Disturbance from Pipeline Project

724. As indicated in underwater noise modelling in **Appendix 9.1** and **Section 11.7.5.4**, the disturbance ranges that could be generated during the cabling works and vessels would be up to 9.284 km (with a disturbance area of 270.78 km^2), for all marine mammal species. This has been used to also inform the assessments for the pipeline project.

725. Only one subsea pipeline has been screened into the cumulative assessment, and this project is not in the screening area for humpback whale, grey seal, or harbour seal.

726. The densities for each marine mammal species are as outlined for the geophysical surveys assessment.

727. For disturbance from the pipeline project alone, with no other cumulative activities, the magnitude is negligible for all marine mammal species (**Table 11.101** to **Table 11.104**).

Potential for Disturbance from UXO Clearance

728. As for piling, the potential risk of PTS from UXO clearance in marine mammals has been screened out from the CIA. If there is the potential for any PTS, suitable mitigation would be put in place to reduce any risk to marine mammals. Therefore, the CIA only considers potential disturbance effects from underwater noise during UXO clearance.

729. It is currently not possible to estimate the number of potential off UXO clearance events that could be undertaken at the same time as construction and potential piling activity for the Project. Therefore, on a worst case basis, the potential for one high-order clearance and one low-order clearance has been assessed as having the potential to take place at the same time as construction of the Project.

730. The magnitude of the potential disturbance from UXO clearance has been estimated based on the following:

- Harbour porpoise
    - The potential impact area of 2,123.7 km^2 per project, based on 26 km EDR for UXO high order detonation, and 78.5 km^2 for low-order detonation, following the current SNCB guidance for the assessment of impact to harbour porpoise in the SNS SAC (**Section 11.7.5.2**).
- Bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and Risso's dolphin
    - The potential impact area during a single UXO clearance event, based on the modelled worst case impact range at the Project for TTS / fleeing response (unweighted SPL_{peak}) of 1.69 km (8.973 km^2) for high-order clearance and 0.075 km (0.018 km^2) for low-order clearance (**Section 11.7.5.2**).
- Minke whale and humpback whale
    - The potential impact area during a single UXO clearance event, based on the modelled worst case impact range at the Project for TTS / fleeing response (weighted SEL) of 35.475 km (3,953.62 km^2) for high-order clearance and 0.66 km (1.368 km^2) for low-order clearance (**Section 11.7.5.2**).
- Grey seal and harbour seal

- The potential impact area during a single UXO clearance event, based on the modelled worst case impact range at the Project for TTS / fleeing response of 6.665 km (139.56 km^2) for high-order clearance (weighted SEL) and 0.25 km (0.196 km^2) for low-order clearance (unweighted SPL_{peak}) (**Section 11.7.5.2**).

731. However, as outlined in the BEIS (2020) RoC HRA, due to the nature of the sound arising from the detonation of UXO, i.e. each blast lasting for a very short duration, marine mammals, including harbour porpoise, are not predicted to be significantly displaced from an area, any changes in behaviour, if they occur, would be an instantaneous response and short-term. Existing guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010a).

732. Mitigation measures required for UXO clearance include the use of low-order clearance techniques, which could include a small donor charge, rather than full high-order detonation which is only used as a last resort. It is therefore highly unlikely that more than one UXO high-order detonation would occur at exactly the same time or on the same day as another UXO high-order detonation, even if they had overlapping UXO clearance operation durations. The CIA is therefore based on potential for disturbance from one UXO high-order detonation without mitigation (worst case), as well as one low-order clearance event.

733. The densities for each marine mammal species are as outlined for the geophysical surveys assessment.

734. For UXO clearance alone, with no other cumulative activities, the magnitude would be negligible for all marine mammal species (**Table 11.101** to **Table 11.104**).

Quantitative Assessment of Disturbance from Underwater Noise from Underwater Noise for Other Noise Sources

735. For harbour porpoise, for disturbance from all other potential noise sources (other than OWFs and the Project), the magnitude is negligible, with less than 1% of the reference population anticipated to be temporarily disturbed (**Table 11.101**).

Table 11.101 Assessment for Disturbance of Harbour Porpoise for All Other Potential Noise Sources (other than OWFs and the Project) Occurring during Construction of the Project

Harbour porpoise			
Project	**Harbour porpoise density (/km^2)**	**Impact area (km^2)**	**Maximum number of individuals potentially disturbed**
Disturbance from two geophysical surveys	0.52	12.8	6.6
Disturbance from aggregate projects	0.52	358.39	186.4
Rosebank Field Development	0.599	0.09	0.05
Teal West Development	0.599	0.09	0.05
Disturbance from one seismic survey	0.52	452.4	235.2
Disturbance from pipeline project	0.52	270.78	140.8
Disturbance from one high-order UXO clearance	0.52	2123.7	1,104.3
Disturbance from one low-order UXO clearance	0.52	78.5	40.8
Total number of harbour porpoise without OWFs and Green Volt			**1,714.3**
Percentage of NS MU			**0.49%**
Magnitude of cumulative impact			**Negligible**

736. For bottlenose dolphin, for disturbance from all other potential noise sources (other than OWFs and the Project) the magnitude is negligible for GNS MU (also negligible for CSE MU). For white-beaked dolphin, Atlantic white-sided dolphin and Risso's dolphin, the magnitude is also negligible (**Table 11.102**).

Table 11.102 Assessment for Disturbance of Dolphin Species for All Other Potential Noise Sources (other than OWFs and the Project) Occurring during Construction of the Project

Project	Dolphin species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Bottlenose dolphin*			
Disturbance from two geophysical surveys**	0.0185	12.8	0.2
Disturbance from aggregate projects	0.0185	211.2	3.9
Rosebank Field Development	0.0298	0.09	0.003
Teal West Development	0.0298	0.09	0.003
Disturbance from one seismic survey**	0.0185	380.1	7.0
Disturbance from pipeline project	0.0185	270.78	5.0
Disturbance from one high-order UXO clearance**	0.0185	8.97	0.2
Disturbance from one low-order UXO clearance**	0.0185	0.02	0.0003
Total number of bottlenose dolphin (without OWFs and Green Volt)			**16.4**
Percentage of CES MU (only projects within the CES MU)			**0.81%**
Percentage of GNS MU (only projects within the GNS MU)			**0.69%**
Magnitude of cumulative impact for GNS MU (CES MU)			**Negligible (Negligible)**
White-beaked dolphin			
Disturbance from two geophysical surveys	0.0202	12.8	0.3
Disturbance from aggregate projects	0.0202	358.39	7.2
Rosebank Field Development	0.243	0.09	0.02
Teal West Development	0.243	0.09	0.02
Disturbance from one seismic survey	0.0202	380.1	7.7
Disturbance from pipeline project	0.0202	270.78	5.5
Disturbance from one high-order UXO clearance	0.0202	8.97	0.2
Disturbance from one low-order UXO clearance	0.0202	0.02	0.0004
Total number of white-beaked dolphin without OWFs and Green Volt			**20.9**
Percentage of CGNS MU			**0.05%**
Magnitude of cumulative impact			**Negligible**

