MONA OFFSHORE WIND PROJECT

Environmental Statement

Volume 2, Chapter 4: Marine mammals (F02)

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Image of an offshore wind farm

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F01	Application	RPS	Mona Offshore Wind Ltd	Mona Offshore Wind Ltd	Feb 2024
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Errata

Document section	Description of errata
Paragraph 4.9.3.38	The duration of piling is described as up to 113 days, within a two-year piling programme (as defined in Table 4.22). The correct duration of piling is actually up to 113.5 days.
Paragraph 4.9.5.22	It is stated that 'Multiplying the area of ensonification by each species-specific density would lead to unrealistic estimates, as serious disturbance would not occur over ranges such as 23 km'. It should state that serious disturbance would not occur over ranges such as 4.08 km.
Paragraph A.3.8.1.4	A cross-reference incorrectly states that 'The iPCoD models were set up as described in sections A.3.2 and A.3.3 for demographic parameters and reference populations, respectively, and with the same days of residual disturbance specified in section 0'. The same days of residual disturbance are specified in section A.3.4.

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Glossary

Term	Meaning
Anthropogenic	An activity resulting from or relating to the influence of humans.
Baseline	The status of the environment without the Mona Offshore Wind Project in place.
Climate change	A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
Collision	The act or process of colliding (crashing) between two moving objects.
Cumulative Effects	The combined effect of the Mona Offshore Wind Project in combination with the effects from other proposed developments, on the same receptor or resource.
Design Envelope	A description of the range of possible elements and parameters that make up the Mona Offshore Wind Project options under consideration, as detailed in Volume 1, Chapter 3: Project Description. This envelope is used to define the Mona Offshore Wind Project for EIA purposes when the exact engineering parameters are not yet known. This is also referred to as the Maximum Design Scenario (MDS) or Rochdale Envelope approach.
Development Consent Order	An order made under the Planning Act 2008, as amended, granting development consent.
Duration (Of Impact)	The time over which an impact occurs. An impact may be described as short, medium or long-term and permanent or temporary.
Dynamic Positioning	Computer-controlled system used to automatically maintain a vessel's heading and position without the use of mooring lines and/or anchors.
Effect	The term used to express the consequence of an impact. The significance of effect is determined by correlating magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Ensonified	Filled with sound.
Environmental Impact Assessment	The process of identifying and assessing the significant effects likely to arise from a project. This requires consideration of the likely changes to the environment, where these arise as a consequence of a project, through comparison with the existing and projected future baseline conditions.
Environmental Statement	The document presenting the results of the Environmental Impact Assessment process.
European Sites	Designated nature conservation sites which include the National Site Network (designated within the UK) and Natura 2000 sites (designated in any European Union country). This includes Sites of Community Importance, Special Areas of Conservation and Special Protection Areas.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to, and information to support, the EIA and Habitats Regulations Assessment processes for certain topics.
Expert Working Group	A forum for targeted engagement with regulators and interested stakeholders through the Evidence Plan process.
Habitat Regulations	The Conservation of Habitats and Species Regulations 2017 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).
Impact	Change that is caused by an action/proposed development, e.g., land clearing (action) during construction which results in habitat loss (impact).
Inter-related Effects	Inter-related effects arise where an impact acts on a receptor repeatedly over time to produce a potential additive effect or where a number of separate impacts, such as sound and habitat loss, affect a single receptor.

Term	Meaning
Kurtosis	A measure of sharpness of the peak of a frequency-distribution curve.
Marine Licence	The Marine and Coastal Access Act 2009 requires a marine licence to be obtained for licensable marine activities. Section 149A of the Planning Act 2008 allows an applicant for to apply for 'deemed marine licences' in English waters as part of the development consent process.
Maximum Design Scenario	The realistic worst case scenario, selected on a topic-specific and impact specific basis, from a range of potential parameters for the Mona Offshore Wind Project.
Mitigation Measures	The purpose of such measures is to avoid, prevent, reduce or, if possible, offset significant adverse environmental effects.
Mysticetes	Baleen whales, also known as whalebone whales, are a parvorder of carnivorous marine mammals of the infraorder Cetacea which use keratinaceous baleen plates in their mouths to sieve planktonic creatures from the water.
National Policy Statement	The current national policy statements published by the Department of Energy and Climate Change in 2011.
Non-statutory consultee	Organisations that an applicant may choose to consult in relation to a project who are not designated in law but are likely to have an interest in the project.
Planning Inspectorate	The agency responsible for operating the planning process for applications for development consent under the Planning Act 2008.
Reversibility	A reversible impact is one where recovery is possible naturally in a relatively short time period, or where mitigation measures can be effective at reversing the impact. An irreversible impact may occur when recovery is not possible within a reasonable timescale, or there is no reasonable chance of action being taken to reverse.
Scoping Opinion	Sets out the Planning Inspectorate's response (on behalf of the Secretary of State) to the Scoping Report prepared by the Applicants. The Scoping Opinion contains the range of issues that the Planning Inspectorate, in consultation with statutory stakeholders, has identified should be considered within the Environmental Impact Assessment process.
Scour Protection	Protective materials to avoid sediment being eroded away from the base of the foundations due to the flow of water.
Sound Exposure Levels	The representation of a sound event if all the energy were compressed into a one second period. This provides a uniform way to make comparisons between sound events of different durations.
Spatial Extent	Geographical area over which the impact may occur.
Statutory Consultee	Organisations that are required to be consulted by an applicant pursuant to section 42 of the Planning Act 2008 in relation to an application for development consent. Not all consultees will be statutory consultees (see non-statutory consultee definition).
Teuthophagous	Feeds on cephalopods.
Transboundary Effects	Effects from a project within one state that affect the environment of another state(s).
Vibrissae	Vibrissae are more generally called whiskers, are a type of stiff, functional hair used by mammals to sense their environment.

Acronyms

Acronym	Description
ADD	Acoustic Deterrent Device
AU	Assessment Unit
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
CCW	Countryside Council for Wales
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CGNS MU	Celtic and Greater North Sea Management Unit
CIEEM	Chartered Institute of Ecology and Environmental Management
CIS	Celtic and Irish Seas
CIS MU	Celtic and Irish Seas MU
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMACS	Centre for Marine and Coastal Studies
CMS	Conservation of Migratory Species
CPT	Cone Penetration Testing
CTV	Crew Transfer Vessel
CV	Coefficient of Variation
DCO	Development Consent Order
DDT	Dichlorodiphenyltrichloroethane
DECC	Department of Energy and Climate Change
EDR	Effective Deterrence Range
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EMP	Environmental Management Plan
EPS	European Protected Species
EWG	Expert Working Group
FCS	Favourable Conservation Status
GBF	Gravity Base Foundation
GES	Good Environmental Status
GIS	Geographical Information System
GSRP	Grey Seal Reference Population
HF	High Frequency
HRA	Habitats Regulations Assessment
HSRP	Harbour Seal Reference Population

Acronym	Description
HVAC	High Voltage Alternating Current
IA	Intermediate Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
IEF	Important Ecological Feature
IoM	Isle of Man
IPCoD	Interim Population Consequences of Disturbance Model
ISAA	Information to Support an Appropriate Assessment
IUCN	International Union for Conservation of Nature
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
KEC	Framework for Assessing Ecological and Cumulative Effects
LF	Low Frequency
MCZ	Marine Conservation Zone
MBES	Multi-Beam Echo-Sounder
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MMEA	Manx Marine Environmental Assessment
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MMOs	Marine Mammal Observers
MNR	Marine Nature Reserve
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MU	Management Units
MWDW	Manx Whale and Dolphin Watch
MWT	Manx Wildlife Trust
NAS	Noise Abatement System
NMFS	National Marine Fisheries Service
NMPI	National Marine Plan Interactive
NPS	National Policy Statements
NPWS	National Parks and Wildlife Service
NRA	Navigational Risk Assessment
NRW	Natural Resources Wales
NRW (A)	Natural Resources Wales Advisory Team
NS MU	North Sea Management Unit

Acronym	Description
NSIP	Nationally Significant Infrastructure Project
OC	Organochlorines
OCSE MU	Offshore Channel and Southwest England MU
ORJIP	Offshore Renewables Joint Industry Programme
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North East Atlantic
PAM	Passive Acoustic Monitoring
PBDE	Penta-mix brominated diphenyl ether congeners
PCB	Polychlorinated Biphenyl
PCW	Pinnipeds in water
PDV	Phocine Distemper Virus
PEIR	Preliminary Environmental Information Report
POP	Persistent Organic Pollutants
PTS	Permanent Threshold Shift
QA	Quality Assurance
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for Protection of Birds
SAC	Special Area of Conservation
SBES	Single Beam Echosounder
SBP	Sub-Bottom Profilers
SCANS	Small Cetacean Abundance in the North Sea
SCOS	Special Committee on Seals
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SMRU	Sea Mammal Research Unit
SOV	Service Operation Vessels
SPL	Sound Pressure Level
SPL_{pk}	Peak Sound Pressure Level
SSC	Suspended Sediment Concentrations
SSS	Side scan Sonar
SSSI	Site of Special Scientific Interest
SWF	Sea Watch Foundation
TBT	Tributyltin
TTS	Temporary Threshold Shift

Acronym	Description
TWT	The Wildlife Trust
UHRS	Ultra-High Resolution Seismic
UK	United Kingdom
US	United States
UXO	Unexploded Ordnance
VHF	Very High Frequency
WNMP	Welsh National Marine Plan
ZOI	Zone Of Influence

Units

Unit	Description
%	Percentage
dB	Decibel
Hz	Hertz
km^2	Square kilometres
m	Metre
m/s	Metres per second
m/s^2	Metres per second squared
MW	Megawatt
rms	Root mean square
s	Second
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single strike Sound Exposure Level
SPL	Sound Pressure Level
SPL_{pk}	Peak Sound Pressure Level
μPa	Micro Pascal (10^{-6})

4 Marine mammals

4.1 Introduction

4.1.1 Overview

4.1.1.1 This chapter of the Environmental Statement presents the assessment of the potential impact of the Mona Offshore Wind Project on marine mammals. Specifically, this chapter considers the potential impact of the Mona Offshore Wind Project seaward of Mean High Water Springs (MHWS) during the construction, operations and maintenance, and decommissioning phases.

4.1.1.2 The assessment presented is informed by the following technical chapters:

- Volume 2, Chapter 3: Fish and shellfish of the Environmental Statement
- Volume 2, Chapter 7: Shipping and navigation of the Environmental Statement
- Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement

4.1.1.3 This chapter also draws upon information contained within Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. The technical report provides a detailed characterisation of the marine mammal species ecology within the vicinity of the Mona Offshore Wind Project, the Irish Sea and wider Celtic Sea. It is based on existing literature and site-specific surveys and provides information on marine mammal species of ecological importance and conservation value. This chapter is also informed by a technical report developed to understand underwater sound emissions associated with the Mona Offshore Wind Project, which is included as Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement.

4.1.2 Purpose of chapter

4.1.2.1 The primary purpose of the Environmental Statement is outlined in Volume 1, Chapter 1: Introduction of the Environmental Statement. In summary, the primary purpose of an Environmental Statement is to support the Development Consent Order (DCO) application for Mona Offshore Wind Project under the Planning Act 2008 (the 2008 Act). The Environmental Impact Assessment (EIA) has been finalised following completion of pre-application consultation and the Environmental Statement will accompany the application to the Secretary of State for Development Consent.

4.1.2.2 In particular, this Environmental Statement chapter:

- Presents the existing environmental baseline established from desk studies, site-specific surveys and consultation
- Identifies any assumptions and limitations encountered in compiling the environmental information
- Presents the potential environmental effects on marine mammals arising from the Mona Offshore Wind Project, based on the information gathered and the analysis and assessments undertaken
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the potential environmental effects of the Mona Offshore Wind Project on marine mammals.

4.2 Legislative and policy context

4.2.1 Legislation

4.2.1.1 The full relevant legislative context for the Mona Offshore Wind Project has been detailed in Volume 1, Chapter 2: Policy and legislation context of the Environmental Statement, with the legislation outlined below being the most relevant to marine mammals.

Habitats Regulations

4.2.1.2 Before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which is likely to have a significant effect on a European offshore marine site or a European site (either alone or in combination with other plans or projects), and is not directly connected with or necessary to the management of the site, the relevant competent authority must undertake an appropriate assessment of the implications for the site in view of that site's conservation objectives. If the potential for adverse effects on European site integrity cannot be discounted, the project could only proceed if imperative reasons of over-riding public interest are found to exist and if compensatory measures can be secured.

4.2.1.3 A person is guilty of an offence if they deliberately capture, injure, or kill any wild animal of a European Protected Species (EPS). In Welsh inshore waters (within 12 nm of the coast), offences relating to the protection of marine EPS are provided for under the Habitats Regulations[1].

4.2.1.4 For marine mammals these internationally important sites include Special Areas of Conservation (SACs), or candidate SACs (cSACs). These designated sites have been given consideration in section 4.5.2, with further detail in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

Marine and Coastal Access Act 2009

4.2.1.5 Parts three and four of the Marine and Coastal Access Act 2009 introduced a new marine planning and licensing system for overseeing the marine environment and a requirement to obtain a marine licence for certain activities and works at sea. Section 149A of the Planning Act 2008 allows applicants for development consent to apply for 'deemed marine licences' as part of the consenting process.

The Marine Works (Environmental Impact Assessment) Regulations 2007

4.2.1.6 The Marine Works (Environmental Impact Assessment) Regulations 2007 requires that certain types of project with the potential to significantly affect the environment have an environmental impact assessment before a marine licence decision is made. It transposes the EIA Directive into United Kingdom (UK) law for marine licence applications.

[1] The Conservation (Natural Habitats, &c.) Regulations (1994 implement the Habitats Directives in territorial waters out to 12 nautical miles (nm). The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended) (the Offshore Marine Regulations) transpose the provisions of the Habitats Directive in offshore waters, beyond 12 nm.

The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) 1994

4.2.1.7 The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) came into force in 1994. The aim of the Agreement is to promote close co-operation amongst Parties with a view to achieving and maintaining a favourable conservation status for small cetaceans.

OSPAR Convention 1992

4.2.1.8 The Convention for the Protection of the Marine Environment of the North-East Atlantic (referred to as the OSPAR (Convention) was signed at the ministerial meeting of the Oslo and Paris Commissions in Paris in 1992 and aims to protect the marine environment of the North-East Atlantic. As part of this work, the need for a network of Marine Protected Areas (MPAs) has been identified, and includes SACs with marine components, which is relevant to marine mammals.

Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention, 1979)

4.2.1.9 The principal aims of the Convention are to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention), to increase co-operation between contracting parties, and to regulate the exploitation of migratory species listed in Appendix III.

4.2.1.10 The UK Government ratified the Bern Convention in 1982. The obligations of the Convention are transposed into UK law by means of the Wildlife and Countryside Act 1981 Nature Conservation (Scotland) Act 2004, Wildlife (Northern Ireland) Order 1985, and the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985.

The Convention on the Conservation of Migratory Species of Wild Animals 1979 (the Bonn Convention)

4.2.1.11 The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention or CMS) was adopted in Bonn, Germany in 1979 and came into force in 1985. Contracting Parties work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species, concluding multilateral Agreements for the conservation and management of migratory species which require or would benefit from international co-operation (listed in Appendix II), and by undertaking co-operative research activities.

The Conservation of Seals Act 1970

4.2.1.12 An Act to provide the protection and conservation of seals in England, Wales, Scotland and in adjacent territorial waters. The Conservation of Seals Act 1970 prohibits killing or taking seals. It is an offence to intentionally or recklessly kill, injure or take a seal. As of 1 March 2021 amendments made to the Conservation of Seals Act 1970 by Schedule 9 of the Fisheries Act 2020 come into force. Individual seals can no longer be controlled under the 'netsman's defence' as this defence was removed from the legislation as of 1 March 2021.

4.2.2 Planning policy context

4.2.2.1 The Mona Offshore Wind Project is located in Welsh offshore waters (beyond 12 nautical miles (nm) from the Welsh coast) and inshore waters, with the onshore infrastructure located wholly within Wales. As set out in Volume 1, Chapter 1: Introduction and overarching glossary of this Environmental Statement, the Mona Offshore Wind Project is an offshore generating station with a capacity of greater than 350 MW located in Welsh waters and is a Nationally Significant Infrastructure Project (NSIP), as defined by Section 15(3) of the Planning Act 2008 (as amended) (the 2008 Act). As such, there is a requirement to submit an application for a DCO to the Planning Inspectorate to be decided by the Secretary of State for the Department for Energy Security and Net Zero.

4.2.3 National Policy Statements

4.2.3.1 There are currently six energy National Policy Statements (NPSs), three of which contain policy relevant to offshore wind development and the Mona Offshore Wind Project, specifically:

- Overarching NPS for Energy (NPS EN-1) which sets out the UK Government's policy for the delivery of major energy infrastructure (Department for Energy Security & Net Zero, 2024a)
- NPS for Renewable Energy Infrastructure (NPS EN-3) (Department for Energy Security & Net Zero, 2024b).
- NPS for Electricity Networks Infrastructure (NPS EN-5) (Department for Energy Security & Net Zero, 2024c).

4.2.3.2 The main policies relevant to marine mammals are in NPS EN-1 and NPS EN-3 and include guidance on what matters are to be considered in the assessment. These are summarised in Table 4.1. NPS EN-1 and NPS EN-3 also highlight a number of factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 4.1 below.