Project	Dolphin species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
Atlantic white-sided dolphin			
Disturbance from two geophysical surveys	0.0087	12.8	0.1
Disturbance from aggregate projects	0.0087	358.39	3.1
Rosebank Field Development	0.01	0.09	0.001
Teal West Development	0.01	0.09	0.001
Disturbance from one seismic survey	0.0087	380.1	3.3
Disturbance from pipeline project	0.0087	270.78	2.4
Disturbance from one high-order UXO clearance	0.0087	8.97	0.08
Disturbance from one low-order UXO clearance	0.0087	0.02	0.0002
Total number of Atlantic white-sided dolphin without OWFs and Green Volt			**9.0**
Percentage of CGNS MU			**0.05%**
Magnitude of cumulative impact			**Negligible**
Risso's Dolphin			
Disturbance from two geophysical surveys	0.0076	12.8	0.1
Disturbance from aggregate projects	0.0076	358.39	2.7
Rosebank Field Development***	0	0.09	0
Teal West Development***	0	0.09	0
Disturbance from one seismic survey	0.0076	380.1	2.9
Disturbance from pipeline project	0.0076	270.78	2.1
Disturbance from one high-order UXO clearance	0.0076	8.97	0.07
Disturbance from one low-order UXO clearance	0.0076	0.02	0.0001
Total number of Risso's Dolphin without OWFs and Green Volt			**7.8**
Percentage of CGNS MU			**0.06%**
Magnitude of cumulative impact			**Negligible**

* Note - some projects are within both MUs and are included in both MU assessments.
** Within both CES and GNS MUs for bottlenose dolphin
*** Risso's dolphin were not assessed for these projects as not in range for this species

737. For minke whale and humpback whale, for disturbance from all other potential noise sources (other than OWFs and the Project) the magnitude is negligible (**Table 11.103**).

Table 11.103 Assessment for Disturbance of Whale Species for All Other Potential Noise Sources (other than OWFs and the Project) Occurring during Construction of the Project

Project	Whale species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
Minke whale			
Disturbance from two geophysical surveys	0.0082	12.8	0.1
Disturbance from aggregate projects	0.0082	358.39	2.9
Rosebank Field Development	0.0387	0.09	0.003
Teal West Development	0.0387	0.09	0.003
Disturbance from one seismic survey	0.0082	314.1	2.6
Disturbance from pipeline project	0.0082	270.78	2.2
Disturbance from one high-order UXO clearance	0.0082	3,953.62	32.4
Disturbance from one low-order UXO clearance	0.0082	1.37	0.01

Project	Whale species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Total number of minke whale without OWFs and Green Volt			**40.3**
Percentage of CGNS MU			**0.2%**
Magnitude of cumulative impact			**Negligible**
Humpback whale*			
Disturbance from two geophysical surveys	0.0000015	12.8	0.00002
Disturbance from aggregate projects**	0.0000015	0.0	0
Rosebank Field Development	0.0000015	0.09	0.0000001
Teal West Development	0.0000015	0.09	0.0000001
Disturbance from one seismic survey	0.0000015	314.1	0.00047
Disturbance from pipeline project**	0.0000015	0	0
Disturbance from one high-order UXO clearance	0.0000015	3,953.62	0.00593
Disturbance from one low-order UXO clearance	0.0000015	1.37	0.000002
Total number of humpback whale without OWFs and Green Volt			**2.6**
Percentage of reference population			**0.007%**
Magnitude of cumulative impact			**Negligible**

* Based on the density at Green Volts (for SCANS-III Block T). Projects in Scotland only given rarity of species in southern North Sea.
** None are located within Scottish waters

738. For grey seal and harbour seal, for disturbance from all other potential noise sources (other than OWFs and the Project) the magnitude is low (**Table 11.104**).

Table 11.104 Assessment for Disturbance of Seal Species for All Other Potential Noise Sources (other than OWFs and the Project) Occurring during Construction of the Project

Project	Seal species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Grey seal			
Disturbance from two geophysical surveys	0.332	12.8	4.25
Disturbance from aggregate projects	0.332	38.3	12.7
Rosebank Field Development	0.063	0.09	0.01
Teal West Development	0.268	0.09	0.02
Disturbance from one seismic survey	0.332	907.9	301.4
Disturbance from pipeline project*	0.332	0	0
Disturbance from one high-order UXO clearance	0.332	139.56	46.3
Disturbance from one low-order UXO clearance	0.332	0.20	0.07
Total number of grey seal without OWFs and Green Volt			**364.8**
Percentage of wider reference population			**1.72%**
Magnitude of cumulative impact			**Low**
Harbour seal			
Disturbance from two geophysical surveys	0.021	12.8	0.27
Disturbance from aggregate projects	0.021	38.3	0.8
Rosebank Field Development	0.037	0.09	0.003
Teal West Development	0.006	0.09	0.001
Disturbance from one seismic survey	0.021	907.9	18.9

Project	Seal species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
Disturbance from pipeline project*	0.021	0	0
Disturbance from one high-order UXO clearance	0.021	139.56	2.9
Disturbance from one low-order UXO clearance	0.021	0.20	0.004
Total number of harbour seal without OWFs and Green Volt			**22.9**
Percentage of wider reference population			**1.16%**
Magnitude of cumulative impact			**Negligible**

* No projects in the screening area

Effect Significance of Potential Disturbance from All Other Noise Sources (other than OWFs and the Project)

739. If all other potential noise sources (other than OWFs and the Project) were undertaken at the same time, there is the potential for a negligible magnitude of impact for harbour porpoise, all dolphin species and all whale species and low magnitude of impact for grey seal and harbour seal (**Table 11.105**).

740. Therefore, taking into account the medium receptor sensitivity for all marine mammal species, the overall cumulative impact assessment for disturbance to marine mammals from other potential noise source (excluding OWFs and the Project) is **minor adverse (not significant)** for all species (**Table 11.105**). This is deemed to be a conservative assessment as it is unlikely that all activities would occur at the same time.

741. As outlined in **Section 11.8.1.3**, the projects included within the cumulative assessment for disturbance for all other potential noise sources that could occur at the same time were based on the current knowledge of their possible construction or activity windows. However, it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the marine mammals that could be at risk of disturbance for other noise sources during the offshore construction period of the Project.

742. The confidence in this impact assessment is relatively high as it is deemed precautionary enough to comfortably encompass the likely uncertainty and variability. Throughout the assessment it has been made clear where multiple and compounding precautionary assumptions have been made.

Table 11.105 Cumulative Effect significance for Disturbance to Marine Mammals from Other Potential Noise Sources (other than OWFs and the Project) during Construction of the Project

Cumulative Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Disturbance from underwater noise for all other noise sources (other than OWFs and the Project)	Harbour porpoise	Medium	Negligible	Minor adverse	None required.	Minor adverse
	Bottlenose dolphin		Negligible (for GNS & CES MUs)	Minor adverse		Minor adverse
	White-beaked dolphin		Negligible	Minor adverse		Minor adverse
	Atlantic white-sided dolphin		Negligible	Minor adverse		Minor adverse
	Risso's dolphin		Negligible	Minor adverse		Minor adverse
	Minke whale		Negligible	Minor adverse		Minor adverse
	Humpback whale		Negligible	Minor adverse		Minor adverse
	Grey seal		Low	Minor adverse		Minor adverse
	Harbour seal		Low	Minor adverse		Minor adverse

11.8.1.5 Impact 1: Overall Cumulative Assessments for Disturbance from Underwater Noise during Piling and Construction at the Project (Impacts 1a, 1b, and 1c)

CIA for Piling at the Project

743. **Table 11.106** provides a summary of the overall CIA for the disturbance of marine mammals from all cumulative noise sources including piling at the Project.