Table 4.1: Summary of the NPS EN-1 and NPS EN-3 provisions relevant to marine mammals.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the Environmental Statement
NPS EN-1	
Where the development is subject to EIA, the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats. (NPS EN-1 paragraph 5.4.17)	The potential effects on internationally, nationally and locally designated sites for ecological or geological features of conservation importance have been identified and assessed for the Mona Offshore Wind Project. The HRA Stage 1 Screening (Document Reference E1.4) identified potential direct or indirect effects on sites which could be affected, and those sites have been assessed in the HRA Stage 2 Information to Support Appropriate Assessment (ISAA) (Document Reference E1.3). Important protected areas for marine mammals have been discussed in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and in section 4.4.3.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the Environmental Statement
The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests. (NPS EN-1 paragraph 5.4.19)	Measures that will be adopted as part of the Mona Offshore Wind Project to conserve biodiversity of marine mammals are presented in section 4.8.
The design of energy NSIP proposals will need to consider the movement of mobile/migratory species such as birds, fish and marine and terrestrial mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development. (NPS EN-1 paragraph 5.4.22)	The movement of mobile/migratory species such as marine mammals is considered in the assessment across the UK (section 4.13) and more widely across Europe in the cumulative and transboundary assessment.
In Wales, applicants should consider the guidance set out in Section 6.4 of Planning Policy Wales and the relevant policies in the Wales National Marine Plan. (NPS EN-1 paragraph 5.4.24)	Consideration of Welsh Planning Policy including Welsh National Marine Plan (WNMP) is presented in section 4.2.4.
Applicants should include appropriate avoidance, mitigation, compensation, and enhancement measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works • The timing of construction has been planned to avoid or limit disturbance • During construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements • Habitats will, where practicable, be restored after construction works have finished • Opportunities will be taken to enhance existing habitats rather than replace them, and where practicable, create new habitats of value within the site landscaping proposals. Where habitat creation is required as mitigation, compensation, or enhancement, the location and quality will be of key importance. In this regard habitat creation should be focused on areas where the most ecological and ecosystems benefits can be realised. • mitigations required as a result of legal protection of habitats or species will be complied with. (NPS EN-1 paragraph 5.4.35)	Appropriate avoidance and mitigation measures (primary and tertiary mitigation) relevant for marine mammals which will be adopted as part of the Mona Offshore Wind Project are detailed in section 4.8. The Maximum Design Scenario (MDS) represents the parameters that make up the realistic worst case scenario (i.e. the maximum project design parameters) and is selected on a topic-by-topic and impact-by-impact basis and assessed in section 4.9. The Mona Offshore Wind Project has also prepared an Outline underwater sound management strategy (Document Reference J16) which is secured in the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone Natural Resources Wales (NRW) marine licence. This establishes a process of investigating options to manage underwater sound levels in consultation with the licensing authority and SNCBs and agreeing, prior to construction, which mitigation measures will be implemented to reduce impacts such that there will be no residual significant effect from the Project.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the Environmental Statement
NPS EN-3	
Given the scale of offshore wind deployment required to meet 2030 and 2050 ambitions, applicants will need to give close consideration to impacts on MPAs, either alone or in combination, and employ the mitigation hierarchy and if necessary provide compensation (both individually and in combination with other plans or projects) which may be needed to approve their projects. It is likely that mitigation may include proactive measures to reduce the impact of deployment (e.g. micrositing of offshore transmission routes to avoid vulnerable habitats, alternatives piling or trenching techniques, noise abatement technology, collision avoidance methods or, if necessary, compensation for habitat loss). (NPS EN-3 paragraph 2.8.52 and 2.8.53)	Important marine protected areas, Special Areas of Conservation (SACs) designated for marine mammals and Marine Nature Reserves ((MNRs) in Manx waters) for marine mammals are considered in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and in section 4.5.2 of this chapter. Primary and tertiary mitigation relevant for marine mammals which will be adopted as part of the Mona Offshore Wind Project are detailed in section 4.8. The Mona Offshore Wind Project has also prepared an Outline underwater sound management strategy (Document Reference J16). This establishes a process of investigating options to manage underwater sound levels in consultation with the licensing authority and SNCBs and agreeing, prior to construction of those works which would lead to underwater sound impacts, which mitigation measures will be implemented to reduce impacts such that there will be no residual significant effect from the Mona Offshore Wind Project.
As part of the Offshore Wind Environmental Improvement Package set out in the British Energy Security Strategy, government committed to establishing Offshore Wind Environmental Standards (OWES; previously referred to as Nature Based Design Standards) to accelerate deployment whilst offering greater protection of the marine environment. OWES aim to support developers to take a more consistent approach to avoiding, reducing, and mitigating the impacts of an offshore wind farm and/or offshore transmission infrastructure. The measures could apply to the design, construction, operation and decommissioning of offshore wind farms and offshore transmission (as defined in EN-5 at section 2.12). Defra will consult on a series of OWES before drafting clear OWES Guidance, which sets out where and how Defra expects each measure to be applied to a development. Once the OWES Guidance is issued, the Secretary of State will expect applicants to have applied the relevant measures to their applications. Applicants should explain how their proposals comply with the guidance or, alternatively, the grounds on which a departure from them is justified. Any reasons for departure from the OWES should be fully detailed within the application documents, with details of any agreements made with statutory consultees. (NPS EN-3 paragraph 2.8.90 to 2.8.92)	The project is aware of the requirements in NPS EN-3 to apply the guidance on environmental standards, once the final OWES guidance is issued. The project will review the guidance once available and determine how the project complies, and consider the guidance, where, if relevant, the project departs from the Offshore Wind Environmental Standards, providing reasoning for any depature including details of any agreements made with statutory consultees.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the Environmental Statement
In addition, Applicants should have regard to the specific ecological and biodiversity considerations that relate to proposed offshore renewable energy infrastructure developments, namely: • Fish • Intertidal and subtidal seabed habitats and species • Marine mammals • Birds • Wider ecosystem impacts and interaction, and other relevant protected migratory species. Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ (Marine Conservation Zone) assessments. (NPS EN-3 paragraph 2.8.98 and 2.8.91)	A full assessment of marine mammals within the Mona marine mammal study area is provided in this chapter (see section 4.9) and includes consideration of direct and indirect potential impacts on marine mammals habitats. Other ecological receptors are considered in their respective Environmental Statement chapters (e.g. fish in Volume 2, Chapter 3: Fish and shellfish ecology, and benthic in Volume 2, Chapter 2 Benthic ecology of the Environmental Statement). This assessment has covered all phases of the Mona Offshore Wind Project.
Applicants need to consider environmental and biodiversity net gain as set out in Section 4.6 of EN-1 and the Environment Act 2021. Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity, as well as negative effects. (NPS EN-3 paragraph 2.8.102 – 2.8.103)	Both potential positive and negative effects have been considered on marine mammals for the Mona Offshore Wind Project (see section 4.9). These are also considered in the Biodiversity benefit and green Infrastructure statement (Document Reference J7).
Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options which should be undertaken. In developing proposals applicants must refer to the most recent best practice advice originally provided by Natural England under the Offshore Wind Enabling Action Programme and/or their relevant SNCB. Any relevant data that has been collected as part of post-construction ecological monitoring from existing operational offshore wind farms should be referred to where appropriate. (NPS EN-3 paragraph 2.8.104 – 2.8.106)	Assessment methodologies and baseline data collection has been consulted on through the Evidence Plan process (see section 4.3.2). Relevant data collected as part of post-construction ecological monitoring from existing operational offshore wind farms has been included where appropriate to inform the baseline (see section 4.5) with further detail given in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the Environmental Statement
Where necessary, assessment of the effects on marine mammals should include details of: • Likely feeding areas impacts on prey species and prey habitat • Known birthing areas/haul out sites for breeding and pupping • Migration routes • Protected sites • Baseline noise levels • Predicted construction and soft start noise levels in relation to mortality, permanent threshold shift (PTS), temporary threshold shift (TTS) and disturbance • Operational noise • Duration and spatial extent of the impacting activities including cumulative/in-combination effects with other plans or projects • Collision risk • Entanglement risk • Barrier risk. The scope, effort and methods required for marine mammal surveys and impact assessments should be discussed with the relevant SNCB. (NPS EN-3 paragraph 2.8.131 – 2.8.132)	The potential effects on marine mammals have been assessed in section 4.9 and a detailed technical baseline, including likely feeding areas, known birthing areas/haul out sites. Known migration or commuting routes has been presented within Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and in this chapter. Relevant protected areas to the Mona Offshore Wind Project for marine mammals are discussed in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and in this chapter. Baseline sound levels, predicted received sound levels in relation to mortality, Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) and disturbance, soft-start sound levels according to proposed hammer and pile design, and operational sound have been considered within Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement. Duration of potentially disturbing activity including potential cumulative/in-combination effects with other plans or projects has been presented in 4.11. Collision risk has been considered within section 4.9.6. Where relevant, the potential for barrier effects have been considered.
The applicant should discuss any proposed noisy activities with the relevant statutory body and must reference the joint JNCC and SNCB underwater noise guidance, and any successor of this guidance, in relation to noisy activities (alone and in-combination with other plans or projects) within SACs, SPAs and Ramsar sites, in addition to the JNCC mitigation guidelines for piling, explosive use, and geophysical surveys. NRW has a position statement on assessing noisy activities which should also be referenced where relevant. Where the assessment identifies that noise from construction and Unexploded Ordnance (UXO) clearance may reach noise levels likely to lead to noise thresholds being exceeded (as detailed in the JNCC guidance) or an offence as described in paragraph 2.8.127 – 2.8.129 above is committed, the applicant must look at possible alternatives or appropriate mitigation. The applicant should develop a Site Integrity Plan (SIP) or alternative assessments for projects in English and Welsh waters to allow the cumulative impacts of underwater noise to be reviewed closer to the construction date, when there is more certainty in other plans and projects. (NPS EN-3 paragraph 2.8.133 – 2.8.135)	The Mona Offshore Wind Project piling activity has been discussed in section 4.9.2, UXO has been discussed in Section 4.11.4 and geophysical surveys have been discussed in 4.11.3, and appropriate measures adopted as part of the Mona Offshore Wind Project to minimise the potential for a significant impact, along with those specific to construction, operations and maintenance and decommissioning presented in section 4.8. Furthermore, an Outline underwater sound management strategy (Document Reference J16) has been prepared to investigate options to reduce any potential significant impacts such that there will be no residual significant effects from the project alone, and is secured in the deemed marine licence within the draft DCO (Document Reference C1) and expected to be secured within the standalone NRW marine licence. NRW's position statement (NRW, 2023b) has been reviewed and incorporated throughout the assessment.

4.2.4 Welsh National Marine Plan

4.2.4.1 The marine mammal impact assessment has been made with consideration to the specific policies set out in the Welsh National Marine Plan (Welsh Government, 2019). Key provisions are set out in Table 4.2 along with details as to how these have been addressed within the assessment.

Table 4.2: Summary of Welsh National Marine Plan policy on decision making relevant to marine mammals.

Policy	Key provisions	How and where considered in the Environmental Statement
ENV_01: Resilient marine ecosystems.	Proposals should demonstrate how potential impacts on marine ecosystems have been taken into consideration and should, in order of preference: a. avoid adverse impacts; and/or b. minimise impacts where they cannot be avoided; and/or c. mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.	Potential impacts on marine mammal ecology have been considered and addressed in section 4.9. Appropriate avoidance and measures adopted (primary and tertiary mitigation) relevant for marine mammals which will be adopted as part of the Mona Offshore Wind Project are detailed in section 4.8. The Applicant will also develop a Marine Mammal Mitigation Protocol (MMMP) (with an Outline MMMP (Document Reference J21) submitted as part of the application for consent), as an annex of the Underwater sound management strategy (Document Reference J16) which will follow the mitigation hierarchy (avoid, minimise, restore, offset).
ENV_02: Marine Protected Areas.	Proposals should demonstrate how they: • avoid adverse impacts on individual MPAs and the coherence of the network as a whole; • have regard to the measures to manage MPAs; and • avoid adverse impacts on designated sites that are not part of the MPA network.	Relevant marine protected areas, SACs designated for marine mammals and Marine Nature Reserves (MNRs) (in Manx waters) to the Mona Offshore Wind Project for marine mammals are considered in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and in section 4.4.5 of this chapter. Designated sites within the regional marine mammal study area have been identified and any potential impacts to features and the network of MPAs have been assessed in the ISAA (Document Reference E1.3).
ENV_05: Underwater noise.	Proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference: a. avoid adverse impacts; and/or b. minimise impacts where they cannot be avoided; and/or c. mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	Sections 4.9.2, 4.9.4, and 4.9.5 assess the potential impact of underwater sound from various activities on marine mammals taking into account measures adopted to reduce potential effects (see section 4.8). In each case, where there is the potential for residual significant effects, further mitigation has been proposed. The project will implement a range of measures (primary and tertiary) adopted as part of the Mona Offshore Wind Project which will reduce the potential effects of sound, detailed in section 4.8. This includes the MMMP (Document Reference J21), based on a draft MMMP submitted alongside the application for consent. The MMMP will present appropriate mitigation for activities that could potentially lead to injurious effects on marine mammals including piling, UXO clearance and some types of geophysical activities. The MMMP will be developed on the basis of the most recent published

Policy	Key provisions	How and where considered in the Environmental Statement
		statutory guidance and in consultation with key stakeholders. Furthermore the Mona Offshore Wind Project has committed to an Underwater sound management strategy (with Outline underwater sound management strategy included as part of the application, Document Reference J16) which will consider further mitigation measures to reduce any residual significant effects from the project to a non-significant level, on the basis of a refined project design post consent, where more detailed information is available.
ENV_07: Fish species and Habitats	Proposals potentially affecting important feeding, breeding (including spawning & nursery) and migration areas or habitats for key fish and shellfish species of commercial or ecological importance should demonstrate how they, in order of preference: a. avoid adverse impacts on those areas; and/or b. minimise adverse impacts where they cannot be avoided; and/or c. mitigate adverse impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding	The potential effects on fish species and their habitats have been assessed in full in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, and this has potential impacts on marine mammals as a prey source. Measures adopted as part of the Mona Offshore Wind Project for fish (see section 3.8 in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement) to reduce potential impacts on fish species will have indirect benefits to marine mammals, as higher trophic level animals. Section 4.9.9 has assessed the potential effects on fish species and habitats in the context of how marine mammal prey species may be impacted.
GOV_01: Cumulative effects	Proposals should demonstrate that they have assessed potential cumulative effects and should, in order of preference: a. avoid adverse effects; and/or b. minimise effects where they cannot be avoided; and/or c. mitigate effects where they cannot be minimised. If significant adverse effects cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to positive cumulative effects are encouraged.	The potential for cumulative effects in relation to other nearby offshore projects has been identified and assessed in the cumulative effects assessment (section 4.11).

4.2.5 The Marine Strategy Framework Directive

4.2.5.1 The Marine Strategy Framework Directive (MSFD) aims to protect more effectively the marine environment across Europe.

Table 4.3: Summary of the MSFD's high level descriptors of Good Environmental Status (GES) relevant to marine mammals and consideration in the Mona Offshore Wind Project.

MSFD Descriptor relevant to marine mammals	How and where considered in the Environmental Statement
Descriptor 1: Biological diversity: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	The potential effects on biological diversity has been described and considered within the assessment for the Mona Offshore Wind Project both alone (section 4.9) and in Cumulative Effects Assessment (CEA) (4.11). A detailed baseline assessment which describes the distribution and abundance of marine mammal species in the study area has been undertaken in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, and a summary presented in section 4.5. Appropriate and precautionary densities to take forward to the assessment have been agreed in consultation with stakeholders (Table 4.12).
Descriptor 4: Elements of marine food webs: 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.	The potential effects of prey species (see assessment of impacts on fish prey species in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement) on the abundance and distribution of marine mammal receptors within the regional marine mammal study area has been described and considered within the assessment for the Mona Offshore Wind Project both alone (section 4.9) and in the CEA (section 4.11).
Descriptor 6: Sea floor integrity: Seafloor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	The potential effects on temporary and long term habitat loss and introduction of new habitat on benthic ecosystems and associated benthic species have been considered within Volume 2, Chapter 2: Benthic subtidal and intertidal ecology and Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. Subsequently, the potential indirect effects on marine mammals in relation to changes in prey species communities within the Mona marine mammal study area has been described and considered within the assessment for the Mona Offshore Wind Project both alone (section 4.9) and in the CEA (section 4.11).
Descriptor 8: Contaminants: Concentrations of contaminants are at levels not giving rise to pollution effects.	The potential effects of contaminants on marine mammal receptors were scoped out as agreed in the Mona EIA Scoping Report and as agreed with the Expert Working Group (EWG) (section 4.3).
Descriptor 10: Marine litter: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.	An appropriate Offshore Environmental Management Plan (EMP) will be produced and implemented. The offshore EMP will also outline any procedures implemented during the operations and maintenance phase. A Decommissioning Programme is required under the provisions of the Energy Act 2004. This must be approved by the Secretary of State for the Department for Energy Security and Net Zero before works commence.
Descriptor 11: Energy including underwater noise: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.	The potential effects of underwater sound from piling of foundations for wind turbines, and Offshore Substation Platform (OSP) foundations, from other construction activities (e.g. cable installation) and from vessel sound have been considered within the assessment for the Mona Offshore Wind Project both alone (section 4.9) and in the CEA (section 4.11).

MSFD Descriptor relevant to marine mammals	How and where considered in the Environmental Statement
	It is noted that the European Union recently adopted thresholds for maximum acceptable levels for impulsive (e.g. piling) and continuous noise (e.g. shipping). The new limits mean, that to be in tolerable status, no more than 20% of a given marine area can be exposed to continuous underwater sound over a year. Similarly, no more than 20% of a marine habitat can be exposed to impulsive sound over a given day, and no more than 10% over a year. The Mona Offshore Wind Project has committed to an Underwater sound management strategy (with Outline underwater sound management strategy included as part of the application, Document Reference J16) which will consider further mitigation measures to reduce any residual significant effects from the project to a non-significant level, on the basis of a refined project design post consent, where more detailed information is available.

4.2.6 North West Inshore and North West Offshore Coast Marine Plans

4.2.6.1 The assessment of potential changes to marine mammals has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). Key provisions are set out in Table 4.4 along with details as to how these have been addressed within the assessment.

Table 4.4: North West Inshore and North West Offshore Marine Plan policies of relevant to marine mammals.

Policy	Key provisions	How and where considered in the Environmental Statement
NW-SCP-1	Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area.	The process of identifying designated sites has been undertaken for the regional marine mammal study area (see section 4.4.5 and 4.5.2) and was done to ensure all habitats and features or species of conservation importance were considered in the assessment.
NW-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network are supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate; Adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	This chapter presents the spatial scale of potential effects in relation to sites protected for marine mammal features (e.g. SACs, MNRs). A detailed assessment of the spatial overlap with European nature conservation designations has been undertaken as part of the HRA (HRA Stage 2 ISAA (Document Reference E1.3)). Measures have been adopted as part of the Mona Offshore Wind Project to reduce the spatial scale of potential effects and are described in section 4.8.
NW-BIO-2	NW-BIO-2 requires proposals to manage negative effects which may significantly adversely impact the	The project will implement a range of measures adopted (primary and tertiary) as part of the Mona

Policy	Key provisions	How and where considered in the Environmental Statement
	functioning of healthy, resilient and adaptable marine ecosystems.	Offshore Wind Project to mitigate potential negative effects which are detailed in section 4.9. The Mona Offshore Wind Project has also committed to an Underwater sound management strategy (with an Outline underwater sound management strategy included as part of the application for consent, Document Reference J16), which, post-consent, will set out the approach to further management measures that may be required to reduce the impact such that there will be no residual significant effect for underwater sound, following a refined project design and more detailed information post consent.
NW-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will avoid, minimise and mitigate.	Potential cumulative effects have been quantified and their significance assessed in section 4.10. A detailed MMMP (Document Reference J16) will be developed post-consent subject to project refinements and will consider mitigation in order to reduce the potential effects for the project alone, which will reduce the project's contribution to potential cumulative effects. The Mona Offshore Wind Project has also committed to an Underwater sound management strategy (with an Outline underwater sound management strategy included as part of the application for consent, Document Reference J16), which post-consent will set out the approach to further management measures that may be required to reduce the magnitude of the impact such that that there will be no residual significant effect from underwater sound from the project.
NW-UWN-2	Proposals that result in the generation of impulsive or non-impulsive noise must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate Adverse impacts on highly mobile species so they are no longer significant.	The potential impacts of underwater sound resulting from the construction, operations and maintenance, and decommissioning phases have been considered in the underwater sound impact assessment (section 4.9.3). The project will implement a range of measures adopted (primary and tertiary) as part of the Mona Offshore Wind Project which will reduce the potential effects of sound, detailed in section 4.8. The Mona Offshore Wind Project has also committed to an Underwater sound management strategy (with an Outline underwater sound management strategy included as part of the application for consent, Document Reference J16), which post-consent will set out the approach to further management measures that may be required to reduce the impact such that that there will be no residual significant effect from underwater sound from the project, following a refined project design and more detailed information post consent.

4.3 Consultation

4.3.1 Overview

4.3.1.1 A summary of the key issues raised during consultation activities undertaken to date specific to marine mammals is presented in below, together with how these issues have been considered in the production of this Environmental Statement chapter. Further detail is presented within Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

4.3.2 Evidence plan

4.3.2.1 The purpose of the Evidence Plan process is to agree the information the Mona Offshore Wind Project needs to supply to the Secretary of State, as part of a DCO application for the Mona Offshore Wind Project. The Evidence Plan has sought to ensure compliance with the Habitat Regulations Assessment (HRA) and EIA. The development and monitoring of the Evidence Plan and its subsequent progress has been undertaken by the Steering Group. The Steering Group comprises of the Planning Inspectorate, the Applicant, NRW, Natural England, Joint Nature Conservation Committee (JNCC) and the Marine Management Organisation (MMO) as the key regulatory and SNCBs. To inform the EIA and HRA process during the pre-application stage of the Mona Offshore Wind Project, a Marine Mammal Expert Working Group (EWG) was also set up to discuss and agree topic specific issues with the relevant stakeholders. Details of the marine mammal EWG meetings, final meeting minutes, any responses from the stakeholders and technical notes provided to the EWG are presented in the Technical engagement plan Part 1 (Document Reference E4.1).

Table 4.5: Summary of consultation activities undertaken for the Mona Offshore Wind Project relevant to marine mammals.

Date	Consultee and type of response	Topics	Response to issue raised and/or where considered in this chapter
February 2022	**Marine Mammals Expert Working Group 1 –** NRW, Natural England, MMO, JNCC, TWT (The Wildlife Trust).	Use of digital aerial survey data requires an assessment of the suitability of analysing data covering 12% of the survey area, such as a power analysis to support approach.	Coverage for Mona aerial surveys are detailed in Appendix A of Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. Coverage for the Mona aerial surveys stands at least 14%, which exceeds some previously consented projects and the 10% minimum coverage suggested by literature (BSH, 2013). Coefficients of variation (CVs) are also provided in this technical report to give a measure of precision to support the approach, but noted CVs will be higher for marine mammals, due to very low sighting numbers given their life history, so the difference between raw counts would be proportionally greater.
		Evidence of sufficient levels of quality assurance should be provided to resolve any concerns regarding the detection probability or species identification confidence associated with the chosen method (e.g. sample images in range of confidence scenarios and visibility conditions).	In processing of aerial data, marine mammals identified in the images were categorised to the lowest taxonomic level possible. Size of individuals were measured to aid in species-level identification. APEM Ltd undertook the aerial surveys for Mona Offshore Wind Project, and full details of the survey methodology, data processing, data analyses, assumptions and limitations have been provided in Appendix A of Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. APEM Ltd. uses the precautionary principle and only identifies to species level when there is 100% confidence and includes a comprehensive internal Quality Assurance (QA) process (details of which are provided in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement). APEM only gives definite species sightings where an animal can be identified to species level with high confidence. Where a marine mammal sighting cannot be identified with high confidence to species level, sightings are given in their own non-species-specific categories (e.g. ‘seal species’, ‘dolphin/porpoise’, ‘marine mammal’).
		Survey feedback - advise caution in applying feedback on the survey design with respect to birds to marine mammals.	Survey design with respect to marine mammals was subsequently discussed with responses provided via the EWG process.

Date	Consultee and type of response	Topics	Response to issue raised and/or where considered in this chapter
		Regional marine mammal study area – NRW query study area extent.	Study areas used in the assessment (as presented in paragraph 4.4.3) were discussed and agreed with the Marine Mammal Expert Working Group as part of the EWG process. The regional study was defined as the Celtic and Irish seas and was confirmed by the Mammal Expert Working Group (following fifth EWG meeting on 3 August 2023). In accordance with advice received during consultation, potential population level effects have been informed by species specific Management Units (MUs) (further detail given in paragraph 4.4.3.2).
		Key species must include minke whale, often sighted around the Isle of Man.	Baseline description of minke whales is included in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and has been scoped into the assessment in section 4.9.
		Desktop data sources – additional sources considered for applicability.	A detailed literature review was undertaken, and additional data sources or informative documents were sought to inform the baseline characterisation. Additional data was provided by Manx Wildlife Trust (MWT), Manx Whale and Dolphin Watch (MWDW) and for Walney Island following direct correspondence and is included in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, to inform the baseline for assessment in section 4.9.
May 2022	**Underwater sound technical note** – provided to EWG.	Provided information on potential sources of underwater sound, methods for determining source sound levels, sound propagation modelling methodologies, exposure modelling and thresholds for injury and disturbance and stakeholders provided feedback the information presented. Feedback included: **NRW**: NRW would not recommend applying a dose-response curve developed for harbour porpoise to all cetacean species when carrying out an EIA to assess the number of	The same dose response curve for harbour porpoise (in the absence of species-specific data for other cetacean species) was assumed to apply to all cetacean Important Ecological Features (IEFs) in this assessment, but note that this is a highly precautionary approach. A dose response curve by Whyte *et al.* (2020) using tracking data from harbour seal was used for the assessment and is explained in detail in paragraph 4.9.2.11. Piling has been modelled both with Acoustic Deterrent Devices (ADDs) (as it is a standard tertiary mitigation

Date	Consultee and type of response	Topics	Response to issue raised and/or where considered in this chapter
		animals that would be disturbed by piling as can lead to over-estimate. Requested justification of dose-response curve in Russell *et al.,* (2016) developed for harbour seal, as a proxy to assess number of grey seals disturbed by piling. **Natural England**: It would be beneficial to consider modelling piling with noise abatement systems in place, to understand the possible reduction in underwater sound (and associated impacts) if such mitigation methods are used. Similarly, sound abatement for Unexploded Ordnance (UXO) clearance where deflagration is not an option should also be considered. A quantitative assessment of the TTS ranges and the number of animals within those ranges would expect to be seen. Natural England advise the outputs from Whyte *et al*. (2020) which provides a dose-response curve for seals in relation to decreasing Sound Exposure Levels (SELs) should be considered. Natural England expect to see the underwater sound from operational wind turbines quantified in Volume 5, Annex 3.1: Underwater sound technical report of the Preliminary Environmental Information Report (PEIR). Request clarification as to whether consecutive piling (i.e. multiple piles, one after the other) is also within the project design envelope. **JNCC**: highlighted using the dose-response curve based on harbour porpoise only for all cetaceans, given they are a high frequency (HF) cetacean species. JNCC recommend further justification for this approach is included and a discussion with the EWG to agree a suitable approach.	measure) and without ADD, and is discussed in the assessment (section 4.9.3). Whilst ADDs are a recognised mitigation measure during piling and UXO clearance, they are not a sound reduction or abatement system. No modelling of Noise Abatement systems (NAS) is presented in this chapter but will be considered as an option under the Underwater sound management strategy (Document reference J16) post consent, if required. For the UXO assessment the TTS metric has been applied as a proxy for potential behavioural effects (as the animal will move away from the sound source) and potential effect ranges have been modelled and applied to the quantitative assessment. Consecutive scenarios have been modelled and assessed and included in section 4.6.

Date	Consultee and type of response	Topics	Response to issue raised and/or where considered in this chapter
June 2022	**Scoping Opinion** The Planning Inspectorate	Harbour seal have been observed in the site-specific digital aerial surveys. The Mona EIA Scoping Report states that low numbers of harbour seal are encountered along the coasts of Wales but that they do not occur in high densities within the regional marine mammal study area. The Planning Inspectorate does not agree that harbour seal can be scoped out of the assessment.	Harbour seal is included in the baseline environment of Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and has been included in the assessment in section 4.9 of in this chapter.
		The Planning Inspectorate notes advice from NRW, Natural England, the JNCC and the Isle of Man Government that the Marine Mammal Management Unit is the appropriate scale for consideration of the regional impacts for marine mammals, as opposed to the Irish Sea geographical area presented, and advises the Applicant to apply this study area within the Environmental Statement.	Marine mammal MUs have been considered as relevant populations against which to assess potential impacts; Irish and Celtic Seas have been defined as regional and cumulative study areas in agreement with relevant stakeholders in the second EWG meeting (see later in this table).
		A number of datasets proposed to be used to inform the regional marine mammal study area (i.e. out with the site-specific survey area) are more than 10 years old. Whilst it is acknowledged site-specific surveys have been undertaken, the Applicant should ensure that the baseline data used in the Environmental Statement assessments are sufficiently up to date to provide a robust baseline.	A detailed literature review was undertaken, and additional data sources or informative documents were sought and used to inform the baseline characterisation (given in section 4.5 with detailed baseline presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement) including the most up-to-date relevant information.
	Scoping Opinion IOM Department of Infrastructure	Refer to the Manx Marine Environmental Assessment (MMEA) which provides a useful overview of the Island's marine environment and should be taken into account as part of both the transboundary and possibly also the cumulative impacts assessment as part of this application.	The MMEA was reviewed as part of the baseline desktop study and findings presented in the marine mammal technical report (Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).
		The Committee notes that the MUs for these cetaceans include Isle of Man territorial waters and, as such, consider it appropriate that this area is included within the assessment for these species.	Manx Wildlife Trust provided data and reports to inform the baseline characterisation for Isle of Man waters (Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).
		Key species should include minke whale.	Baseline description of minke whales is included in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and has been included in the assessment in section 4.9 of in this chapter.

Date	Consultee and type of response	Topics	Response to issue raised and/or where considered in this chapter
		Recommends engagement with the Manx Whale and Dolphin Watch (MWDW) and Manx Wildlife Trust (MWT).	MWDW and MWT were contacted as part of desk study and data obtained have been presented in the baseline characterisation (Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).
		Several Manx MNRs specifically include cetaceans in their designation features, including presumed feeding grounds for Cardigan Bay Bottlenose Dolphin, regionally important populations of Risso's dolphins and wide-ranging populations of grey seal.	Description of Manx MNRs have been included in the marine mammal technical report (Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).
		Inclusion of Isle of Man Wildlife Act 1990.	Isle of Man Wildlife Act 1990 has been referred to in the legislation section of this report (section 4.5.2).
	Scoping Opinion JNCC	Morgan and Mona regional marine mammal study areas – JNCC query study area extent.	Study areas were discussed and agreed with JNCC as part of the EWG and the regional study was defined as the Celtic and Irish Seas for use in both assessment and the CEA study area.
		Agree that harbour porpoise, minke whale, bottlenose dolphin, common dolphin, Risso's dolphin, & grey seal are scoped into the EIA; and white-beaked dolphin and harbour seal are scoped out.	White-beaked dolphin has been scoped out, but harbour seal has been scoped in as result of EWG discussions.
	Scoping Opinion Natural England	Marine Mammal Mus should be used as the regional study area for the purposes of calculating the reference populations, the screening extent as regards SACs, and for cumulative impacts spatial screening extent.	Study areas were discussed and agreed with Natural England as part of the EWG and the regional marine mammal study area was defined as the Celtic and Irish Seas.
		Suggests harbour seal cannot yet be excluded from the high-level assessment until there is suitable evidence (i.e. from the results of the complete digital aerial survey campaign) for their exclusion.	Harbour seal has been scoped in as a key species as a result of EWG discussions. Baseline description of harbour seal is included in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and has been included in the assessment in section 4.9 of in this chapter.
		Advise data derived from the site-specific aerial surveys is considered alongside existing data for the area when	Data from site-specific aerial surveys has been presented along with broadscale published data and precautionary

Date	Consultee and type of response	Topics	Response to issue raised and/or where considered in this chapter
		selecting the best/most precautionary estimate of marine mammal density to use for the quantitative assessment.	density estimates have been carried forward to the assessment (see Table 4.12).
		Data source suggestions for inclusion.	All suggested data sources have been included in the baseline (Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).
		Note that a number of individuals could not be identified to species level. We welcome clarification on how these observations are going to be included in the assessment to ensure that species' density estimates are not underestimated.	Individuals identified as 'seal species' were combined with the data on grey seal, whilst those identified as 'cetacean species' were combined with data on harbour porpoise. These were the only two species where it was possible to generate density estimates and combining higher taxonomic identifications provided the most precautionary estimate of density for use in the impact assessment (see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement (Appendix A)). Design of aerial surveys with respect to marine mammals were agreed by NRW and JNCC following the fifth EWG meeting technical note issued to the marine mammal EWG on 11 September 2023 (presented in the Technical engagement plan Part 1 (Document Reference E4.1)).
	Scoping Opinion NRW	NRW (A) advise that the Marine Mammal MU is the appropriate scale for consideration of offsite impacts for marine mammals as per NRW's Position Statement.	Marine mammal MUs have been considered as relevant populations against which to assess potential impacts (see section 4.9), and the Irish and Celtic Seas have been defined as the regional marine mammal study area. The Celtic and Irish Seas MU is defined as the cumulative marine mammal study area in agreement with relevant stakeholders as per the second EWG meeting, with the addition of an extended screening area for grey seal only (OSPAR Region III) (see section 4.4.3).
		If Digital Aerial Survey data is to be used in environmental assessments, an assessment of the suitability of analysing data covering 12% of the survey area, such as a power analysis, should be provided to support the approach taken.	Coverage for Mona digital aerial surveys are detailed in Appendix A of Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, with mean coverage standing at over 14%, exceeding several previously consented projects and 10% minimum coverage suggested by literature (BSH, 2013). CVs also provided in

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			Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement to give measure of precision to support approach, but noted CVs will be higher for marine mammals, due to very low sighting numbers given their life history, so the difference between raw counts would be proportionally greater.
		Additional data sources or informative documents should be sought to those outlined	Additional data sourced have been included in the baseline presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.
		Where there is no density estimate in Small Cetacean Abundance in the North Sea (SCANS) III, SCANS II may be recommended for use in its place. NRW advise that a short, proportionate assessment on species of very low densities is preferable to scoping them out.	For short-beaked common dolphin, estimates from Evans and Waggitt (2023) have been used for densities (see Table 4.12).
July 2022	**Marine Mammals Expert Working Group 2 –** Natural England, MMO, JNCC, NRW, TWT, Cefas (Centre for Environment, Fisheries and Aquaculture Science).	Agreement sought on approach to the baseline characterisation with regards to regional marine mammal study area. NRW in agreement that Celtic and Irish Sea (harbour porpoise) MU is an appropriate study area for dolphin and minke whale.	Species-specific MUs were used as reference populations. Celtic and Irish Sea (harbour porpoise MU) was adopted as the regional marine mammal study area and has been used to screen in cumulative projects.
		Discussion of species to scope in/out of the EIA and HRA. Agreement that white-beaked dolphin can be scoped out.	Harbour seal included in the baseline environment of the Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. White-beaked dolphin are scoped out.
November 2022	**Marine Mammals Expert Working Group 3 –** MMO, Natural England, NRW, TWT, DEFA, Isle of Man Government, Cefas.	Discussion on densities and reference populations for marine mammals. Proposed approach set out in EWG03 and pre-meeting note.	Approach to density and reference populations is presented in detail in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement with a summary presented in Table 4.12).
		Approach to assessment presented, covering: • Dose response curves and use of National Marine Fisheries Service (NMFS) thresholds • Assumptions of the cumulative assessment	Dose response curve derived from Graham *et al.* (2019) for cetaceans due to lack of other approach for species. NMFS thresholds are also included in the assessment in this chapter and discussed in detail in 4.9.2.25. A tiered approach has been used in the cumulative assessment, with modelling carried out across Tier 1 projects to provide a quantitative assessment. Tier 2

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			projects where quantitative information is available in the public domain has also been included in modelling. Detailed description of the cumulative assessment approach is provided in section 4.10.
		Initial underwater sound modelling outputs for piling presented to the EWG. Highlighted sensitivity of iPCoD modelling to parameters chosen.	PTS has been carried forward to the assessment in section 4.9.3. The ranges for TTS are presented in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement but are not included in the assessment for injury and disturbance for elevated underwater sound during piling. The method for Interim Population Consequences of Disturbance Model (iPCoD) modelling used to understand potential long term population effects is presented in paragraph 4.9.3.13, and a detailed iPCoD report is presented in Appendix A.
		Agreement on defining the mitigation zone using the dual metric approach of peak sound pressure level (SPL_{pk}) and cumulative sound exposure level (SEL_{cum}).	The dual metric approach has been used in the impact assessment of injury and disturbance from elevated underwater sound from piling (section 4.9).
		NRW recommended that when assessing the area disturbed for harbour porpoise, in parallel to Effective Deterrence Ranges (EDRs), an unweighted noise threshold of 143 dB re 1 μPa (or 103 dB re 1 μPa Very High Frequency (VHF)-weighted) single strike sound exposure level (Brandt *et al.* 2018; Heinis *et al.* 2019) should be used to represent the minimum fixed noise threshold at which significant disturbance would occur from impulsive noise sources.	An unweighted sound threshold value of 143 dB re 1μPa (SEL_{ss}) has been applied to represent the minimum fixed sound threshold at which significant disturbance could occur for the final application in addition to dose response for the EIA (see section 4.9.3). The EDR approach has only been used for the purposes of the HRA (Document Reference E.1.2). NRWs position statement (NRW, 2023b) has been reviewed and incorporated to the assessment where relevant.
February 2023	**Marine Mammals Expert Working Group 04**	The baseline for Morgan Offshore Wind Project: Generation Assets was presented.	Comments from this EWG meeting are not relevant for this chapter as the meeting covered Morgan Offshore Wind Project: Generation Assets.
June 2023	**Statutory Consultation (S42)**	MMO, NRW, NE and JNCC recommended use of noise abatement measures. NRW highlighted the use of noise mitigation strategies/attenuation technology such as bubble curtains,	Measures adopted as part of the Mona Offshore Wind Project are presented in Table 4.17. A commitment to considering Noise Abatement Systems (NAS) as an option as part of the Underwater sound management strategy (Document Reference J16) has been made as part of a