744. For harbour porpoise, up to 4.52% of NS MU could be disturbed as a result of cumulative underwater noise including piling at the Project. However, the contribution of the piling at the Project to the cumulative impacts is small, with up to 4.40% of the NS MU potentially disturbed from other noise sources without piling at the Project. The potential magnitude of the temporary impact is assessed as low, with less than 5% of the NS MU anticipated to be affected, with or without piling at the Project (**Table 11.106**).

745. For bottlenose dolphin, up to 2.67% of GNS MU could be disturbed as a result of cumulative underwater noise including piling at the Project. However, the contribution of the piling at the Project to the cumulative impacts is small, with up to 2.61% of the GNS MU potentially disturbed from other noise sources without piling at the Project. The potential magnitude of the temporary impact is assessed as low, with less than 5% of the GNS MU anticipated to be affected, with or without piling at the Project (**Table 11.106**).

746. For bottlenose dolphin from the CES MU, up to 8.39% of CES MU could be disturbed as a result of cumulative underwater noise including piling at the Project (**Table 11.106**). The potential magnitude of the temporary impact is assessed as medium, with between 5% and 10% of the CES MU anticipated to be affected, with or without piling at the Project. However, this is considered an over estimation as bottlenose dolphin from the CES MU are typically within 2 km of the coast (**Section 11.6.2.2**) and are unlikely to be disturbed as a result of underwater noise at offshore projects. Therefore, the CIA for the GNS MU is considered the most realistic worst case scenario.

747. The magnitude for disturbance as a result of cumulative underwater noise including piling at the Project is assessed as negligible for white-beaked dolphin, Atlantic white-sided dolphin, Risso’s dolphin and humpback whale; low for minke whale and harbour seal; and medium for grey seal. However, the contribution of piling at the Project to the overall cumulative effects is small for all species (**Table 11.106**).

748. It is also important to note that piling duration to install the OSP foundation piles is up to two days (maximum of 40 hours) for active piling. Therefore, the cumulative effects during piling at the Project would be temporary for a short duration. As a result, the contribution of piling at the Project to cumulative underwater noise is unlikely to result in any significant disturbance effects to marine mammals.

Table 11.106 Quantified CIA for the Potential Disturbance of Marine Mammals from Cumulative Underwater Noise Sources During Piling at the Project

Cumulative Impact	Number of Individuals									
	Harbour porpoise	Bottlenose dolphin GNS	Bottlenose dolphin CES	White-beaked dolphin	Atlantic white-sided dolphin	Risso's dolphin	Minke whale	Humpback whale	Grey seal	Harbour seal
Piling at Worst caseGreen Volt	423.41	1.14	1.14	9.30	1.07	0.07	192.59	0.075	1.88	0.00008
Piling at other offshore wind farms	10,692.83	1.14	1.14	9.61	0.38	0	391.64	0.075	38.02	0.0005
Construction activities including vessels at other offshore wind farms	2,845.65	35.28	9.07	302.19	27.81	0	79.0	0.03	792.31	15.98
Geophysical surveys	6.64	0.24	0.24	0.26	0.11	0.10	0.10	0.00002	4.25	0.27
Aggregates and dredging	186.36	3.91	0	7.24	3.12	2.72	2.94	0	12.71	0.80
Oil and gas installation	0.11	0.005	0	0.04	0.002	0	0.007	0.0000003	0.03	0.004
Oil and gas seismic surveys	235.25	7.03	7.03	7.68	3.31	2.89	2.58	0.0005	301.42	18.88
Subsea pipeline	140.81	5.01	0	5.47	2.36	2.06	2.22	0	0	0
UXO clearance	1,145.14	0.17	0.17	0.18	0.08	0.07	32.43	0.0059	46.4	2.91
Total number of individuals *(without Green Volt)*	**15,676.19 *(15,252.78)***	**53.92 *(52.78)***	**18.79 *(17.65)***	**341.98 *(332.67)***	**38.24 *(37.16)***	**7.90 *(7.84)***	**703.55 *(510.96)***	**0.19 *(0.11)***	**1,197.02 *(1,195.14)***	***38.83 (38.83)***
Percentage of MU *(without Green Volt)*	**4.52% *(4.40%)***	**2.67% *(2.61%)***	**8.39% *(7.88%)***	**0.78% *(0.76%)***	**0.21% *(0.21%)***	**0.06% *(0.06%)***	**3.50% *2.54%***	**0.0005% *(0.0003%)***	**5.64% *(5.63%)***	**1.97% *(1.97%)***
Magnitude of cumulative impact *(without Green Volt)*	**Low *(Low)***	**Low *(Low)***	**Medium *(Medium)***	**Negligible *(Negligible)***	**Negligible *(Negligible)***	**Negligible *(Negligible)***	**Low *(Low)***	**Negligible *(Negligible)***	**Medium *(Medium)***	**Low *(Low)***

CIA for Other Construction Activities including Vessels at the Project

749. **Table 11.107** provides a summary of the overall CIA for the disturbance of marine mammals from all cumulative noise sources including other construction activities (such as cable installation or mooring installation) and vessels at the Project.

750. As outlined in **Section 11.7.5.5**, the area of potential disturbance for vessels is the same the potential disturbance for construction activities, such as cable or mooring installation. Therefore, during these construction activities, disturbance from vessels would not be additive as they have the same footprint / area of disturbance.

751. For harbour porpoise, up to 4.45% of NS MU could be disturbed as a result of cumulative underwater noise including other construction activities and vessels at the Project. However, the contribution the Project to the cumulative impacts is small, with up to 4.40% of the NS MU potentially disturbed from other noise sources without underwater noise from the Project. The potential magnitude of the temporary impact is assessed as low, with less than 5% of the NS MU anticipated to be affected, with or without other construction activities and vessels at the Project (**Table 11.107**).

752. For bottlenose dolphin, up to 3.01% of GNS MU could be disturbed as a result of cumulative underwater noise including other construction activities and vessels at the Project. However, the contribution of the Project to the cumulative impacts is relatively small, with up to 2.61% of the GNS MU potentially disturbed from other noise sources without underwater noise from the Project. The potential magnitude of the temporary impact is assessed as low, with less than 5% of the GNS MU anticipated to be affected, with or without other construction activities and vessels at the Project (**Table 11.107**).