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		timing of piling and piling methods have not been proposed as potential mitigation methods.	stepped strategy post consent and following the mitigation hierarchy - avoid, reduce, mitigate. The project has prepared an Outline underwater sound management strategy (Document Reference J16) which is secured in the deemed marine licence in Schedule 14 of the draft DCO. This establishes a process of investigating options (such as NAS) to manage underwater sound levels in consultation with the licensing authority and SNCBs and agreeing, prior to construction, which mitigation measures will be implemented to reduce impacts such that there will be no residual significant effect.
		NRW did not agree with the EDR approach and disagreed with using dose response curves to assess area disturbed for harbour porpoise. Instead recommended that in addition/in parallel to EDRs, an unweighted noise threshold of 143 dB re 1µPa (or 103 dB re 1µPa VHF-weighted) single strike sound exposure level should be used to represent the minimum fixed noise threshold at which significant disturbance would occur from impulsive noise sources.	An unweighted sound threshold value of 143 dB re 1µPa (SEL_{ss}) has been applied to represent the minimum fixed sound threshold at which significant disturbance could occur for the final application in addition to dose response for the EIA. Advice from NRW is being followed as agreed with the EWG. Quantification of the percentage overlap with the SAC has been provided in paragraph 4.9.3.60. The Effective Deterrence Range approach has only been used for the purposes of the Habitats Regulation Assessment. NRW's position statement (NRW, 2023b) has been reviewed and incorporated throughout the assessment.
		For harbour porpoise and bottlenose dolphin, NRW did not agree with the densities used for PEIR. For harbour porpoise, the site-specific density was substantially lower than more up to date densities. For bottlenose dolphin, NRW did not agree with the more complex approach of using dual densities (higher coastal density and lower offshore density). Furthermore they did not recommend that water depth or distance from the coastline alone are used to predict density distributions since other factors need to be taken into consideration. NRW recommended the use of the Marine Mammal Atlas (Evans and Waggitt, 2023) ensuring that the most precautionary or the most scientifically robust values are taken forward to the assessment.	The final densities used in the assessment for harbour porpoise, bottlenose dolphin and short-beaked common dolphin has been based on the latest edition of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) as agreed with NRW and other stakeholders via the marine mammals EWG and therefore some values are higher than previously assessed for PEIR. Densities have been presented in Table 4.12 (as agreed via the EWG) and the assessment updated.

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		CEA screening area NRW suggested the use of MUs as the appropriate screening distance was not always followed when screening in projects for the assessment of potential cumulative effects on marine mammals. NRW and JNCC also suggested the two populations of bottlenose dolphins (Irish Sea MU (IS MU) and Offshore Channel and Southwest England MU (OCSE MU)) will need to be assessed separately due to being part of separate MUs. NRW also recommended for screening in projects for the assessment of injury and disturbance from pre-construction site investigation surveys, all projects that fall within that MU should be screened in (rather than the approach of using the maximum impact ranges).	For the purpose of the cumulative assessment screening of projects was undertaken within the relevant species MUs with the maximum extent delineated by the Celtic and Irish Seas (CIS). With respect to grey seal, however, an extended screening area was applied following specific feedback from NRW and included projects within the OSPAR Region III, as detailed in paragraph 4.10.1.5. For bottlenose dolphin the approach agreed with the marine mammal EWG was to consider cumulative projects only within the Irish Sea MU, and therefore the Offshore Channel and Southwest England MU is no longer included within the cumulative study area for this species. For site-investigation surveys, screening used the species-specific CEA areas (rather than the maximum modelled impact ranges derived from the underwater sound modelling assessment used in PEIR) and used a proportionate number to assume how many surveys will occur at the same time. Justification of approach has been provided in detail in Table 4.52, with a conservative approach which assumed as a maximum design scenario up to two surveys in addition to Mona site-investigation surveys. This approach was agreed with the marine mammal EWG (September 2023 technical note, provided in the technical engagement plan appendices Part 1 (Document Reference E4.1))
		NRW tentatively agreed that it may be unrealistic to assess injury and disturbance from vessel use by presenting a sum of the impact ranges of all vessels within each offshore windfarm, but highlighted no alternative method has been proposed to gauge the impact and advise that this impact pathway is adequately assessed.	A more detailed approach to assessing vessel sound has been included in section 4.9.5 to give further quantification of the potential impacts. Empirical data has been gathered from field studies to determine realistic impact ranges and a quantification of the number of animals potentially affected based on densities of key species has been provided. In addition, further quantification of the baseline levels of activity (as provided in Volume 2, Chapter 7: Shipping and navigation of the Environmental Statement) has been included to demonstrate the potential elevation in sound above background levels in the Mona Array Area.

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		Barrier effects from piling for grey seal have not been adequately assessed.	Further detail has been provided in section 4.9.3.94 on potential barrier effects specifically in relation to any potential elevations in underwater sound close to high density areas for grey seal with evidence derived from recent studies on measurable responses of grey seals to underwater sound as per Whyte *et al* (2020).
		Based on the contours provided for PEIR, concurrent piling of monopiles at a maximum hammer energy of 5,000 kJ at the greatest spatial extent showing contours in 5 dB isopleths, it could be difficult to rule out an adverse effect on the North Anglesey Marine SAC for the MDS of two simultaneous monopiles.	Monopiles has been removed from the project design envelope, and the impact of pin piles are assessed in section 4.9. Further assessment of the potential effects on SACs is provided in the HRA Stage 2 ISAA (Document Reference E1.3).
		NRW did not agree with the approach taken to assume that Morgan Generation Assets, Morecambe Offshore Wind Farm Generation Assets, Morgan and Morecambe Offshore Wind Farms: Transmission Assets, North Irish Sea Array and Oriel Wind farm would not be expected to contribute to the impacts of bottlenose dolphin within the Irish Sea MU.	At the time of the Mona PEIR, the Morecambe PEIR was not available. The assessment, including iPCoD modelling, has been reviewed on the basis of the latest information at the time and therefore includes additional projects that have since released information into the public domain, including Morgan Generation Assets, Morecambe Offshore Windfarm: Generation Assets and Morgan and Morecambe Offshore Wind Farms: Transmission Assets (see section 4.11.2).
		NRW recommended that the ratio of the impacted versus unimpacted population over a set period of time (for example the first 6 years, based on the former Favourable Conservation Status (FCS) reporting period), and the full 25 year modelled period are provided.	Both a six-year time period and the full 25 year modelled period have been provided within the project alone (section 4.9.3) and the CEA impact assessments for elevated underwater sound from piling (section 4.11.2), for harbour porpoise, bottlenose dolphin, minke whale and grey seal.
		JNCC recommend consent for UXO clearance is obtained via a separate marine licence once investigative surveys have been completed and though agreed with the inclusion of low order techniques highlighted it should be the preferred method not a clearance option.	UXO clearance is included in this Application to capture the full suite of potential impacts from the Mona Offshore Wind Project and as such has been included in the application for consent. The draft DCO submitted with the application for consent secures the marine licence condition to provide the regulator with a UXO clearance method statement and marine mammal mitigation protocol (Document Reference: J16) for approval prior to commencement of clearance activities.

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			Therefore, acknowledging the limitations of the assessment at this stage and for this reason the draft MMMP (Document Reference J21), post consent, will be produced on the basis of a more accurate understanding of the number and types of UXO requiring clearance and the type of clearance approach that will be appropriate to employ. The assessment has considered the maximum adverse scenario, which in this case is high order clearance. Inclusion of low order techniques has been considered as a clearance option (as presented in Table 4.17). Where detonation of UXO using low order techniques occurs this is considered to be primary mitigation noting, however, that it is not possible to fully commit to this measure at this stage. A more detailed assessment of mitigation will be undertaken post-consent as further information becomes available to inform the draft MMMP (Document Reference J21).
		JNCC requested for behavioural disturbance further maps showing the nearest designated sites to help visualise proximal sites. JNCC did not agree that the magnitude is low and advised that the survey assessments of population densities are conservative in themselves and highlighted that the suggestion that all the estimates are over-cautious is not validation for dismissing the outputs of this assessment, as the precautionary approach must be taken because of the data limitations.	A map of designated sites for marine mammals is presented in Figure 4.4 and the 143 dB re 1µPa threshold maps (used for area assessment) present the proximal SACs (Figure 4.10, Figure 4.11 and Figure 4.12). It is important to provide context regarding the precautionary nature of the assessment as the resulting quantification of magnitude is a result of layers of conservatism at each stage (e.g. development of the MDS and conservative assumptions in the underwater sound modelling). Description of the magnitude of impact has been reviewed for the Environmental Statement. For all species the assessment considers both the spatial and temporal nature of the impact. Disturbance arising from underwater sound could disrupt normal behaviours but where such an event is short lived and reversible in the context of the life span of a species this is also considered. For the final assessment an average density for bottlenose dolphin across the entire study area has been applied (rather than only considering densities within a coastal buffer) and therefore our assessment has been updated

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			within Volume 2, Chapter 4: Marine mammals of the Environmental Statement. However, overlap with key habitats for the species has been considered, including the inshore coastal waters around Wales/NW England and the Isle of Man (IoM), and consideration of the movement of animals between these habitats (and potential for barrier effects).
		Natural England did not agree that a 30 minute ADD should be included in the underwater noise modelling to predict impact ranges for the assessment. Natural England advises that the assessment should be based on the underwater noise modelling without ADDs and revise any assessments, including cumulative and HRA, that are based on the predicted ranges with 30 min ADDs.	The assessment of injury and disturbance from piling in section 4.9.3 presents the ranges both without ADD and with ADD, the latter providing evidence to demonstrate the potential efficacy of using ADD as a tool in the mitigation strategy.
		IoM key responses The Isle of Man government stated they would like to see specific evidence of the consideration of Risso's dolphins, given their proximity to the development and the estimated density and impact on the reference population. IoM also highlighted the Sea Mammal Research Unit (SMRU) report appendix in the technical report excluded any IoM data.	In further EWG meetings the Isle of Man Government was content that Risso's dolphin have been adequately included in the assessment (EWG meetings with final meeting minutes and any responses from the stakeholders is provided in the Technical engagement plan appendices Part 1 (Document Reference E4.1)). Specific detail has been included in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and a further detailed consideration of the Manx populations has been included in the impact assessment in section 4.9. The Carter *et al.* (2022) maps used to derive seal densities in the impact assessment cover the IoM. Furthermore, SMRU has confirmed it does not hold any additional data than what is presented in relation to the IoM. The SMRU data is an additional data source rather than the only data source that has been used in the assessment. Further tracking information was provided in August 2023 by MWT and has been included in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.
June 2023	**Marine Mammals Expert Working Group 05**	NRW did not agree with the PEIR approach based upon site-investigation surveys outlined for screening	For site-investigation surveys, screening used the species-specific CEA areas (rather than the maximum modelled impact ranges derived from the underwater sound

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		cumulative impacts for site investigation surveys for marine mammals.	modelling assessment used in PEIR) and used a proportionate number to assume how many surveys will occur at the same time. Justification of approach has been provided in detail in Table 4.52, with a conservative approach which assumed as an MDS scenario that up to two surveys (in addition). This approach was agreed with the marine mammal EWG (September 2023 technical note).
		Agreement on densities and reference populations NRW recommended the use of densities from the Welsh Marine Mammal Atlas which links 30 years of sightings and effort data with a number of other environmental parameters for bottlenose dolphin and short-beaked common dolphin (rather than Waggitt *et al.* 2020 which was proposed). Agreed to remaining species densities and reference populations provided with minutes for minke whale, Risso's dolphin, grey seal and harbour seal. NRW agreed that the use of the combined SMU populations in parallel with the OSPAR Region III would be beneficial.	The final densities used in the assessment for bottlenose dolphin and short-beaked common dolphin are from the latest edition of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) (Table 4.12) Both the Grey Seal Reference Population (GSRP) and OSPAR Region III region has been presented in the project impact assessment (section 4.9).
		NRW agreed to scoping out project Erebus for the cumulative assessment, particularly given that their assessment focused on quantifying potential impacts to the Offshore MU.	For bottlenose dolphin the approach agreed with the marine mammal EWG was to consider cumulative projects only within the Irish Sea MU and therefore the Offshore Channel and Southwest England MU is no longer included within the cumulative study area for this species.
		NE and NRW recommended maintaining a sensitivity score of high for all species for PTS, and a magnitude of medium.	Sensitivity has been reviewed for Volume 2, Chapter 4: Marine mammals of the Environmental Statement, with regards to feedback from all stakeholders and adopting a precautionary approach and as per comments from Natural England, the sensitivity to PTS is considered to be high although noting that this is highly conservative as per Booth and Heinis (2018).
		NRW and Natural England recommended modelling impact ranges without ADDs in parallel.	The assessment in section 4.9.3 presents the ranges both without ADD and with ADD, the latter providing evidence to

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			demonstrate the potential efficacy of using ADD as a tool in the mitigation strategy.
August 2023	**Marine Mammals Expert Working Group 5: additional meeting with Isle of Man Government**	Specific requests from the Isle of Man Government were covered: • Confirmation content with data sources to be used in assessment • Specific request for further consideration of Risso's dolphin in assessment. Following discussions in EWG05 the Isle of Man Government was content that Risso's dolphin have been adequately included in the assessment • Following suggestion of restricted baseline using SMRU data, IoM Government provided a personal communication to explain connectivity of grey seals around the Isle of Man • Isle of Man confirmed the 400 seal estimate for the Manx population was suitable • Further discussion on the movement of dolphins between Cardigan Bay and the east coast of the Isle of Man. Evidence of populations mixing and therefore summer dolphins in Cardigan Bay may be subject to impacts in Manx waters. Following discussions in EWG05 the Isle of Man Government was content that bottlenose dolphin has been adequately included in the assessment.	Risso's dolphin have been included in the impact assessment using the same approach and the same detail as other species (section 4.9). Detailed baseline information is presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. Connectivity of grey seals for the marine mammal study area has been presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and is used to inform the impact assessment (section 4.9). The Manx seal population of 400 has been included in the GSRP detailed in section 4.4 and Table 4.12.
September 2023	**Marine Mammals Expert Working Group Technical Note**	**CEA** Refinement of the approach to CEA based on projects within relevant species-specific MUs only, and use of OSPAR Region III as the appropriate screening area for grey seal. NRW agreed that the use of the Celtic and Irish Seas MU (CIS MU) would be a pragmatic screening distance for all cetacean species with large MUs such as minke whale and dolphin species other than bottlenose dolphin.	Following EWG05, the Marine Mammals Expert Working Group Technical Note and S42 responses to the PEIR, the CEA assessment (for EIA) has adopted a species-specific approach for screening as discussed in 4.10.1.5 which uses the CIS MU for most cetacean species, the IS MU for bottlenose dolphin (therefore excluding the OCSE MU) and OSPAR Region III for grey seal (rather than the GSRP).

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		NE agreed to GSRP for CEA.	
		Design of aerial surveys with respect to marine mammals and use of an appropriate buffer around Mona and Morgan Array Areas. NRW agreed with approach outlined in technical note. JNCC content with proposed additions to ES and noted baseline characterisation does not rely on the aerial surveys alone.	Further detail about the consistency of coverage of surveys over the survey area (comprising the Mona Array Area and buffer) during the monthly survey and discussion on a spatial coverage monthly and seasonally has been included in Volume 6, Annex 4.1: Marine mammal technical report.
		Agreement of densities NRW, NE and JNCC agreed with densities and reference populations for harbour porpoise, bottlenose dolphin, Risso's dolphin, minke whale, grey seal and harbour seal submitted via email following EWG05. NRW recommended for short-beaked common dolphin the use of densities from the newest version of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) instead of Waggitt *et al.* (2020). Final agreements on all densities for the Mona Offshore Wind Project was presented in the technical note and NRW and JNCC agreed with densities, including update to short-beaked common dolphin. NE agreed with use of Welsh Marine Mammal Atlas unless new data reveals evidence of greater densities (e.g. SCANS IV; or site-specific surveys).	The final densities used in the assessment as agreed with stakeholders via the marine mammals EWG technical note issued in September 2023 are presented in Table 4.12. Densities to take forward to assessment for harbour porpoise, bottlenose dolphin and short-beaked common dolphin have been derived from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023). Densities for minke whale and Risso's dolphin are derived from SCANS-III. Densities for grey seal and harbour seal are derived from Carter *et al.* (2022). The latest SCANS-IV data was consulted on with the EWG (post the fifth EWG meeting), and the approach remained as presented in Table 4.12.
		Revised approach to CEA screening area for site investigation surveys and use of a maximum number of SI surveys occurring concurrently was presented. NRW agreed with the proposed approach of two site investigation surveys occurring simultaneously, and the rationale on which the estimate is based on. NE agreed MU approach over impact radius and broadly agreed with two geophysical surveys overlapping Mona site-survey investigations.	The CEA methodology presented 4.10.1, has screened in using the species-specific CEA areas for site-investigation surveys rather than using maximum modelled impact ranges.