753. For bottlenose dolphin from the CES MU, up to 11.48% of CES MU could be disturbed as a result of cumulative underwater noise including other construction activities and vessels at the Project (**Table 11.107**). The potential magnitude of the temporary impact is assessed as high with other construction activities and vessels at the Project, and medium (up to 7.88% of the CES MU) with other construction activities and vessels at the Project (**Table 11.107**). However, as outlined above, this is considered an over estimation as bottlenose dolphin from the CES MU are typically within 2 km of the coast (**Section 11.6.2.2**) and are unlikely to be disturbed as a result of underwater noise at offshore projects. Therefore, the CIA for the GNS MU is considered the most realistic worst case scenario.

754. The magnitude for disturbance as a result of cumulative underwater noise including other construction activities and vessels at the Project is assessed as negligible for white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and humpback whale; low for minke whale and harbour seal; and medium for grey seal. However, the contribution of piling at the Project to the overall cumulative effects is small for most species (**Table 11.107**).

755. It is also important to note that construction activities, including vessels and potential disturbance of marine mammals would not be consistent throughout the construction period for the Project. For example, as outlined in **Section 11.7.5.4**, the duration of the export cable installation is estimated to take approximately 31-32 days and the array cable installation is estimated to take approximately 33-34 days.

756. The contribution of any potential disturbance from cumulative underwater from the Project would be temporary while the construction activities were undertaken and localised to the area of work, with the potential impact area around the activity location and vessel. As a result, the contribution of other construction activities and vessels at the Project to cumulative underwater noise is unlikely to result in any significant disturbance that could affect marine mammal populations.

Table 11.107 Quantified CIA for the Potential Disturbance of Marine Mammals from Cumulative Underwater Noise Sources During Other Construction Activities including Vessels at the Project

Cumulative Impact	Number of Individuals									
	Harbour porpoise	Bottlenose dolphin GNS	Bottlenose dolphin CES	White-beaked dolphin	Atlantic white-sided dolphin	Risso's dolphin	Minke whale	Humpback whale	Grey seal	Harbour seal
Other construction activities including vessels at Worst case Green Volt	162.21	8.07	8.07	65.80	7.58	0.49	10.48	0.004	116.44	0.0005
Piling at other offshore wind farms	10,692.83	1.14	1.14	9.61	0.38	0	391.64	0.075	38.02	0.0005
Construction activities including vessels at other offshore wind farms	2,845.65	35.28	9.07	302.19	27.81	0	79.0	0.03	792.31	15.98
Geophysical surveys	6.64	0.24	0.24	0.26	0.11	0.10	0.10	0.00002	4.25	0.27
Aggregates and dredging	186.36	3.91	0	7.24	3.12	2.72	2.94	0	12.71	0.80
Oil and gas installation	0.11	0.005	0	0.04	0.002	0	0.007	0.0000003	0.03	0.004
Oil and gas seismic surveys	235.25	7.03	7.03	7.68	3.31	2.89	2.58	0.0005	301.42	18.88
Subsea pipeline	140.81	5.01	0	5.47	2.36	2.06	2.22	0	0	0
UXO clearance	1,145.14	0.17	0.17	0.18	0.08	0.07	32.43	0.0059	46.4	2.91
Total number of individuals *(without Green Volt)*	**15,414.99 *(15,252.78)***	**60.85 *(52.78)***	**25.72 *(17.65)***	**398.47 *(332.67)***	**44.75 *(37.16)***	**8.32 *(7.84)***	**521.44 *(510.96)***	**0.12 *(0.11)***	**1,311.58 *(1,195.14)***	***38.83 (38.83)***
Percentage of MU *(without Green Volt)*	**4.45% *(4.40%)***	**3.01% *(2.61%)***	**11.48% *(7.88%)***	**0.91% *(0.76%)***	**0.25% *(0.21%)***	**0.07% *(0.06%)***	**2.59% *2.54%***	**0.0003% *(0.0003%)***	**6.18% *(5.63%)***	**1.97% *(1.97%)***
Magnitude of cumulative impact *(without Green Volt)*	**Low *(Low)***	**Low *(Low)***	**High *(Medium)***	**Negligible *(Negligible)***	**Negligible *(Negligible)***	**Negligible *(Negligible)***	**Low *(Low)***	**Negligible *(Negligible)***	**Medium *(Medium)***	**Low *(Low)***

Effect significance of Potential Disturbance for Cumulative Underwater Noise

757. If piling and construction at all offshore wind farms and all other potential noise sources, included in the CIA, were undertaken at the same time as piling and construction at the Project, there is the potential for a negligible to medium magnitude of impact (dependent on species; **Table 11.108**).

758. Taking into account the magnitude for each species and medium sensitivity for all marine mammal species, the overall cumulative effect significance for disturbance to marine mammals from underwater noise including the Project, is **minor adverse (not significant)** for all marine mammals, except for grey seal which could have a **moderate adverse** effect (**Table 11.108**). This is deemed to be a precautionary and conservative assessment, based on the worst case scenarios for all potential offshore wind farms that could be piling or constructing at the same time as the Project.

759. While there is a moderate effect significance for grey seal, as previously outlined, the Project is contributing a relatively small amount to the overall cumulative underwater noise disturbance. For grey seal, the effect significance is moderate adverse with and without underwater noise during piling and construction at the Project.

760. As previously outlined, the projects and noise sources included within the CIA for disturbance from underwater noise were based on current knowledge of their possible construction or activity windows. However, it is very unlikely that all activities would be taking place on the same day or in the same season. Therefore this likely represents an over-precautionary and worst case estimate of the marine mammals that could be at risk of disturbance during piling and construction of the Project. The confidence in this impact assessment is relatively high as it is deemed precautionary enough to comfortably encompass the likely uncertainty and variability.

761. No mitigation measures are proposed for the Project based on the CIA for disturbance from underwater noise during piling and construction. As clearly demonstrated, the contribution of the Project to cumulative underwater noise is small, the duration for underwater noise at the Project is relatively short, especially for piling and the effect significance for disturbance from cumulative noise is the same with and without the Project. However, there could be requirements for other OWFs piling monopiles to consider noise mitigation or management measures to reduce cumulative noise once schedules are finalised prior to construction.

Table 11.108 Cumulative Effect significance for Disturbance to Marine Mammals from all Offshore Wind Farms and Other Potential Noise Sources during Piling and Construction at the Project

Cumulative Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Disturbance from underwater noise during piling at the Project	Harbour porpoise, bottlenose dolphin (GNS), minke whale, harbour seal	Medium	Low	Minor adverse	None required or proposed for the Project due to low contribution to cumulative impacts. However, other OWFs piling monopiles may have to consider noise mitigation or management measures to	Minor adverse
	Grey seal		Medium	**Moderate adverse**		**Moderate adverse**
	White-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and humpback whale		Negligible	Minor adverse		Minor adverse

Cumulative Impact	Species	Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Disturbance from underwater noise during other construction activities and vessels at the Project	Harbour porpoise, bottlenose dolphin (GNS), minke whale, harbour seal	Medium	Low	Minor adverse	reduce cumulative noise once schedules are finalised prior to construction.	Minor adverse
	Grey seal		Medium	**Moderate adverse**		**Moderate adverse**
	White-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and humpback whale		Negligible	Minor adverse		Minor adverse

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762. As summarised in **Table 11.106**, up to 704 minke whale could be temporarily disturbed as a result of cumulative noise including piling at the Project (or 511 minke whale without the Project), equating to 3.5% (or 2.5%) of the CGNS MU reference population.

763. It is important to note that the CIA covers projects and noise sources in the wider North Sea area. Also that projects and activities included in the CIA are based on the current knowledge of their possible construction or activity windows, however, it is very unlikely that all activities could be taking place on the same day or in the same season. Therefore this likely represents an over-precautionary and worst case estimate of the number of minke whale that could be disturbed.

764. The contribution of the Project to cumulative underwater noise is small, the duration for underwater noise at the Project is relatively short, especially for piling, during the construction period. As outlined in **Section 11.7.5.4**, any disturbance during construction of the Project is likely to be an over-estimation in terms of impact range, area and duration. As a result, the likely number of minke whale that could be disturbed would be less than the worst case assessments.

765. Therefore, it is not expected that there would be any potential disturbance to the minke whale population in relation to the Southern Trench MPA due the cumulative effects of underwater noise during piling and construction at the Project.

11.8.2 Impact 2: Cumulative Barrier Effects from Underwater Noise or Physical Presence during Construction and Operation

766. For the assessment of the potential for barrier effects due to underwater noise, the impact to marine mammal species would be as per the assessments provided in **Section 11.8.1.5**, with a magnitude of moderate adverse for grey seal and minor adverse for all other species (**Table 11.108**).

767. It is important to note that the OWFs and other noise sources included in the CIA are spread over the wider area of the North Sea. Taking into account the locations of the OWFs and other noise sources from the Project, the maximum underwater impact ranges for disturbance would not overlap with the maximum underwater impact ranges for disturbance at the Project during piling and construction. Therefore, there is no potential for underwater noise from the Project, other OWFs and noise sources in the CIA to result in a barrier to marine mammals.

768. For the potential of barrier effects due to the physical presence of the Project, as outlined in **Section 11.7.6.7**, marine mammals are not anticipated to be deterred from transiting through the Windfarm Site, based on current information. Therefore, the Project would not contribute to any cumulative barrier effects due to the physical presence of the Project. There is evidence to indicate that marine

mammals are present and move through offshore wind farms (with fixed foundations) while operational. Taking into account the spacing distance between each turbine in offshore wind farms, including the Project, that would allow the movement of marine mammals at each site, and locations and distances of offshore wind farms and other structures from the Project, it is not expected that would be any potential for a cumulative barrier effect across different projects. Therefore the potential for any cumulative barrier effects from physical presence has a negligible magnitude for marine mammals.

769. Therefore, with the sensitivity of negligible for all marine mammal species, and the expected magnitude level of negligible (at worst), the effect significance for all marine mammal species would be **negligible**.

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770. It is also not expected that there would be any cumulative barrier effects that could have an impact on the minke whale population in relation to the Southern Trench MPA.

11.8.3 Impact 3: Cumulative Increased Collision Risk with Vessels during Construction and Operation

771. As outlined in **Sections 11.7.5.6** and **11.7.6.4**, the increased collision risk, even using a very precautionary approach, has an effect significance of negligible, with less than one individual (0.11 harbour porpoise being the highest number at risk) of all marine mammal species at risk.

772. Vessel movements to and from any port will be incorporated within existing vessel routes, and therefore there would be no increased collision risk as the increase in the number offshore wind farm vessels would be relatively small compared to the baseline levels of vessel movements in these areas.

773. Once on-site, offshore wind farm vessels and other construction related vessels would be stationary or slow moving, as they undertake the activity they are associated with. Therefore, the risk of any increased collision risk for cumulative projects for marine mammals would be negligible, at worst.

774. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low or negligible.

775. Good practice measures would ensure any risk of vessels colliding with marine mammals is avoided.

776. Therefore, with the sensitivity of high for all marine mammal species, and the expected magnitude level of negligible (at worst), the effect significance for all marine mammal species would be **minor adverse**.

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777. Taking into account the points above, it is not expected that cumulative collision risk with vessels would have any potential for significant impact on the minke whale population in relation to the Southern Trench MPA.

11.8.4 Impact 4: Cumulative Entanglement during Operation

778. As assessed in **Section 11.7.6.5**, marine mammals are not expected to be at risk of entanglement with the mooring lines associated with floating wind farms, due to either direct or secondary entanglement. **Section 11.7.6.5** outlines the baseline levels of entanglement of marine mammal species in Scottish waters due to entanglements in fishing gear. The operation of the Project is not expected to increase the rates of entanglement of marine mammals in fishing gear, as it is likely that the presence of the wind farm infrastructure would provide marine mammals greater opportunity to detect (and avoid) any fishing gear that may be caught on the mooring lines associated with the

Project. While there is the potential for a number of other floating offshore wind farms to be developed in Scottish waters through the construction and operation periods of the Project (**Appendix 11.1**), the risk of entanglement would be as assessed for the Project. In addition, it is expected that all floating wind farms will be required to undertake monitoring to ensure that no fishing gear is caught on the mooring lines, and all projects would need to undertake such monitoring for infrastructure integrity purposes as well as to reduce the risk of entanglement.

779. The sensitivity of minke whale and humpback whale is negligible (direct entanglement) to high (secondary entanglement) and with a low magnitude, the effect significance would be negligible to moderate adverse. For all other marine mammal species, the sensitivity is negligible (direct entanglement) to medium (secondary entanglement) and with a negligible magnitude, the effect significance for would be negligible. Monitoring measures, as outlined in **Section 11.7.6.5**, would reduce the potential risk of entanglement to **negligible to minor adverse (not significant)** for all marine mammal species.

780. The assessment of the potential risk of entanglement for the Project, is considered appropriate for other floating wind farms and any potential cumulative effects. However, it is not expected that would be any potential for cumulative entanglement, and therefore the risk is considered to be **negligible**.

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781. Taking into account the assessment and points above, it is not expected that there would be a risk of cumulative entanglement to have any potential for significant impact on the minke whale population in relation to the Southern Trench MPA.

11.8.5 Impact 5: Cumulative Changes to Prey Resources during Construction or Operation

782. For any potential changes to prey resources, it has been assumed that any potential impacts on marine mammal prey species from underwater noise, including piling, would be the same or less than those for marine mammals. Therefore, there would be no additional cumulative impacts other than those assessed for marine mammals, i.e. if prey are disturbed from an area as a result of underwater noise, marine mammals will be disturbed from the same or greater area. As a result any changes to prey resources would not affect marine mammals as they would already be disturbed from the area.

783. Any impacts on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat for prey species in the surrounding area.

784. Taking into account the assessment for the Project alone (**Sections 11.7.5.8** and **11.7.6.8**), and assuming similar impacts for other projects and activities, along with the range of prey species taken by marine mammals and the extent of their foraging ranges (**Section 11.6**). There would be no potential for cumulative impact to have any significant effects on marine mammal populations as a result of changes to prey resources. Therefore, the effect is considered to be **negligible**.

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785. It is not expected that any potential cumulative changes in prey resources would have any significant impact on the minke whale population in relation to the Southern Trench MPA.