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		Noise modelling clarifications NRW and NE supported use of dual metric approach (SPL_{pk} and SEL_{cum}) for impact assessment with the largest range of impact being taken forward for the purpose of mitigation. Approach to presenting both with and without ADD and to base the conclusions of the assessment on the impacts which take into account any designed-in measures, including the use of ADDs. NRW agreed with the proposed approach. NE advised assessment should be based on the underwater noise modelling without ADDs.	Both SPL_{pk} and SEL_{cum} have been presented in the impact assessment with the metric predicting the largest range of impact taken forward for the purposes of mitigation and considered in the adoption of appropriate measures to reduce injury to marine mammals. ADDs are included as part of standard industry tertiary measures (Table 4.17) and therefore the assessment has considered the implementation of an indicative 30 minute ADD deployment duration as well as the predicted ranges without the use of an ADD.
		Use of the area-based approach for HRA based on EDR and 143 dB threshold for harbour porpoise only. For all other marine mammal species considered in HRA the NMFS level-B harassment threshold of 160 dB SPL_{rms} will be applied for piling alongside the relevant EDR (NMFS, 2005). NRW, NE, JNCC agreed with the proposed approach. NRW recommend the use of the dose-response approach alone to assess behavioural disturbance from piling noise in the EIA.	In this chapter, a dose-response approach has been used alongside the threshold of 143 dB re 1µPa. EDRs have not been used in the EIA. For HRA, an unweighted sound threshold value of 143 dB re 1µPa^{2}s SEL_{ss} has been used to represent the minimum fixed generalised response threshold at which significant disturbance could in occur for harbour porpoise, in addition to the Effective Deterrence Range (EDR) approach. Dose-response has not been applied to the area-based assessment. For all other species the NMFS (2005) threshold of 160 dB re 1 µPa (root mean square (rms)) has been used.
		iPCoD • Presenting the 6-year time step in the modelling period for iPCoD modelling, alongside 25 years • At PEIR, only the spatial design scenario was presented but for the Environmental Statement the temporal MDS as well as spatial MDS will be presented • NRW advised that applying projects screened in for the GSRP to the larger OSPAR III population would effectively be diluting the impact.	• Both a six year time period and the full 25 year modelled period are provided within the project alone (section 4.9.2) and the CEA impact assessments for elevated underwater sound from piling (section 4.11.2), for harbour porpoise, bottlenose dolphin, minke whale and grey seal • Both the spatial MDS and temporal design scenario has been modelled (Appendix A) and presented in the cumulative impact assessment (section 4.11.2)

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		NRW, NE and JNCC agreed with approach related to iPCoD modelling.	• The CEA has modelled Tier 1 projects screened in using the OSPAR Region III population (see Appendix A for detail).
December 2023	**Marine Mammals Expert Working Group 6**	**Presented updated Mona assessment** Changes from PEIR to Environmental Statement: • Removal of monopiles from project design. • Separation distances between concurrent piling. • Additional information on haul out connectivity for grey seals has been included, utilising SMRU telemetry data for the four SMUs covering the Irish Sea. • Impacts assessment uses the combination of four seal management units as the Grey Seal Reference Population (GSRP) alongside OSPAR Region III. • OSPAR Region III has been used as extended screening area for grey seal for offshore wind projects only to allow a proportionate approach to assessment. List of cumulative projects has been updated and the marine mammal assessments have been updated with any changes to information available. White Cross now included in the CEA assessment in Tier 1. Presented key results of injury and disturbance from piling and UXO. Discussed hierarchy approach to UXO.	The MDS (Table 4.16) summarises the scenarios used for the assessment, and the impact of pin piles are assessed in section 4.9. Commitments to separation distances are given in the Outline MMMP (Document reference J21). Information on haul out connectivity for grey seals has been included in section 4.9.3 in the assessment of underwater sound from piling (paragraphs 4.9.3.96 to 4.9.3.100). Relevant study areas are described in section 4.4.3 for use in the project alone assessment (section 4.9) and the cumulative assessment (section 4.11). The projects used in the cumulative assessments are given in section 4.10.2 (and detailed in Table 4.50).
		Presented the **Underwater sound management strategy** which focuses on the impacts of underwater sound for marine mammals and fish. The Underwater sound management strategy will set out potential mitigation options which could be employed if there are residual concerns about the cumulative impacts of underwater sound following refined project design.	The Outline underwater sound management strategy (Document Reference J16) includes potential further mitigation options, should the measures in the MMMP (Document Reference J21) not reduce impacts, such that there will be no residual significant effect from the project. The Underwater sound management strategy is discussed in the Table 4.17 and discussed in the relevant sections throughout the assessment (piling and UXO).
		Presented updates to HRA approach and screening areas:	Further HRA assessment of the potential effects on SACs is provided in the HRA Stage 2 ISAA (Document Reference E1.3).

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		• OSPAR Region III been considered to identify any additional sites with grey seal as a qualifying feature, which may have connectivity with the Mona Offshore Wind Project. Telemetry data used to screen out additional sites that did not show connectivity. • Approach to the assessment of disturbance resulting from piling for harbour porpoise in the ISAA now presents both EDRs (15 km for pin piles) and area-based threshold approach (using 143 dB re 1 μ Pa). For all other species, the NMFS level-B harassment threshold of 160 dB SPL_{rms} will be applied for piling alongside the relevant EDR (NMFS, 2005).	

4.4 Baseline methodology

4.4.1 Relevant guidance

4.4.1.1 Several guidance documents have been considered for marine mammals to aid baseline characterisation. These include use of Inter-Agency Marine Mammal Working Group (IAMMWG) (IAMMWG, 2021) defined management units (MUs) for seven common cetacean species in UK waters, which provides abundance estimates which were calculated for each species within their respective MUs using the most recent data available at the time. Formal advice is given by the Special Committee on Seals (SCOS) (SCOS, 2022), under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) which has a duty to provide scientific advice to government on matters related to the management of seal populations.

4.4.1.2 The identification of designated sites for marine mammals is a key feature of this chapter (discussed in detail in section 4.5.2 and 0).

4.4.2 Scope of the assessment

4.4.2.1 The scope of this Environmental Statement has been developed in consultation with relevant statutory and non-statutory consultees as detailed in Table 4.5. This consultation process involved the scoping opinion, a number of regular EWGs and the statutory Section 42 consultation period. The consultation added detail to the range of potential impacts which could affect marine mammal receptors, taking into account local and national views about adequate coverage of important species within the marine mammal study area.

4.4.2.2 Considering the scoping and consultation process, Table 4.6 summarises the issues considered as part of this assessment.

Table 4.6: Issues considered within this assessment.

Activity	Potential effects scoped into the assessment
Construction phase	
Piling of foundations for wind turbines and OSPs	Injury and disturbance to marine mammals from elevated underwater sound during piling
UXO clearance prior to commencement of construction	Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance
Vessel traffic (e.g. vessels associated with sand wave clearance, installation vessel, construction vessel, rock placement vessel and cable installation vessels, boulder clearance, jack-up rig, tug/anchor handlers, guard vessels, survey vessel and support vessels crew transfer vessel (CTV), scour/cable protection/seabed preparation/installation vessels) and other sound-producing activities (cable trenching, cable laying, jack-up rig, drilled piling)	Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities Increased risk of injury of marine mammals due to collision with vessels
Site-investigation surveys – geophysical and geotechnical surveys	Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys
Potential effects on fish assemblages	Changes in fish and shellfish communities affecting prey availability

Activity	Potential effects scoped into the assessment
Operations and maintenance	
Wind turbine operation	Underwater sound from wind turbine operation
Potential effects on fish assemblages	Changes in fish and shellfish communities affecting prey availability
Vessel traffic associated with operations and maintenance (e.g. CTVs, jack-up vessels, cable repair vessels, service operations vessels (SOV), excavator/backhoe dredger).	Injury and disturbance from vessel use and other (non-piling) sound producing activities.
Decommissioning	
Potential effects on fish assemblages	Changes in fish and shellfish communities affecting prey availability
Vessels used for a range of decommissioning activities such as removal of foundations. Sound from vessels assumed to be as per vessel activity described for construction phase above.	Injury and disturbance from vessel use and other (non-piling) sound producing activities.

4.4.2.3 Potential effects which are not considered likely to be significant have been scoped out of the assessment. A summary of the potential effects scoped out, together with justification for scoping them out and whether the approach has been agreed with key stakeholders through either scoping or consultation, is presented in Table 4.7.

Table 4.7: Impacts scoped out of the assessment for marine mammals.

Potential impact	Justification
Accidental pollution	The impact of pollution including accidental spills and contaminant releases associated with the construction and decommissioning of infrastructure and use of supply/service/decommissioning vessels may lead to direct mortality of marine mammals or a reduction in prey availability, either of which may affect species' survival rates. With implementation of an Offshore EMP (including Marine Pollution Contingency Plan (MPCP) secured by deemed Marine Licence conditions under the DCO (see Draft DCO (Document Reference C1)) and based on evidence from other offshore wind farm consent applications (for example Awel y Mór Offshore Wind Farm Environmental Statement (2022)) it is considered that a significant impact within the equivalent extent of a wind farm's array plus buffer area is very unlikely to occur, and a major incident that may impact any species at a population level is considered very unlikely. It was predicted that any impact would be of local spatial extent, short-term duration, intermittent and medium reversibility within the context of the regional populations and therefore not significant in EIA terms. This is considered to be equally applicable to the Mona Offshore Wind Project for which construction will be comparable in scale and operation within the same environment, whilst implementing an appropriate pollution prevention plan. Consultees (The Planning Inspectorate, NRW) agreed to scope out this impact for all stages of the Mona Offshore Wind Project via the Mona EIA Scoping Opinion (Document Reference J8).
Increased Suspended Sediment Concentrations (SSC) and associated sediment deposition	Disturbance to water quality as a result of construction and decommissioning operations can have both direct and indirect potential impacts on marine mammals. Potential direct impacts include the impairment of visibility and therefore foraging ability of marine mammals, which might be expected to reduce foraging success. Marine mammals are well known to forage in tidal areas where water conditions are turbid and visibility conditions poor. For example, harbour porpoise and harbour seal in the UK have been documented foraging in areas with high tidal flows (e.g. Pierpoint, 2008; Marubini *et al.*, 2009; Hastie *et al.*, 2016); therefore, low light levels, turbid waters and suspended

Potential impact	Justification
	sediments are unlikely to negatively impact marine mammal foraging success. When the visual sensory systems of marine mammals are compromised, they are able to sense the environment in other ways, for example, seals can detect water movements and hydrodynamic trails with their mystical vibrissae; while odontocetes primarily use echolocation to navigate and find food in darkness. Whilst elevated levels of SSC arising during construction of Mona Offshore Wind Project may decrease light availability in the water column and produce turbid conditions, the maximum impact range is expected to be localised with sediments rapidly dissipating over one tidal excursion. In addition, there is likely to be large natural variability in the SSC within the Mona marine mammal study area due the proximity to Liverpool Bay, so marine mammals living here are considered likely to be tolerant of any small-scale increases, such as those associated with the construction activities. In summary, the Zone Of Influence (ZOI) of increased SSC will be small, particularly in the context of the wider available habitat, and the duration of potential impacts will be short and dissipate rapidly (e.g. one tidal excursion). Therefore, marine mammal receptors in the Mona marine mammal study area are not considered to be sensitive to increases in SSC as they are likely to be adapted to high natural variation in sediment levels. It is proposed that this impact is scoped out of the EIA. Consultees agreed to scope out this impact for all stages of the Mona EIA Scoping Opinion (Document Reference J8).
Impact of Electromagnetic Fields (EMF) (from surface lain or buried cables) during the operations and maintenance phase.	Based on the data available to date, there is no evidence of EMF related to marine renewable devices having any impact (either positive or negative) on marine mammals (Copping, 2018). There is no evidence that seals can detect or respond to EMF, however, some species of cetaceans may be able to detect variations in magnetic fields (Normandeau *et al*., 2011). To date, two species have been shown to respond to EMF. The Guiana dolphin *Sotalia guianensis* has been shown to possess an electroreceptive system, which uses the vibrissal crypts on its rostrum to detect electrical stimuli similar to those generated by small to medium sized fish and shows potential behavioural effects (attraction and perception) (Czech-Damal *et al*. (2012)). Bottlenose dolphin has also recently been shown to detect the presence of electrical stimuli, with four dolphin demonstrating electroreceptive behaviours (Hüttner *et al*., 2021) but further studies are needed to determine potential impacts of EMF on cetaceans and behavioural responses. It has not been shown in any other species of marine mammal to date. Consultees agreed to scope out this impact during marine mammals via the Mona EIA Scoping Opinion (Planning Inspectorate, 2022).

4.4.3 Study area

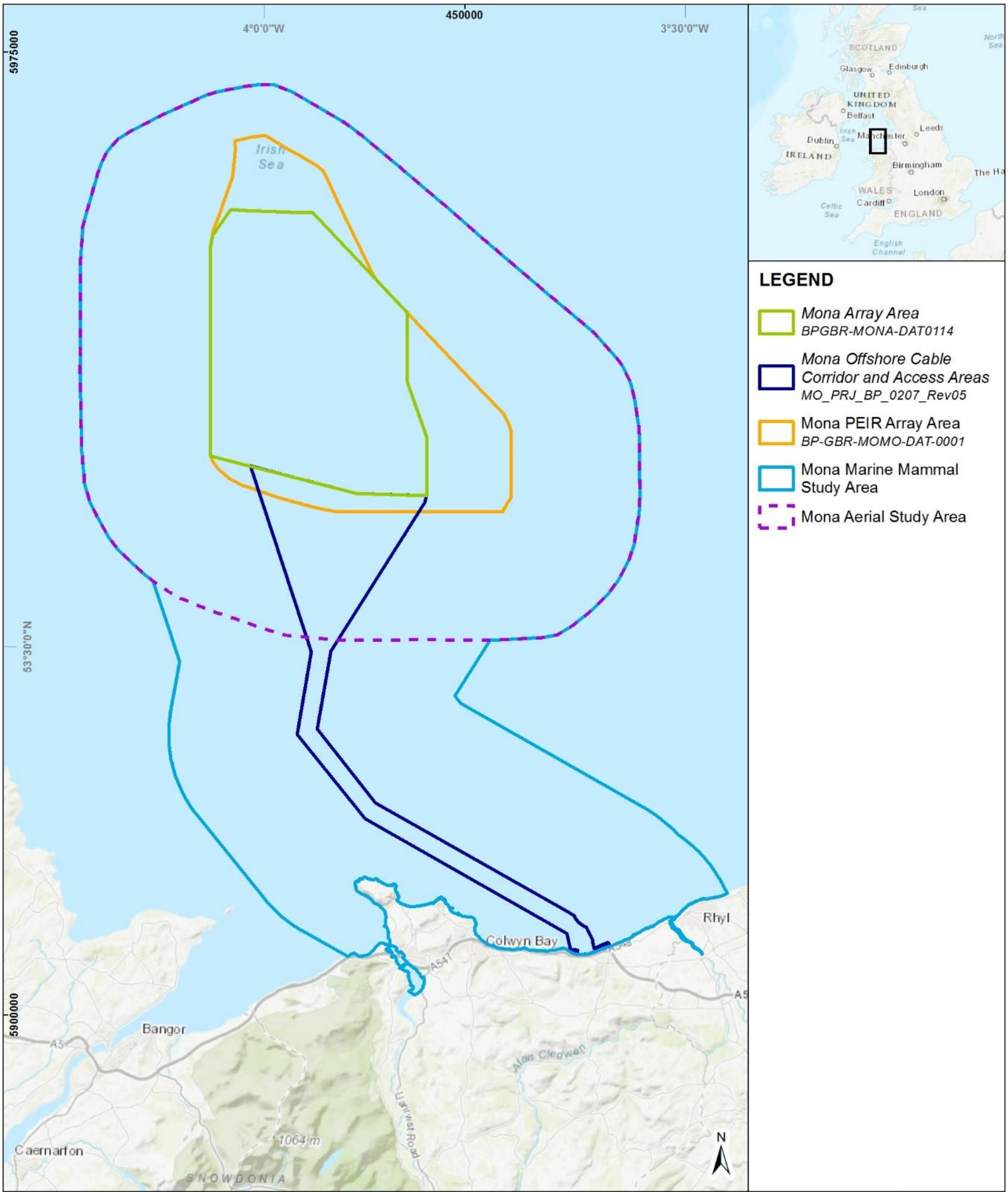
4.4.3.1 For the purpose of the marine mammal characterisation, two appropriate marine mammal study areas have been defined:

- Mona marine mammal study area: this area broadly encompasses the Mona Array Area including a 7 km to 16.5 km buffer (which is based upon the Mona Aerial Survey Area, see section 4.4.6) plus the Mona Offshore Cable Corridor and Access Areas with a 10 km buffer. Following the PEIR, the size of the array project boundary has been reduced for the Environmental Statement, so whilst the study area remains the same as for PEIR, the area of the buffer has increased around the redefined Mona Array Area (previously a 4 to 10 km buffer) (see Figure 4.1)
- Regional marine mammal study area: marine mammals are highly mobile and may range over large distances and therefore, to provide a wider context, the

desktop review considered the marine mammal ecology, distribution and density/abundance within the Irish Sea and wider Celtic Sea.

4.4.3.2 The regional marine mammal study area boundaries were discussed EWG meetings (with a summary provided in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement and in Table 4.5 in this chapter). In accordance with advice received during consultation, potential population level effects were informed by species MUs (Figure 4.2 and Figure 4.3). For grey seal and harbour seal the approach taken was to include those MUs whereby connectivity was demonstrated as presented in the seal telemetry report (Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement). This meant that a number of different MUs from English, Welsh, Scottish, Isle of Man and Irish waters (where connectivity with the Project boundary was demonstrated) were combined to represent a Grey Seal Reference Population (GSRP) and a Harbour Seal Reference Population (HSRP). Further, for grey seal, The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) Region III 'interim' MU was also included to provide additional context as requested by Natural Resources Wales (NRW) during the EWG process. The spatial extent of the species MUs is presented in Figure 4.2 and Figure 4.3 and further information on the reference populations (and combined reference populations for seal species) provided in section 4.5.3.