11.8.6 Cumulative Impacts During Operation and Maintenance

786. The potential for any disturbance from cumulative underwater noise sources would be less than the worst case assessed for during construction and piling for the Project (**Section 11.8.1**).

787. As outlined in **Appendix 11.1**, due to the low noise levels associated with operational OWFs, the BEIS (2020) RoC HRA concluded that there would be no potential for significant impact from the

operation of OWFs, alongside the construction of OWFs (BEIS, 2020). Therefore, operational OWF including the Project were screened out for any potential cumulative effects.

788. Any potential cumulative barrier effects from underwater noise or physical presence during operation are as assessed in **Section 11.8.2**.

789. Any cumulative increased collision risk with vessels during operation are assessed in **Section 11.8.3**.

790. Any potential cumulative entanglement risk during operation is assessed in **Section 11.8.4**.

791. Any potential cumulative effects on prey resources are assessed in **Section 11.8.5**.

11.8.7 Cumulative Impacts During Decommissioning

792. Any potential cumulative impacts during decommissioning would be the same or less than those assessed for construction and operation.

793. As outlined in **Section 11.7.7**, a full assessment including cumulative impacts will be undertaken prior to decommissioning.

11.9 Transboundary Impacts

794. The highly mobile nature of marine mammals included within this assessment means that there is the potential for transboundary impacts. This has been taken into account throughout the assessment, as the study area for each species is based on their relevant MU (or area within which the same individuals are considered to part of one larger overall population). The MUs (and therefore reference populations) for each species covers an area wider than the UK (**Table 11.109**). This approach has been taken through the assessments.

Table 11.109 Countries Considered in the Marine Mammal Assessments Through the Relevant MU Reference Populations

Marine mammal species	Countries	Inclusion within assessments
Harbour porpoise	Norway Sweden Denmark Germany Netherlands Belgium France	North Sea MU for harbour porpoise (**Figure 11.1**; IAMMWG, 2022)
Bottlenose dolphin	Norway Sweden Denmark Germany Netherlands Belgium	Greater North Sea MU for bottlenose dolphin (**Figure 11.2**; IAMMWG, 2022)
White-beaked dolphin **Atlantic white-sided dolphin** **Risso's dolphin** **Minke whale**	Norway Sweden Denmark Germany Netherlands Belgium France Ireland	Celtic and Greater North Sea MU (**Figure 11.3**; IAMMWG, 2022)
Humpback whale	Norway Sweden Denmark Germany Netherlands Belgium France Ireland	North Atlantic population (NAMMCO, 2022)

795. There is a substantial level of marine development being undertaken, and being planned, by other countries (including Belgium, the Netherlands, Germany and Denmark) in the North Sea. Each of these countries have their own independent environmental assessment requirements and controls. As noted above, marine mammals are highly mobile and there is therefore the potential for transboundary impacts, especially with regard to noise. The potential for transboundary impacts has been assessed with the other cumulative impacts, as these are based on the wide MU areas; and European wind farms, where relevant, are included in the CIA.

11.10 Inter-relationships

796. For marine mammals, potential inter-relationships between impact pathways are already covered as part of the marine mammal assessments. **Table 11.110** provides a signposting to where these potential inter-relationship impacts have been assessed.

Table 11.110 Marine Mammal Inter-Relationships

Topic and description	Related chapter	Where addressed in this chapter	Rationale
Underwater noise from vessels	**Chapter 14: Shipping and Navigation**	**Section 11.7.5.5** for construction and **Section 11.7.6.2** for operation and maintenance	Increased vessel traffic could affect the level of disturbance for marine mammals.
Increased risk of collision with vessels	**Chapter 14: Shipping and Navigation**	**Section 11.7.5.6** for construction and **Section 11.7.6.4** for operation and maintenance	Increased vessel traffic could affect the level of collision risk for marine mammals.
Changes to prey availability	**Chapter 10: Fish and Shellfish Ecology** **Chapter 9: Benthic Ecology**	**Section 11.7.5.8** for construction and **Section 11.7.6.8** for operation and maintenance	Potential impacts on fish species could affect the prey resource available for marine mammals.

11.11 Interactions

797. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts due to that interaction.

798. The areas of potential interaction between impacts are presented in **Table 11.111**. This provides a screening tool for which impacts have the potential to interact.

799. The worst case impacts assessed within the chapter take these interactions into account, and therefore the impact assessments are considered conservative and robust. Synergistic impacts of potential disturbance from underwater noise during construction from all potential noise sources have been assessed as potential barrier effects in the following tables.

800. In **Table 11.111** the impacts are assessed relative to each development phase (assessment for construction, operation and maintenance or decommissioning) to determine if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor. The lifetime assessment considers the potential for impacts to affect receptors across all development phases.

801. The significance of each individual effect is determined by the sensitivity of the receptor and the magnitude of impact; the sensitivity is constant whereas the magnitude may differ. Therefore, when considering the potential for impacts to be additive it is the magnitude of impact which is important – the magnitudes of the different impacts are combined upon the same sensitivity receptor.

Table 11.111 Potential for Interaction between Impacts for Marine Mammals

Potential Interaction between Impacts								
Construction	**Impact 1**	**Impact 2**	**Impact 3**	**Impact 4**	**Impact 5**	**Impact 6**	**Impact 7**	**Impact 8**
Impact 1: Underwater noise during geophysical surveys	-	No	No	No	Yes	Yes	No	Yes
Impact 2: Underwater noise during UXO Clearance	No	-	No	No	Yes	Yes	No	Yes
Impact 3: Underwater noise during piling	No	No	-	Yes	Yes	Yes	Yes	Yes
Impact 4: Underwater noise during other construction activities	No	No	Yes	-	Yes	Yes	Yes	Yes
Impact 5: Underwater noise from vessels	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes
Impact 6: Increased collision risk with vessels	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes
Impact 7: Barrier effects from underwater noise	No	No	Yes	Yes	Yes	Yes	-	Yes
Impact 8: Changes to prey resource	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
Operation and Maintenance	**Impact 1**	**Impact 2**	**Impact 3**	**Impact 4**	**Impact 5**	**Impact 6**	**Impact 7**	**Impact 8**
Impact 1: Underwater noise from operational turbines	-	Yes	Yes	No	No	Yes	Yes	Yes
Impact 2: Underwater noise during maintenance activities and from vessels	Yes	-	Yes	No	No	Yes	Yes	Yes
Impact 3: Barrier effects from underwater noise	Yes	Yes	-	No	No	Yes	Yes	Yes
Impact 4: Increased collision risk with vessels	No	No	No	-	No	No	No	No
Impact 5: Entanglement	No	No	No	No	-	No	No	No
Impact 6: EMF	Yes	Yes	Yes	No	No	-	Yes	Yes
Impact 7: Barrier effects from physical presence of windfarm	Yes	Yes	Yes	No	No	Yes	-	Yes
Impact 8: Changes to prey resource	Yes	Yes	Yes	No	No	Yes	Yes	-
Decommissioning								
It is anticipated that the decommissioning impacts will be no greater than construction								

Table 11.112 Interaction Between Impacts – Phase and Lifetime Assessment

Marine Mammals	Highest residual significance level				
Assessment	**Construction**	**Operation and Maintenance**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Harbour porpoise Bottlenose dolphin White-beaked dolphin Atlantic white-sided dolphin Risso's dolphin Minke whale Humpback whale Grey seal Harbour seal	Minor Adverse	Minor Adverse	Minor Adverse	**No greater than individually assessed impact** **Construction** The MMMP (for both UXO and piling) will reduce the risk of injury for mammals and therefore during UXO clearance or piling there will be no pathway for interaction of potential injury with disturbance effects (i.e. all individuals are assumed to be disturbed if within range and excluded from the disturbance footprint). Likewise, there is no pathway for vessel interaction or effects on prey resource to interact with noise impacts as it is assumed that individuals will be excluded from the disturbance footprint (i.e. there cannot be a vessel interaction if the individual is excluded from the vicinity of the construction works). Once noisy activities have ceased the footprint of disturbance and changes to prey resource will be highly localised. It is therefore considered that the interaction of these impacts would not represent an increase in the significance level. **Operation** Operational noise impacts from wind turbines will be highly localised to within 0.1 km of each wind turbine, whilst the majority of change to habitat for prey species will also be confined to the immediate footprint of wind turbine. The magnitude of impact is negligible and relates to largely the same spatial footprint. Therefore, there is no greater impact from any interaction between these impacts. There is potential for interaction with maintenance noise disturbance and vessel interaction, but given the negligible magnitude of impacts and episodic nature of these impacts it is not considered that that the interaction of these impacts would not represent an increase in the significance level.	**No greater than individually assessed impact.** The greatest magnitude of impact will be the spatial footprint of construction noise (i.e. UXO clearance and piling). Once this disturbance impact has ceased all further impact during construction and operation will be small scale, highly localised and episodic. There is no evidence of long term displacement of marine mammals from operational wind farms. It is therefore considered that over the project lifetime these impacts would not combine and represent an increase in the significance level.

Marine Mammals	Highest residual significance level				
Assessment	Construction	Operation and Maintenance	Decommissioning	Phase Assessment	Lifetime Assessment
				The potential for entanglement could interact with the potential for collision risk, however, both are unlikely to cause any significant (or determinable) effect on the marine mammal populations assessed. Any potential entanglement or collision (in the unlikely event that it occurs) would not alter the overall population level. Management and best-practice measures would be put in place to reduce the likelihood of either event occurring, and there would not be any increase in risk due to both impacts interacting.	

11.12 Summary

802. A summary of the potential impacts on marine mammals, during the construction, operation, maintenance and decommissioning phases of the Project, including cumulative impacts, are summarised in **Table 11.113**.

Table 11.113 Summary of Potential Impacts Identified for Marine Mammals [effect significance of moderate adverse and major adverse are highlighted]

Potential Impact	Receptor	Value / Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
Construction						
C1: PTS from underwater noise during geophysical surveys	All marine mammal species	High	Negligible	Minor adverse	Mitigation for geophysical surveys (see **Section 11.7.1.3**).	Minor adverse – not significant
C1: TTS and disturbance from underwater noise during geophysical surveys	All marine mammal species	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
C2: PTS from underwater noise during UXO clearance	Harbour porpoise	High	Medium	Major adverse	MMMP for UXO Clearance (see **Section 11.7.1.2**).	Minor adverse – not significant
	Bottlenose dolphin, grey seal	High	Low to Medium	Moderate to Major adverse		Minor adverse – not significant
	White-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, humpback whale	High	Negligible	Minor adverse		Minor adverse – not significant
	Minke whale	High	Low	Moderate adverse		Minor adverse – not significant
	Harbour seal	High	Low to Negligible	Minor to Moderate adverse		Minor adverse – not significant
C2: PTS from underwater noise during low-order UXO clearance	All marine mammal species	High	Negligible	Minor adverse		Minor adverse – not significant
C2: TTS and disturbance from underwater noise during high-order or low-order UXO clearance	All marine mammal species	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
C2: Disturbance from ADD activation for low-order UXO clearance	All marine mammal species	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
C2: Disturbance from ADD activation for high-order UXO clearance	Bottlenose dolphin	Medium	Low to Negligible	Minor adverse	None required.	Minor adverse – not significant
	All other marine mammal species	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
C3: PTS from a single strike pile	All marine mammal species	High	Negligible	Minor adverse	MMMP for piling (see **Section 11.7.1.1**).	Minor adverse – not significant
	Harbour porpoise, minke whale, humpback whale	High	Negligible	Minor adverse		Minor adverse – not significant

Potential Impact	Receptor	Value / Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
C3: PTS due to cumulative exposure of the installation of one pile without ADD activation	All other marine mammal species	No impact				
C3: PTS due to cumulative exposure of the installation of one pile with 15 minutes of ADD activation	All marine mammal species	No impact				
C3: TTS from a single strike of the pile	All marine mammal species	Medium	Negligible	Minor adverse	MMMP for piling (see **Section 11.7.1.1**).	Minor adverse – not significant
C3: TTS due to cumulative exposure of the installation of one pile without ADD activation	Harbour porpoise, humpback whale, grey seal, harbour seal	Medium	Negligible	Minor adverse		Minor adverse – not significant
	Minke whale	Medium	Low	Minor adverse		Minor adverse – not significant
	All dolphin species	No impact				
C3: TTS due to cumulative exposure of the installation of one pile with 15 minutes of ADD activation	Harbour porpoise, minke whale, humpback whale	Medium	Negligible	Minor adverse	MMMP for piling (see **Section 11.7.1.1**).	Minor adverse – not significant
	All other marine mammal species	No impact				
C3: Disturbance from piling	All marine mammal species	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
C4: PTS from underwater noise for other construction activities	All marine mammal species	No impact				
C4: TTS from underwater noise for other construction activities	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
	All dolphin and whale species	No impact				
C4: Disturbance from underwater noise for other construction activities	Bottlenose dolphin	Medium	Negligible to Low	Minor adverse	None required.	Minor adverse – not significant
	All other marine mammal species	Medium	Negligible	Minor adverse		Minor adverse – not significant
C5: PTS from underwater noise of vessels	All marine mammal species	No impact				
C5: TTS from underwater noise of vessels	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
	All dolphin and whale species	Medium	No impact	No impact		No impact