4.4.3.3 For the purpose of the cumulative assessment screening of projects was undertaken within the relevant species MUs with the maximum extent delineated by the Celtic and Irish Seas (CIS) MU (as agreed with consultees; section 4.2.6). This was to ensure a proportionate approach was taken, such that the screening focussed on the region within which receptor-impact pathways are considered likely to occur. Potential cumulative effects from the Mona Offshore Wind Project are considered unlikely to occur with projects over the entire extent of the Celtic and Greater North Seas (CGNS) MU. With respect to grey seal, however, an extended screening area was applied following specific feedback from NRW and included projects within the OSPAR Region III.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client

Project Name: MONA OFFSHORE WIND PROJECT

Scale: 0 2.5 5 nm; 0 5 10 km

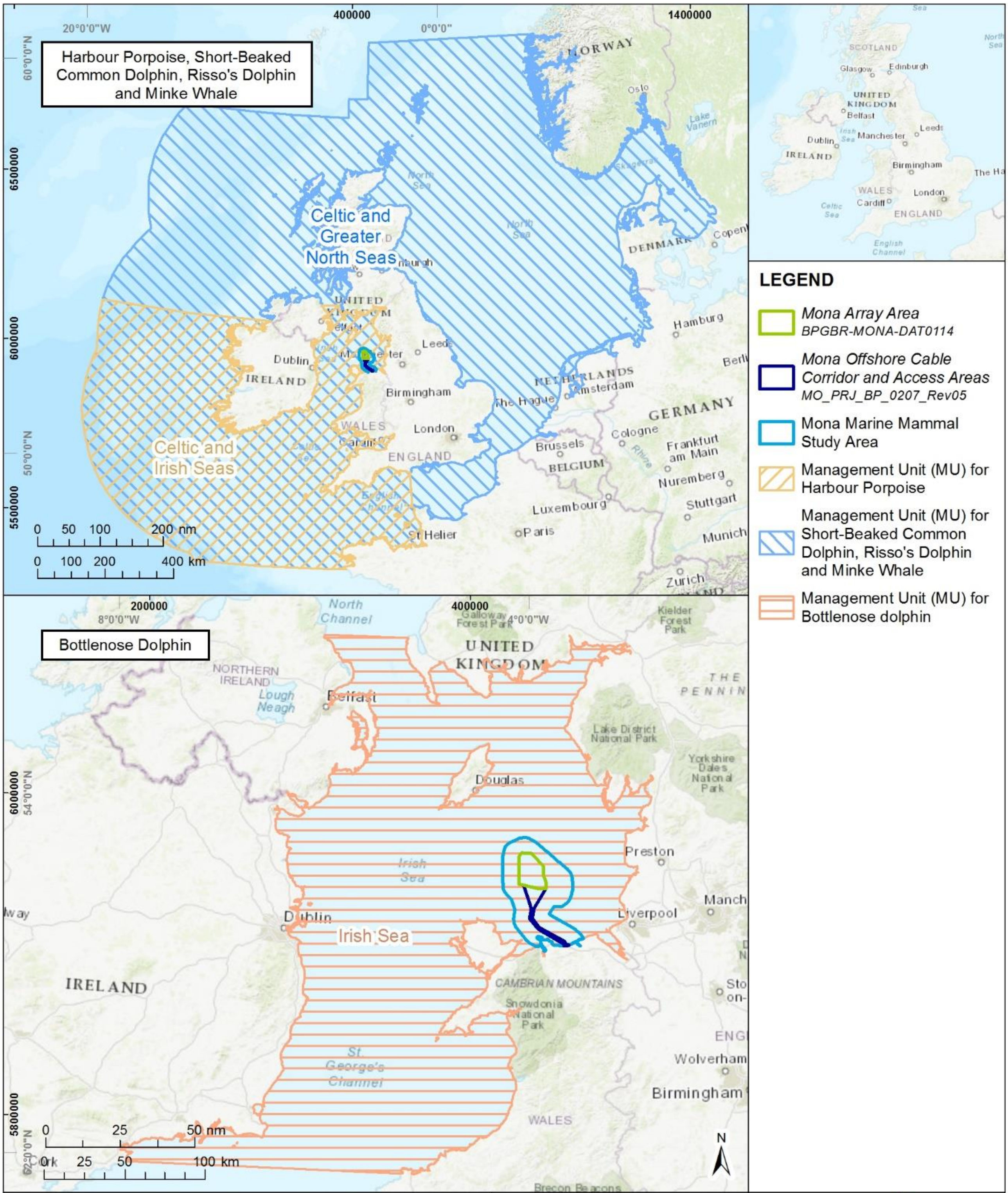
Drawing Number: RPSE-MN-ES-MAM-056-01

Drawing Title: MONA ARRAY AREA AND MARINE MAMMAL STUDY AREA CHANGES

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:500,000

VER	DATE	DETAILS	BY	CHECK
00	27/07/23	First Issue	MJ	BP
01	27/09/23	Revision	MJ	TGB

Figure 4.1: Relevant Mona Offshore Wind Project boundaries and the marine mammal study area.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC

Project Name:
MONA OFFSHORE WIND PROJECT

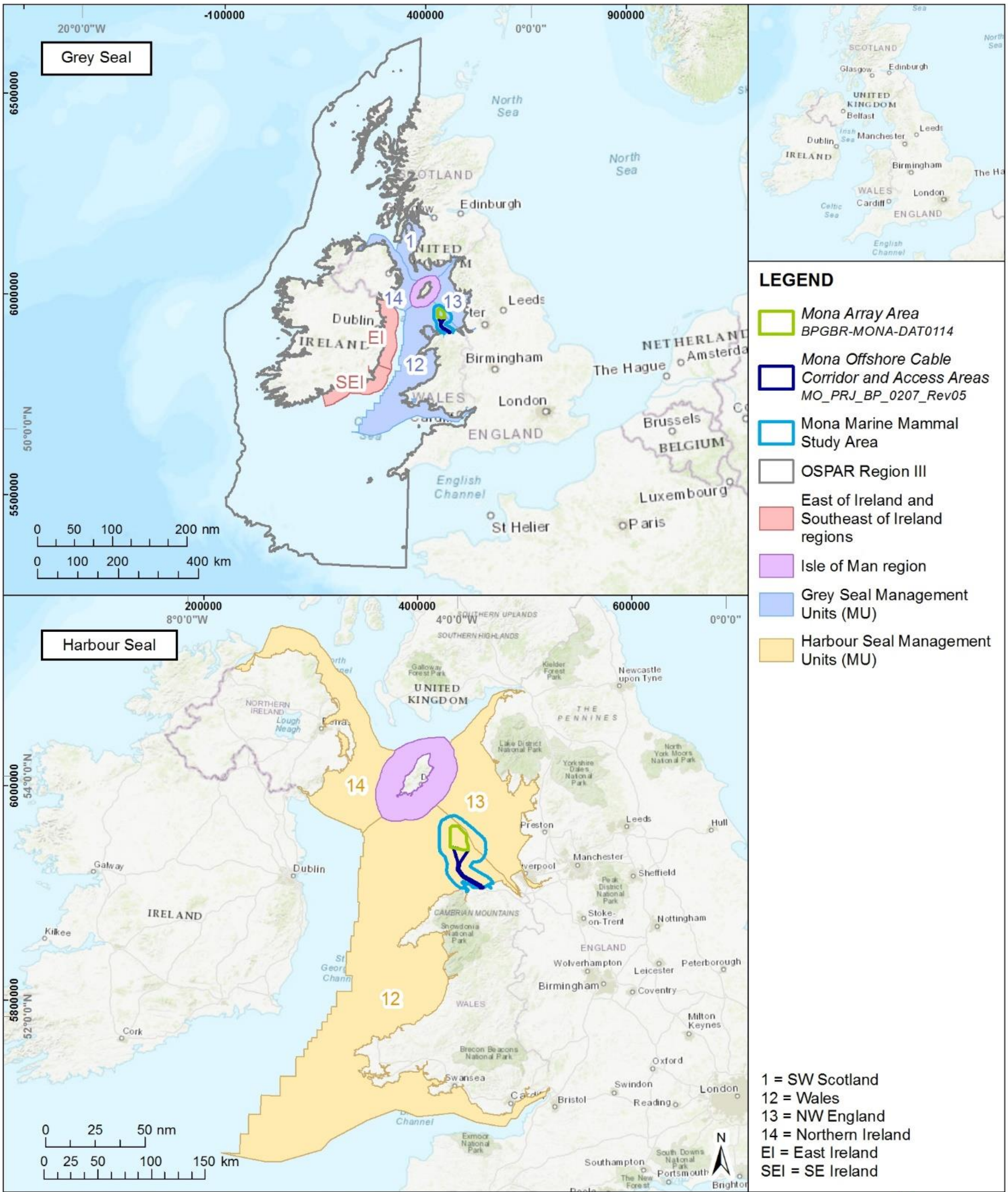
Drawing Number:
RPSE-MN-ES-MAM-001-01

Drawing Title:
MARINE MAMMAL STUDY AREAS AND RELEVANT SPECIES MANAGEMENT UNITS (MUS)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:19,000,000

VER	DATE	DETAILS	BY	CHECK
00	13/07/23	First Issue	NA	BP
01	27/09/23	Revision	MJ	TGB

Figure 4.2: Marine mammal study area and relevant cetacean species management units.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community	**Data Sources:** Client, JNCC, SCOS, NPWS	
Project Name: MONA OFFSHORE WIND PROJECT		**Drawing Number:** RPSE-MN-ES-MAM-002-01
Drawing Title: MARINE MAMMAL STUDY AREAS AND RELEVANT SPECIES MANAGEMENT UNITS (MUS)	**Geodetic Information:** Datum: ETRS 1989 Projection: ETRS 1989 UTM Zone 30N Scale@160mmx220mm: 1:16,000,000	

VER	DATE	DETAILS	BY	CHECK
00	13/07/23	First Issue	NA	BP
01	27/09/23	Revision	MJ	TGB

Figure 4.3: Marine mammal study area and relevant seal species management units.

4.4.4 Desktop study

4.4.4.1 Information on marine mammals within the regional marine mammal study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 4.8.

Table 4.8: Summary of key desktop reports.

Title	Source	Year	Author
Awel y Môr Windfarm surveys	APEM Ltd.	2019 to 2021	Sinclair *et al*. (2021)
Gwynt y Môr Windfarm baseline	Centre for Marine and Coastal Studies (CMACS)	2003 to 2005	CMACS Ltd. (2011; 2013); Goddard *et al*. (2017); Goddard *et al*. (2018); Goulding *et al*. (2019)
Rhiannon Windfarm aerial and boat-based surveys	Celtic Array Ltd.	2010 to 2013	Celtic Array Ltd. (2014)
Morecambe Offshore Windfarm Generation Assets Marine Mammal Information and Survey data (this includes HiDef aerial digital site surveys)	Morecambe Offshore Windfarm, Ltd.	Aerial surveys from March 2021 to February 2022	Morecambe Offshore Windfarm, Ltd (2023)
Morgan Offshore Wind Project: Generation Assets	Morgan Offshore Wind Project: Generation Assets	April 2021 to March 2022	Morgan Offshore Wind Project Ltd (2023)
Estimates of cetacean abundance in European Atlantic waters from the SCANS aerial and shipboard surveys	SCANS	1994; 2005; 2016; 2022	Hammond *et al*. (2002); Hammond *et al*. (2017); Hammond *et al*. (2021); Gilles *et al.* (2023)
Density surface modelling from SCANS-III surveys	SCANS	2016	Lacey *et al*. (2022)
Joint Cetacean Protocol (JCP) Phase I, III Analysis	JCP	1994 to 2010	Paxton and Thomas, (2010); Paxton *et al*. (2016)
JNCC Report 544: Harbour Porpoise Density	JNCC	1994 2011	Heinänen and Skov (2015)
Atlas of the Marine Mammals of Wales (2012)	Countryside Council for Wales (CCW)	1990 to 2009	Baines and Evans (2012)
Modelled Distribution and Abundance of Cetaceans and Seabirds in Wales and Surrounding Waters (2023) (Welsh Marine Mammal Atlas)	NRW	1990 to 2020	Evans and Waggitt (2023)
Distribution maps of cetacean and seabird populations in the North-East Atlantic (2020)	Bangor University	1980 to 2018	Waggitt *et al.* (2020)

Title	Source	Year	Author
ObSERVE surveys	National Parks and Wildlife Service (NPWS)	2015 to 2017	Rogan *et al.*, 2018
Strategic Environmental Assessment 6 (SEA)	SMRU	2005	Hammond *et al*., 2005
SCOS Reports	SMRU	1990 to 2021	SMRU
Seal Telemetry Data	SMRU	2004 to 2018	Wright and Sinclair (2022)
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles	Report to Department for Business, Energy and Industrial Strategy (BEIS)	1996 to 2015	Carter *et al*. (2020; 2022)
MWDW surveys: • Opportunistic and effort-based sighting data	MWDW	2006 to 2022	Data from MWDW Manley (2021, 2020, 2019); Clark *et al.* (2019, 2017); Felce and Adams (2016); Felce, (2015); Adams (2017)
MWT surveys: • Seal pup surveys on Calf of Man • Opportunistic land sightings • Seal haul-out survey data • Calf of Man Seal Survey Reports 2017 to 2021	MWT	2017 to 2021 2016 to 2022 2017 2017 to 2021	MWT
Manx Marine Environmental Assessment	Isle of Man Government	2018	Howe (2018a); Howe (2018b)
Walney Nature Reserve survey data	Cumbria Wildlife Trust	1981 to 2023	Data from Cumbria Wildlife Trust
Anglesey based surveys	Various sources	2002 to 2018	Shucksmith *et al*., 2009, Jacobs, 2018; Veneruso and Evans (2012); Pesante *et al*., (2008); Duckett (2018); Evans *et al*., (2015)
Updated abundance estimates for cetacean MUs in UK waters	JNCC	2021	IAMMWG (2021)

4.4.5 Identification of designated sites

4.4.5.1 All designated sites within the regional marine mammal study area and qualifying interest features that could be affected by the construction, operations and maintenance, and decommissioning phases of the Mona Offshore Wind Project were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the regional marine mammal study area were identified using a number of sources. These sources included JNCC, SCOS, National Marine Plan Interactive (NMPI) and European Nature Information System (EUNIS) websites.

- Step 2: Information was compiled on the relevant marine mammal features for each of these sites as follows:
  - The known occurrence of species within the regional marine mammal study area was based on relevant desktop information (section 4.5) and site-specific surveys presented within Appendix A of Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the Mona Offshore Wind Project
  - Sites and associated features were located within the potential Zone Of Influence (ZOI) for impacts associated with the Mona Offshore Wind Project (e.g. potential injury and/or disturbance ranges of underwater sound as a result of piling activities during construction section 4.9.3)
  - Marine mammal features of a designated site were either recorded as present during historic surveys or recent Mona aerial digital surveys within the Mona Aerial Survey Area, identified during the desktop study as having the potential to occur within the Mona marine mammal study area.

4.4.6 Site specific surveys

4.4.6.1 In order to inform the Environmental Statement, site-specific surveys were undertaken, as agreed with the marine mammal EWG (see Table 4.5 for further details). A summary of the surveys undertaken to inform the marine mammals impact assessment is outlined in Table 4.9 below.

Table 4.9: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Survey date	Reference to further information
Aerial Digital Surveys - Mona	Mona Array Area plus a buffer extending between 7 to 16.5 km from the boundary – known as the Mona Aerial Survey Area.	Aerial digital survey	APEM Ltd.	March 2020 to February 2022	Aerial Survey Report in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

4.5 Baseline environment

4.5.1 Overview

4.5.1.1 The Mona Offshore Wind Project, which lies within the east Irish Sea, is an important area for marine mammals, with 24 species of cetacean and two species of pinniped having been sighted here to date. Seven marine mammal species are known to occur regularly in the regional marine mammal study area: harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso’s dolphin, minke whale, grey seal and harbour seal. Other cetacean species are occasional or rare visitors.

4.5.1.2 The distribution of marine mammals in the Irish Sea is patchy; cetaceans are highly mobile and their occurrence is unpredictable. Harbour porpoise occur throughout the entire Irish Sea, whilst short-beaked common dolphin and Risso’s dolphin are largely restricted to the south of the Irish Sea. Sightings of bottlenose dolphin are highest in the Cardigan Bay SAC.

4.5.1.3 Grey seal extensively use areas of the southern Irish Sea, the north of St George's Channel, and Liverpool Bay. Several sites in Wales (such as the Marloes Peninsula and north Pembrokeshire coast and islands off the west coast of Pembrokeshire and the Llŷn Peninsula), southwest England (especially Lundy and the Scilly Isles) Northern Ireland (e.g. Strangford Lough) the Republic of Ireland (e.g. the Saltee Islands and Lambay Island) and Liverpool Bay (Solway Firth) support important haul-out sites and genetic studies suggest that individuals here may form a distinct population from those found off western Scotland (SCOS, 2022). Telemetry studies have demonstrated adults and pups travel between Pembrokeshire Marine SAC, Llŷn Peninsula and the Sarnau SAC and the Saltee Islands SAC (Ireland) (SCOS, 2014).

4.5.1.4 Harbour seal are concentrated along the northeast coast of Ireland, east coast of Northern Ireland and the Firth of Clyde. In Northern Ireland most harbour seal haul-outs are located in the southeast of the country, with most harbour seal being counted at Carlingford Lough, Murlough SAC and Rathlin Island (Duck and Morris, 2019), but also counted in aerial surveys in the Maidens SAC, Strangford Lough SAC and Murlough SAC.

4.5.1.5 A summary of the marine mammal baseline characterisation within the Mona marine mammal study area, in the context of the regional marine mammal study area, is presented in Table 4.10 and in detail in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

Table 4.10: Summary of marine mammals baseline ecology.

Species	Baseline Summary	Conservation importance
Harbour porpoise *Phocoena phocoena*	Widespread in cold and temperate northwest European shelf waters, and abundant throughout the Irish Sea. Harbour porpoise is a common inshore species found in high densities in the Irish Sea. The highest relative abundances are found in the western half of the central Irish Sea (Wall *et al*., 2013). High predicted relative densities in both winter and summer in the Irish Sea (Waggitt *et al.,* 2020). Mona digital aerial surveys found that harbour porpoise was sighted in most months of the year (sighted March 2020 to February 2022: but no sightings in April 2020, July 2020, November 2020 and December 2020). Wide-scale historical data collating heterogenous datasets from 1990 to 2009 confirms regular widespread sightings of harbour porpoise across the regional marine mammal study area (Baines and Evans 2012). SCANS-III data estimated densities of 0.239 animals per km^2 (CV = 0.282) in Block E and 0.086 animals per km^2 (CV = 0.383) in Block F (Hammond *et al.,* 2021). Heinänen and Skov (2015) divide the year into two bio-seasons based upon bimodal patterns of distribution: summer (April to September) and winter (October to March). In this study which modelled predicted densities between 1997 and 2009, predicted densities reached >3.0 animals per km^2 in the western region of the Irish Sea, between Anglesey and the Isle of Man in summer 2003, and north of the Isle of Man in winter 1997, and persistent high-density areas were identified in these areas, with lower densities towards the Mona Offshore Wind Project. Estimates from the Mona Aerial Survey Area indicated densities of 0.061 animals per km^2 in the summer bio-season, and 0.097 animals per km^2 in the winter bio-season (when adjusted for availability bias). As agreed with the EWG, the density of 0.2773 animals per km^2 taken forward to assessment is the density for the Mona Array Area derived from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) as proportionate but precautionary density for the area (Table 4.12). The Welsh Marine Mammal Atlas uses 30 years of data from 1990 to 2020 from dedicated aerial and vessel surveys (including SCANS surveys) across Wales and the surrounding waters to produce modelled density distribution maps at a 2.5 km^2 resolution. The study is designed to quantify broad level habitat preferences and seasonality of species within regions of interest (such as the Mona marine mammal study area.) This allows a robust representation of densities at a fine scale within the Irish Sea, rather than broad-scale densities derived from a single survey season conducted over a short timescale, such as the SCANS IV surveys. Harbour porpoise is a qualifying interest of a number of SACs and MNRs (Isle of Man) within the regional marine mammal study area (Table 4.11).	Annex II species protected under the European Council directive on the conservation of natural habitats and of wild fauna and flora (92/43/EEC) (Habitats Directive) within a European Marine Site, European Protected Species (EPS), OSPAR protected species, IUCN Red List Least Concern.
Bottlenose dolphin *Tursiops truncatus*	Near global distribution, widely distributed in the North Atlantic and occurs year-round throughout the Irish Sea. There is evidence of large home ranges for bottlenose dolphin, but in the Irish sea their distribution is largely coastal (Quick *et al.*, 2014), with resident populations in Cardigan Bay and off the coast of County Wexford. Seasonal differences in dispersion have been noted (e.g. dolphins in summer occurring mainly in small groups near the coast, centred upon Cardigan Bay, dispersing more widely and generally northwards, where they may form very large groups in winter).	Annex II species protected under the Habitats Directive within a European Marine Site, EPS, IUCN Red List Least Concern.