Potential Impact	Receptor	Value / Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
C5: Disturbance from underwater noise of vessels	Bottlenose dolphin	Medium	Negligible to Low	Minor adverse	None required.	Minor adverse – not significant
	All other marine mammal species	Medium	Negligible	Minor adverse		Minor adverse – not significant
C6: Increased collision risk from construction vessels	Harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin, minke whales, grey seal	High	Negligible	Minor adverse	Best practice measures in CEMP (see **Section 11.7.5.6**).	Minor adverse – not significant
	Bottlenose dolphin	High	Negligible to Low	Minor to Moderate adverse		Minor adverse – not significant
	Harbour seal	High	Low	Moderate adverse		Minor adverse – not significant
C7: Barrier effect due to underwater noise	All marine mammal species	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
C8: Changes to prey availability	Harbour porpoise, minke whale, humpback whale	Low to Medium	Negligible to Low	Negligible to Minor adverse	None required.	Negligible to Minor adverse – not significant
	All dolphin and seal species	Low	Negligible to Low	Negligible to Minor adverse		Negligible to Minor adverse – not significant
Operation & Maintenance						
O1: Underwater noise impacts from operational wind turbines	All marine mammal species	Medium	Low	Minor adverse	None required.	Minor adverse – not significant
O2: PTS from underwater noise during maintenance activities including vessels	All marine mammal species	High	No impact	No impact	None required.	No impact
O2: TTS from underwater noise during maintenance activities including vessels	Harbour porpoise, grey seal, harbour seal	Medium	Negligible	Minor adverse	None required.	Minor adverse – not significant
	All dolphin and whale species	Medium	No impact	No impact		No impact
O2: Disturbance from underwater noise during maintenance activities including vessels	Bottlenose dolphin	Medium	Negligible to Low	Minor adverse	None required.	Minor adverse – not significant
	All other marine mammal species	Medium	Negligible	Minor adverse		Minor adverse – not significant
O3: Barrier effect due to underwater noise	All marine mammal species	Medium	No impact	No impact	None required.	No impact

Potential Impact	Receptor	Value / Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
O4: Increased collision risk from operation vessels	All marine mammal species	High	Negligible	Minor adverse	Best practice measures in CEMP (see **Section 11.7.5.6**).	Minor adverse – not significant
O5: Entanglement	Harbour porpoise, all dolphin and seal species	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to Minor adverse	Monitoring measures in PEMP (see **Section 11.7.6.5**).	Negligible adverse – not significant
	All whale species	Negligible (direct entanglement) High (secondary entanglement)	Low	Negligible to Moderate adverse		Negligible to Minor adverse – not significant
O6: EMF effects	All marine mammal species	Low	Low	Minor adverse	None required.	Minor adverse – not significant
O7: Barrier effect due to physical presence of wind farm	All marine mammal species	Negligible	Negligible	Negligible adverse	None required.	Negligible adverse – not significant
O8: Changes to prey resource	Harbour porpoise, minke whale, humpback whale	Low to medium	Negligible	Negligible to Minor adverse	None required.	Negligible to Minor adverse – not significant
	All dolphin and seal species	Low	Negligible	Negligible adverse		Negligible adverse – not significant
Decommissioning						
The same or less than assessment for construction						
PTS from underwater noise: - Cutting of OSP foundations (dependent on method) – based on piling	All marine mammal species	High	Negligible	Minor adverse	MMMP, if required.	Minor adverse – not significant
TTS and Disturbance from underwater noise: - Turbine anchor and mooring substructure removal - OSP foundation removal - Other decommissioning activities - Vessels	All marine mammal species	Medium	Negligible to Low	Minor adverse	None required.	Minor adverse – not significant
Barrier effects from underwater noise	All marine mammal species	Medium	Negligible to Low	Minor adverse	None required.	Minor adverse – not significant
Increased collision risk with vessels	Bottlenose dolphin	High	Negligible to Low	Moderate to Minor adverse		Minor adverse – not significant

Potential Impact	Receptor	Value / Sensitivity	Magnitude of Impact	Effect significance	Mitigation	Residual Effect
	Harbour seal	High	Low	Moderate adverse	Best practice measures in CEMP (see **Section 11.7.5.6**).	Minor adverse – not significant
	All other marine mammal species	High	Negligible	Minor adverse		Minor adverse – not significant
Changes to prey resources	All marine mammal species	Low to Medium	Negligible to Low	Negligible to Minor adverse	None required.	Negligible to Minor adverse – not significant
Cumulative						
CIA1: Cumulative disturbance from underwater noise during piling and construction at the Project	Harbour porpoise, bottlenose dolphin (GNS), minke whale, harbour seal	Medium	Low	Minor adverse	None proposed for the Project due to low contribution to cumulative impacts.	Minor adverse – not significant
	Grey seal	Medium	Medium	**Moderate adverse**		**Moderate adverse - significant**
	White-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and humpback whale	Medium	Negligible	Minor adverse		Minor adverse – not significant
CIA2: Cumulative barrier effects from underwater noise or physical disturbance during construction and operation	All marine mammal species	Negligible	Negligible	Negligible adverse	None required.	Negligible adverse – not significant
CIA3: Cumulative increased collision risk with vessels during construction and operation	All marine mammal species	High	Negligible	Minor adverse	None required.	Minor adverse – not significant
CIA4: Cumulative entanglement during operation	All marine mammal species (direct entanglement)	Negligible	Negligible	Negligible adverse	Monitoring at floating wind farms including the Project.	Negligible adverse – not significant
	Harbour porpoise, dolphin and seal species (secondary entanglement)	Medium	Negligible	Minor adverse		Minor adverse – not significant
	Whale species (secondary entanglement)	High	Low	**Moderate adverse**		Minor adverse – not significant
CIA5: Cumulative changes to prey resources during construction and operation	All marine mammal species	Low to medium	Negligible / No impact	Negligible / No impact to Minor adverse	None required.	Negligible / No impact to Minor adverse
Transboundary						
Considered as part of all assessments as summarised above.						

11.12.1 EPS Licence Application

803. EPS licence applications will be made for all activities that have the potential for injury or disturbance on EPS (cetaceans). The activities that may require an EPS licence are:

- Geophysical surveys
- UXO clearance
- Piling and offshore construction activities

804. Prior to any of these activities taking place, an EPS RA will be undertaken, following the staged approach as outlined in Marine Scotland (2020) and JNCC *et al*. (2010).

805. Mitigation will be put in place for geophysical surveys, UXO clearance, and piling (see **Section 11.7.1**), following current guidelines and advice. Where ADD activation is required, these will also be considered within the EPS RA.

11.12.2 Summary of Marine Mammal Mitigation and Monitoring

806. Mitigation will be required for the following activities, and will use the relevant guidance and advice at the time (the current guidelines are noted below):

- Geophysical surveys (see **Section 11.7.1.3**)
  - Following the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, 2017)
- UXO clearance (see **Section 11.7.1.2**)
  - Following the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010a)
- Piling (see **Section 11.7.1.1**)
  - Following the Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b)

807. The relevant guidelines will be used as a standard, however, if required, they may be adapted to ensure that any predicted impact ranges are effectively mitigated for all marine mammal species. It is expected that ADDs will be used as part of the mitigation for both UXO clearance and piling.

808. Mitigation protocols (**MMMPs**) will be developed for UXO clearance and piling. These will be presented in the licence conditions prior to construction.

809. In addition to the mitigation above, the following measures will also be put in place to reduce vessel collision risk and entanglement:

- Best practice to reduce vessel collision risk and the Scottish Marine Wildlife Watching Code (Scottish Natural Heritage, 2017) (see **Section 11.7.1**). These measure and requirements will be detailed in the CEMP.
- Monitoring of entanglement risk (see **Section 11.7.6.5**). The entanglement monitoring requirements will be detailed in the PEMP.

810. The mitigation and monitoring of marine mammals for the Project will be agreed with Marine Scotland and NatureScot prior to construction.

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