Species	Baseline Summary	Conservation importance
	Six bottlenose dolphins were sighted across the 24-month Mona aerial digital survey period: four animals in June 2021 and two animals in January 2022. Using lower uniform densities for this area (such as those in SCANS-III) is unsuitable for this species as it does not take consideration of their specific habitat preferences. SCANS-III surveys in 2016 estimated a density of 0.008 animals per km^2 (CV = 0.573) in Block E, with no animals sighted within Block F. The survey period was limited to 35 days in summer, so densities may vary in other months of the year, and in Manx waters, bottlenose dolphin do show a very clear temporal pattern, with 73% of sightings being reported between October and March (Howe, 2018). There is suggestion of temporal movement between Manx waters for winter habitat and Cardigan Bay for calving (Howe, 2018; Pesante and Evans, 2008), as well as movement between UK and Irish waters (Robinson *et al.*, 2012). As agreed with the EWG, the density 0.0017 animals per km^2 taken forward to assessment is a single density from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Mona marine mammal study area, which focuses on the specific inshore ecotype found in the Irish Sea, providing a precautionary but proportionate density for the area (Table 4.12). The data allows a robust representation of densities at a fine scale within the Irish Sea, rather than broad-scale densities derived from a single survey season conducted over a short timescale, such as the SCANS IV surveys. Bottlenose dolphin is a qualifying interest of a number of SACs and three MNRs (Isle of Man) within the regional marine mammal study area (Table 4.11).	
Risso's dolphin *Grampus griseus*	Worldwide distribution, and in northwest Europe appears to be a continental shelf species. Clusters regularly seen in the Irish Sea, with a relatively localised distribution, forming a wide band running southwest-northeast that encompasses west Pembrokeshire, the western end of the Llŷn Peninsula and Anglesey in Wales, the southeast coast of Ireland in the west, and waters around the Isle of Man in the north (Evans et al., 2003). The Mona Offshore Wind Project lies within Block F for the SCANS-III surveys and although no Risso's dolphin were sighted within this block in 2016 they were recorded in the adjacent Block E with an estimated density at 0.0313 animals per km^2 (CV = 0.686). As agreed with the EWG, this density is applied to the Mona marine mammal study area in the assessment (Table 4.12). In recent years, predicted distribution maps of Risso's dolphin at monthly scales by Waggitt et al. (2020) demonstrated Risso's dolphin densities to be lower in the Irish Sea from November to May, with increased densities in summer months between June to September. Two animals were observed during the November 2020 Mona aerial digital survey, with no further observations during the rest of the survey period. Risso's dolphin are a feature of interest for four MNRs in the Isle of Man (Table 4.11).	Annex II species protected under the Habitats Directive within a European Marine Site, EPS, IUCN Red List Least Concern.

Species	Baseline Summary	Conservation importance
Short-beaked common dolphin *Delphinus delphis*	This is the most numerous offshore cetacean species in the temperate northeast Atlantic. Widespread and abundant, centred upon the Celtic Deep at the southern end of the Irish Sea, where water depths range from 50 to 150 metres. High-density area extends eastwards towards the coast and islands of west Pembrokeshire. Elsewhere in the Irish Sea, the species occurs at low densities mainly offshore, in a central band that extends northwards towards the Isle of Man. SCANS-III is a key baseline dataset, and the Mona Offshore Wind Project lies within Block F for the SCANS-III surveys in 2016, but no common dolphin were sighted within that block or the adjacent Block E, and no animals were observed for the duration of the Mona aerial digital survey. Predicted density values using SCANS-III data showed common dolphin densities were low (0.00 to 0.07 animals per km^2) in the Irish sea but increased towards the Celtic Sea (BEIS, 2022). SCANS-II densities for Block O (corresponding to SCANS-III blocks E and F combined) was 0.018 animals per km^2 (CV = 0.780). As agreed with the EWG, the density taken forward to assessment (0.0006 animals per km^2) is from the Welsh Marine Mammal Atlas (2023) (Evans and Waggitt, 2023) for the Mona Array Area to provide a precautionary but proportionate density for the area from recent robust data modelling rather than older SCANS II data from 2006 (Table 4.12).	Annex II species protected under the Habitats Directive within a European Marine Site, EPS, IUCN Red List Least Concern.
Minke whale *Balaenoptera acutorostrata*	Minke whales inhabit all major oceans of the world and are most abundant on the continental shelf, in relatively cool waters. Around the UK, minke whales are widely distributed and present year-round, and in the Irish Sea, they mainly occur in the south and west of the area (Hammond *et al.*, 2005), and are present from late April to early August (Wall, 2013). This is confirmed by a high degree of seasonality in Manx waters, with presence between June and November, and a clear spatial aspect to the distribution of Minke whale sightings in Manx waters, where the majority of summer sightings are on the west coast of the island, and most autumn sightings made on the east coast (Howe, 2018). No minke whale were recorded during the Mona aerial digital survey, and no sightings were made within SCANS-III Block F, but estimated densities of 0.0173 animals per km^2 (CV = 0.618) were reported in Block E. SCANS-III data were also used to model density surfaces for minke whale in 2016 (BEIS, 2022), with high predicted density around the Isle of Man (0.027 – 0.036 animals per km^2) and moderate densities across the entire Irish Sea (0.012 – 0.02 animals per km^2) (BEIS, 2022). JCP III (Paxton *et al.,* 2016) density surface modelling gave UK wide mean densities of 0.022 animals per km^2, with areas of persistent high relative density around the Isle of Man (0.100 animals per km^2 in summer 2010). As agreed with the EWG, the SCANS III Block E estimate (0.0173 animals per km^2) is applied to the Mona marine mammal study area in the impact assessment (Table 4.12), to provide a precautionary estimate for the area. Minke whale is a feature of interest for one MNR in the Isle of Man (Table 4.11).	Annex II species protected under the Habitats Directive within a European Marine Site, EPS, IUCN Red List Least Concern.
Grey seal *Halichoerus grypus*	Approximately 38% of the world's grey seal population occurs in the UK (SCOS, 2014), where numbers have increased steadily over the past 60 years, in part due to its favourable conservation status. The main grey seal population centre in the UK is at the Scottish colonies, which account for approximately 77% of the UK estimated	Annex II species protected under Habitats Directive within

Species	Baseline Summary	Conservation importance
	population. The Irish Sea is also an important centre of grey seal abundance, being used by animals tagged at haul-out sites in the Southwest Scotland, Northwest England and Wales Management Units. Grey seal were observed in 12 of the 24 months of Mona digital aerial surveys, with April, August and December being the only months in which animals were not sighted across both survey years. Mean absolute density (i.e. density adjusted for availability bias) across the whole survey period was 0.109 animals per km^2, with a mean absolute density of 0.049 animals per km^2 during the pupping season (August to November) and 0.139 animals per km^2 during the non-pupping season (December to July). UK-wide at-sea distribution for grey seal by Carter *et al.*, (2022) demonstrated areas of high use around Liverpool Bay, the east coast of Ireland and to the northwest of the Isle of Man. Finer scale seasonal movements were also identified, with seals transitioning between sites within the Irish Sea, but not leaving Wales (Carter *et al*, 2020). SMRU-tagged grey seal also showed presence throughout the regional marine mammal study area, with highest density of tracks in the Northwest England and Wales MUs (Wright and Sinclair, 2022). A detailed overview of grey seal abundance is provided in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. Average grey seal density for the Mona Array Area plus buffer was estimated at 0.037 animals per km^2 (Carter *et al.*, 2022). For the Mona Offshore Cable Corridor and Access Areas (plus 10 km buffer), average densities were 0.180 animals per km^2, with maximum estimated densities of 1.812 animals per km^2 along the coast. These inshore and offshore densities are taken forward to the impact assessment for all potential impacts except piling, which uses Carter *et al.* grid cells to quantify number of animals impacted (Table 4.12). Grey seal is a qualifying interest of several SACs and three MNRs (Isle of Man) within the regional marine mammal study area (Table 4.11). Designated haul-out sites located in the Southwest Scotland MU are: Little Scares (SW-006); Solway Firth Outer Sandbank (SW-007); Sanda and Sheep Island (SW-001); Sound of Pladda Skerries (SW-002), and Lady Isle (SW-005).	a European Marine Site, IUCN Red List Least Concern

Species	Baseline Summary	Conservation importance
Harbour seal *Phoca vitulina*	Harbour seal are widely distributed, inhabiting temperate and subpolar seas throughout the Northern Hemisphere. The UK and Ireland represents an important population centre for both species, with approximately 36% of the pup production for Eastern Atlantic subspecies of harbour seal (SCOS, 2020). Carter *et al.* (2022) suggested large centres of harbour seal abundance in Shetland, The Wash (in southeast England) and west Scotland, with high density at-sea areas adjacent to those hotspots. The main harbour seal haul-outs are located in the northern region of the regional marine mammal study area, in the Southwest Scotland MU, and the nearest designated haul out sites for harbour seals in the vicinity of the Mona Array Area are Manx MNRs (Calf and Wart Bank, Langness, Ramsey and West Coast), and Murlough SAC, Strangford Lough SAC and The Maidens SAC. Harbour seal presence in the vicinity of the Mona marine mammal study areas is low (Carter *et al.*, 2022), with mean at-sea usage estimated (via telemetry studies) at a density of 0.0002 animals per km^2, and only one animal observed during the 24-month Mona digital aerial survey. For the Mona Offshore Cable Corridor and Access Areas plus 10 km buffer), the average density was estimated at 0.0001 animals per km^2. These inshore and offshore densities are taken forward to the impact assessment for all potential impacts except piling, which uses Carter *et al.* grid cells to quantify number of animals impacted (Table 4.12). A detailed overview of harbour seal abundance is provided in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. Harbour seal is a qualifying interest of several SACs and three MNRs (Isle of Man) within the regional marine mammal study area (Table 4.11). Designated haul-out sites located in the Southwest Scotland MU are Sanda and Sheep Island (SW-001); Yellow Rock (SW-004); Sound of Pladda Skerries (SW-002); Rubha nan Sgarbh (SW-003); and Lady Isle (SW-005).	Annex II species protected under Habitats Directive within a European Marine Site, IUCN Red List Least Concern.

4.5.2 Designated sites

4.5.2.1 A number of marine mammal species are listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC) as species whose conservation requires the designation of SACs. In the UK Annex II marine mammal species for which SACs are designated include harbour porpoise, grey seal, harbour seal and bottlenose dolphin. Designated sites identified for this chapter are described below in Table 4.11.

4.5.2.2 All cetacean species listed under Annex IV of the Habitats Directive are EPS. Cetacean EPS are afforded strict protection wherever they occur within a Member State's territory, both inside and outside designated protected areas.

4.5.2.3 In the UK, a number of international conventions afford specific protection to marine mammals as follows:

- All species of marine mammals are listed under Appendix I and II of the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals (CMS))
- The Bern Convention (Conservation of European Wildlife and Natural Habitats) affords protection to all species of cetacean under Appendix II (strictly protected fauna) and to grey seal and harbour seal under Appendix III (protected fauna species)
- All species of cetacean are listed under Appendix II of the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES)
- OSPAR protects marine mammals under Annex V, including the prevention and control of adverse impacts from human activities, such as anthropogenic sound.

4.5.2.4 In the UK, all species of marine mammal are protected under the Wildlife and Countryside Act 1981 and are also protected in Manx waters by the Isle of Man Wildlife Act 1990.

Table 4.11: Designated sites and relevant qualifying interests for the marine mammal chapter.

Designated Site	Distance to the Mona Array Area (km) (marine route)	Distance to the Mona Offshore Cable Corridor and Access Areas (km) (marine route)	Features
North Anglesey Marine/Gogledd Môn Forol SAC	23.67	17.5	Harbour porpoise *Phocoena phocoena*
Langness MNR	40.97	56.5	Harbour seal *Phoca vitulina*
			Grey seal *Halichoerus grypus*
			Harbour porpoise *Phocoena phocoena*
			Risso's dolphin *Grampus griseus*
Little Ness MNR	44.6	62.1	Harbour porpoise *Phocoena phocoena*
			Bottlenose dolphin *Tursiops truncatus*

Designated Site	Distance to the Mona Array Area (km) (marine route)	Distance to the Mona Offshore Cable Corridor and Access Areas (km) (marine route)	Features
			Minke whale *Balaenoptera acutorostrata*
			Risso's dolphin *Grampus griseus*
Douglas Bay MNR	46.68	64.6	Bottlenose dolphin *Tursiops truncatus*
			Risso's dolphin *Grampus griseus*
Laxey Bay MNR	48.91	67.8	Harbour porpoise *Phocoena phocoena*
			Minke whale *Balaenoptera acutorostrata*
			Bottlenose dolphin *Tursiops truncatus*
Baie Ny Carrickey MNR	49.98	64.6	Risso's dolphin *Grampus griseus*
			Harbour porpoise *Phocoena phocoena*
			Bottlenose dolphin *Tursiops truncatus*
Calf and Wart Bank MNR	53.25	66.6	Risso's dolphin *Grampus griseus*
			Harbour porpoise *Phocoena phocoena*
Ramsey Bay MNR	56.98	76.6	Harbour seal *Phoca vitulina*
			Grey seal *Halichoerus grypus*
Port Erin Bay MNR	58.79	72	Harbour porpoise *Phocoena phocoena*
Niarbyl MNR	63.93	76.5	Harbour porpoise *Phocoena phocoena*
			Grey seal *Halichoerus grypus*
West Coast MNR	68.74	81.9	Harbour porpoise *Phocoena phocoena*
			Harbour seal *Phoca vitulina*
			Grey seal *Halichoerus grypus*
North Channel SAC	80.97	94.5	Harbour porpoise *Phocoena phocoena*
West Wales Marine/Gorllewin Cymru Forol SAC	90.2	94.4	Harbour porpoise *Phocoena phocoena*
Pen Llŷn a`r Sarnau/Llŷn Peninsula and the Sarnau SAC	95.68	93	Bottlenose dolphin *Tursiops truncatus*
			Grey seal *Halichoerus grypus*

Designated Site	Distance to the Mona Array Area (km) (marine route)	Distance to the Mona Offshore Cable Corridor and Access Areas (km) (marine route)	Features
Strangford Lough SAC	112.01	125.1	Harbour seal *Phoca vitulina*
Murlough SAC	115.62	127.1	Harbour seal *Phoca vitulina*
Rockabill to Dalkey Island SAC	126.13	129.3	Harbour porpoise *Phocoena phocoena*
Lambay Island SAC	129.18	132.2	Harbour seal *Phoca vitulina*
			Grey seal *Halichoerus grypus*
Cardigan Bay/Bae Ceredigion SAC	164.83	161.5	Bottlenose dolphin *Tursiops truncatus*
			Grey seal *Halichoerus grypus*
Slaney River Valley SAC	211.53	210.2	Harbour seal *Phoca vitulina*
Pembrokeshire Marine/Sir Benfro Forol SAC	215.24	210.7	Grey seal *Halichoerus grypus*
Saltee Islands SAC	237.94	234.4	Grey seal *Halichoerus grypus*
Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC	281.11	273.8	Harbour porpoise *Phocoena phocoena*
Lundy SAC	320.28	308.5	Grey seal *Halichoerus grypus*

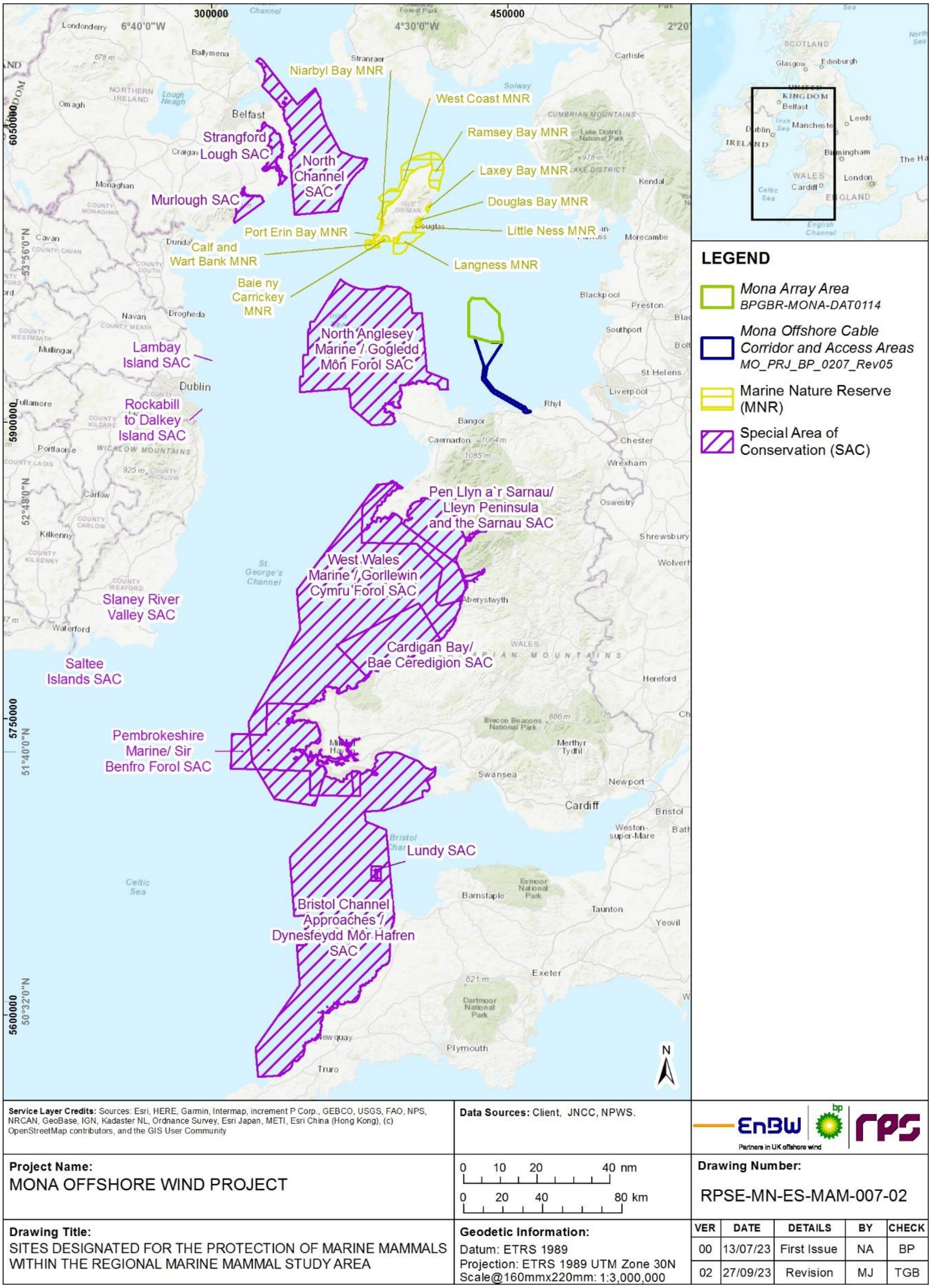


Figure 4.4: Designated sites within the regional marine mammal study area.

4.5.3 Important ecological features

4.5.3.1 Important ecological features (IEFs) are those marine mammal receptors that have the potential to be affected by the Mona Offshore Wind Project. The importance of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM, 2018). Marine mammal IEFs have been identified based on biodiversity importance, recognised through international or national legislation, conservation status/plans and on assessment of value according to the functional role of the species within the context of the regional marine mammal study area. Relevant legislation/conservation plans for marine mammals would include, for example: Annex II species under the Habitats Directive; Annex IV(a) of the Habitats Directive as EPS; species listed as threatened and/or declining by OSPAR; International Union for Conservation of Nature (IUCN) Red List species; and UK Biodiversity Action Plan (BAP) priority species either alone or under a grouped action plan.

Table 4.12 presents the value/importance that has been assigned to each ecological feature and a summary of the densities and the relevant MU populations carried forward to the assessment. Densities presented below have been agreed in advance with consultees via the marine mammal EWG (see Table 4.5). For most cetaceans the densities applied to the assessment were taken from the most recent Welsh Marine Mammal Atlas (Evans and Waggitt, 2023). The exceptions were Risso's dolphin and minke whale where the densities agreed were the precautionary values from the SCANS-III surveys (Hammond *et al.,* 2021). For pinnipeds, offshore densities are given for average and inshore densities are used for maximum, both taken from Carter *et al.* (2022) maps. Further detail on the baseline and the densities and reference populations taken forward to assessment is given in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement. All marine mammals with the potential to be affected by the Mona Offshore Wind Project are protected under some form of international legislation and/or are important from a conservation perspective in an international/national context (section 4.5.2) and therefore the 'importance' of all marine mammal IEFs was determined to be International.

Table 4.12: Marine mammal IEFs, densities, MU populations and their importance within the regional marine mammal study area.

[1] Density from Evans and Waggitt (2023).

[2] Density from SCANS-III (Hammond *et al.,* 2021)

[3] Density from Carter *et al.* (2022).

[4]The minimum estimate (nmin) is used as a precautionary estimate rather than the mean estimate (n).

IEF	Density (Animals per km^2)	Management Unit (MU)	Reference population estimate	Importance
Harbour porpoise *Phocoena phocoena*	0.2773[1]	Celtic and Irish Sea	62,517	International
Bottlenose dolphin *Tursiops truncatus*	0.0017[1]	Irish Sea	293	International
Short-beaked common dolphin *Delphinus delphis*	0.0006[1]	CGNS	102,656	International
Risso's dolphin *Grampus griseus*	0.0313[2]	CGNS	12,262	International

IEF	Density (Animals per km²)	Management Unit (MU)	Reference population estimate	Importance
Minke whale *Balaenoptera acutorostrata*	0.0173[2]	CGNS	20,118	International
Grey seal *Halichoerus grypus*	Mona Array Area plus buffer (offshore) = 0.037[3] Mona Offshore Cable Corridor and Access Areas plus buffer (inshore) = 0.180[3]	'Grey Seal reference population' (GSRP) which sums: • 12 Wales • 13 NW England • 14 Northern Ireland • 1 SW Scotland • Isle of Man estimate • East of Ireland • Southeast of Ireland.	• 3,579 • 994 • 2,008 • 2,056 • 400 • 1,662 • 2,211. GSRP = 12,910	International International International International International International
		OSPAR Region III (nmin)[4]	60,780	International
Harbour seal *Phoca vitulina*	Mona offshore (Array Area) = 0.0002[3] Mona inshore (Offshore Cable Corridor and Access Areas) = 0.001[3]	HSRP which sums: • 12 Wales • 13 NW England • 14 Northern Ireland (No estimate available for the Isle of Man)	• 13 • 6 • 1,405. HSRP = 1,424	International International International

4.5.4 Future baseline scenario

4.5.4.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that "an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge" is included within the Environmental Statement. In the event that the Mona Offshore Wind Project does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

4.5.4.2 The baseline environment is not static and will exhibit some degree of natural change over time, even if the Mona Offshore Wind Project does not come forward, due to naturally occurring cycles and processes and additionally any potential changes resulting from climate change and anthropogenic activity. Therefore, when undertaking impact assessments, it is necessary to place any potential impacts within the context of the envelope of change that might occur over the timescale of the Mona Offshore Wind Project.

4.5.4.3 Marine mammals are known to be impacted by various anthropogenic activities, including offshore developments, but also fisheries, anthropogenic sound and transportation. Avila *et al*. (2018) reported that between 1991 and 2016, globally almost all species of marine mammals (98%) were documented to be affected by at least one threat. Catch of marine mammals in active fishing gear (bycatch) was the most common threat category for odontocetes and mysticetes, followed by pollution (solid waste), commercial hunting and boat-collisions. Ghost-net entanglements, solid and liquid wastes, and infections were reported to be the main threats for pinnipeds.

4.5.4.4 In addition to anthropogenic impacts, marine mammals are also vulnerable to indirect impacts, including climate change which can result in increasing sea temperatures.

4.5.4.5 Shifts in spatial distribution is one of the most common responses to temperature changes by marine mammals and has the potential to modify the ranges of certain species. Furthermore, changes in water temperatures are likely to alter the life cycles of marine mammal prey species and may result in predator-prey mismatch, where there is a discrepancy between the abundances of prey species and those of marine mammals, affecting migratory marine mammal species and species displaying some site fidelity. Additionally, climate change could affect survival rates of marine mammals by affecting reproductive success, increasing the stress of the animal and fostering the development of pathogens (Albouy *et al.,* 2020).

4.5.4.6 Given that anthropogenic pressures are now exacerbated by climatic changes, it is challenging to predict future trajectories of marine mammal populations in the absence of the Mona Offshore Wind Project. In terms of data, monitoring is not in place at the relevant temporal or spatial scales in order to assess the baseline dynamics of some marine mammal populations, especially for minke whale and Risso's dolphin. Therefore, a summary of current and future pressures and where data is available, information about population dynamics is presented below.

Harbour porpoise

4.5.4.7 Harbour porpoise are severely vulnerable to incidental entanglements in fishing gear, known as bycatch (Moan *et al.,* 2020). Harbour porpoise are most likely to die shortly after entanglement, as they cannot drag fishing gear to the surface to breathe, and this mortality can have large population-level effects, causing negative population trajectories (IMR/NAMMCO, 2019). The Celtic and Irish Sea assessment units (AUs, as defined in IMR/NAMMCO, 2019) have a higher bycatch level than other AUs, with bycatches constituting 852 animals or 2.42% of the abundance estimated for the AU (Moan *et al.*¸ 2020). The Celtic Sea region has known concern for harbour porpoise bycatch (Andersens, 2013). A study by Brown *et al. (*2015) on potential risk to cetaceans from static fishing gears demonstrated gillnets were considered to have high potential for capturing harbour porpoise and were likely to result in fatality from an interaction.

4.5.4.8 Prey availability also influences harbour porpoise abundance. Given that the harbour porpoise has a high metabolic rate (Rojano-Doñate *et al*., 2018) and therefore has to feed regularly, it is thought to be highly dependent on year-round proximity to food sources and harbour porpoise distribution and condition is considered likely to reflect the availability and energy density of prey (Santos and Pierce, 2003). Therefore, any changes in the abundance and density of harbour porpoise prey species may have the potential to affect harbour porpoise foraging in an area.

4.5.4.9 Harbour porpoise has high parasitic exposure, with post-mortem examinations of regularly revealing heavy parasitic worm burdens (Bull *et al.,* 2006). A causal immunotoxic relationship between Polychlorinated Biphenyl (PCB) exposure and infectious disease mortality has also been highlighted (Murphy *et al.,* 2015), with total PCB levels significantly higher in the infectious disease group compared to the physical trauma group (Jepson *et al.*, 2005), suggesting that anthropogenic contaminants are having adverse effects on harbour porpoise. In a toxicology database from harbour porpoise stranded and incidentally caught between 1990 and 2011 (Jepson *et al.*, 2005; Deaville and Jepson, 2011; Law *et al*., 2012) results showed show stable and often high levels of PCBs in harbour porpoise, but declining levels of organochlorine pesticides (e.g. Dichlorodiphenyltrichloroethane (DDT) and dieldrin) (Law *et al*., 2012) and penta-mix brominated diphenyl ether congeners (PBDEs) (Law *et al*., 2010), and only trace levels of butyltins (including Tributyltin (TBT)) (Law *et al*., 2012). These Persistent Organic Pollutants (POPs) may have impacts on reproduction, as during pregnancy lipid-soluble contaminants, such as Organochlorines (OCs), may be transferred from the mother to the foetus (in particular the firstborn calf) (Murphy *et al*., 2013).

4.5.4.10 The impact of climate change on harbour porpoise remains poorly understood (Evans and Bjørge, 2013), with existing research limited and uneven in distribution. Potential impacts of climate change on marine mammals in general have included geographical range shifts (Kaschner *et al*., 2011; Lambert *et al*., 2011; Hazen *et al*., 2013; Ramp *et al*.,2015; Nøttestad *et al*., 2015; Vikingsson *et al*., 2015; Silber *et al*., 2017), food web changes (Ramp *et al*., 2015; Nøttestad *et al*., 2015; Vikingsson *et al*., 2015), and increased susceptibility to disease and contaminants (Hall and Frame, 2010; Twiner *et al*., 2011; Fire and Van Dolah, 2012; Jensen *et al*., 2015; Haüssermann *et al*., 2017; Mazzariol *et al*., 2018).

4.5.4.11 Data from SCANS I to SCANS IV suggested that the abundance of harbour porpoise in the North Sea Management Unit (NS MU) (for which there is enough data to assess trends) is stable (IAMMWG, 2015; IAMMWG, 2021, Gilles *et al.* 2023). Comparison of the impact of climate change on the species range and distribution in van Weelden *et al.* (2021) suggested a northward shift and expansion of harbour porpoise range, similar to MacLeod *et al.* (2009), but no increase in maximum latitude. This may lead to range contraction and present a risk for northwest European populations with their preference for sub-polar to temperate water temperature preference. There has been an increase in strandings of harbour porpoise (and short-beaked common dolphin) in northwest Scotland (Haelters *et al.*, 2011; Leeney *et al.*, 2008; MacLeod *et al.*, 2005), and a decrease in cold-temperate water species (northern bottlenose whale, *Hyperoodon ampullatus,* long-finned pilot whale *Globicephala melas*, Sowerby's beaked whale *Mesoplodon bidens* and white-beaked dolphin *Lagenorhynchus albirostris*) suggesting a shift in habitat in the region, favouring warm-water species over cold-water species.

4.5.4.12 Climate change may also affect prey distribution, having implications for predators such as harbour porpoise (as discussed in section 4.5.4.8). Warming sea temperatures are predicted to cause changes in prey abundance and distribution, and enhanced stratification forcing earlier occurrence of the spring phytoplankton bloom and potential cascading effects through the food chain (Evans and Bjørge, 2013). The impacts of climate change on marine predator-prey distributions in Sadykova *et al.* (2020) predicted a large future distribution shift in sandeel and porpoise habitat overlap (164 km) but a small shift (16 km) in overlap between herring and porpoise.

4.5.4.13 The results of the most recent UK assessment of favourable conservation status show that the current range of harbour porpoise covers all of the UK's continental shelf and there appears to have been no change in range since 1994 (Paxton *et al*., 2016; JNCC, 2019a). The future trend in the range of this species has therefore been assessed as overall stable (good). Due to insufficient data the future trend in the population and consequently future prospects of harbour porpoise was assessed as unknown (JNCC, 2019a). Due to the establishment of SACs for this species in UK waters, the future prospects for the supporting habitat was assessed as good. The report on conservation status assessment for the species concluded that, assuming that conservation measures are maintained, and further measures are taken should other pressures emerge (or existing pressures change) then the future prospects for harbour porpoise in UK waters should remain favourable (JNCC, 2019a).

Bottlenose dolphin

4.5.4.14 Abundance estimates of bottlenose dolphin in the Irish Sea MU have declined in recent years (IAMMWG, 2021), with 379 animals in the MU in 2015 based upon Evans (2012), and 293 in 2021 based upon Hammond *et al.* (2021) and Rogan *et al.* (2018) estimates. Bottlenose dolphin have been monitored annually in Cardigan Bay since 2001 and increased in abundance until peaking in 2007 to 2008 but have generally declined since then, although numbers now are similar to those in 2001 (Lohrengel *et al*., 2017).

4.5.4.15 The potential impacts of climate change for cetaceans are described in section 4.5.4.10. For the Irish Sea, Evans and Waggitt (2020) suggested no obvious trends in bottlenose dolphin since 2005 (Hammond *et al*., 2013, 2017).

4.5.4.16 Evans and Waggitt (2020) highlighted both the frequency and severity of toxic algal blooms are also predicted to increase as a result of nutrient enrichment (via increased rainfall and freshwater runoff) and increased temperature (via climate change) and salinity, and mass die-offs due to fatal poisonings have been reported in bottlenose dolphin (Fire *et al*., 2007, 2008).

4.5.4.17 The results of the most recent UK assessment of favourable conservation status show that the future trend in the range of bottlenose dolphin is, overall, stable (good) (JNCC, 2019b). However, although the pressures impacting bottlenose dolphin population and available habitat are not thought to be increasing and there are no threats identified which are likely to impact in the next 12 years, due to insufficient data to establish a current trend for this species, the future trend and consequently the future prospects for the population and habitat parameters are unknown (JNCC, 2019b). Therefore, the overall assessment of future prospects and conservation status for bottlenose dolphin is unknown (JNCC, 2019b).

Short-beaked common dolphin

4.5.4.18 In the Irish Sea and Celtic Sea, there appears to be no obvious trends in status for common dolphin (Baines & Evans, 2012). In other areas such as the North Sea off northeast Scotland, Orkney and Shetland, common dolphin are more regularly observed, even in winter (Sea Watch Foundation, unpublished data in Evans and Waggitt, 2020, Macleod *et al.*, 2005). This may reflect the expanding range of fish species like anchovy and sardine that are warmer water species.

4.5.4.19 Climate change may impact these predator-prey dynamics, alongside other impacts of a warming climate. Short-beaked common dolphin are wide ranging with a capacity for range expansion (Murphy *et al.*, 2013*)* typically warmer water species and appear to be extending their shelf sea range further north off western Britain and around the northern North Sea (Evans *et al*., 2003; MacLeod *et al*., 2005). Short-beaked common dolphin show a positive relationship with increasing temperature (Evans and Waggitt, 2020), and thus warming waters may lead to a shift in the range of short-beaked common dolphin (MacLeod *et al*., 2005).

4.5.4.20 Other pressures on common dolphin include fisheries interactions, pollutants, sound pollution and habitat disturbance. In ICES sub-division VII, which encompasses the Celtic Sea, the English Channel and the Irish Sea, 410 to 610 common dolphin were killed in pelagic trawl and static net fisheries between 2005 and 2006 (Northridge *et al*., 2007) and whilst these levels of bycatch were not of major conservation concern, when combined with gill or tangle nets impacts may be greater. Common dolphin have been observed taking fish from the cod end and foraging on discarded fish (Svane, 2005), inside sea bass trawls in the English Channel (Northridge *et al*. 2004), and off the southwest coast of Ireland they have been observed targeting horse mackerel in the vicinity of pelagic trawl nets (Couperus *et al*., 1997).

4.5.4.21 Common dolphin, as with all marine mammals, are susceptible to POPs which may bio magnify (higher levels occur higher up the food chain) and bioaccumulate (increased concentration with age). As discussed in 4.5.4.9, trends in POPs in harbour porpoise are likely to be found in common dolphins around the UK (Murphy *et al.*, 2013). Potential impacts of POPs on female short-beaked common dolphin were investigated from strandings in the northeast Atlantic from 2001 to 2003, found the threshold reported to have adverse health effects (17 mg kg^{-1}) was frequently exceeded in common dolphins (40%), and was driven primarily by individual feeding history (Pierce *et al*., 2008). Subsequent studies found the existence of non-reproductive female short-beaked common dolphin strandings on the southwest coast of the UK due to high contaminant burdens (Murphy *et al*., 2010), which may have implications for future population trajectories.

4.5.4.22 The results of the most recent UK assessment of favourable conservation status show that the future trend in the range of short-beaked common dolphin was overall stable (good) (JNCC, 2019c). However, although the pressures impacting short-beaked common dolphin populations and available habitat are not thought to be increasing and there are no threats identified which are likely to impact in the next 12 years, due to insufficient data to establish a current trend for this species, the future trend and consequently the future prospects for the population and habitat parameters are unknown (JNCC, 2019c). Therefore, the overall assessment of future prospects and conservation status for short-beaked common dolphin is unknown (JNCC, 2019c).

Risso’s dolphin

4.5.4.23 In the Irish Sea and Celtic Sea, there appears to be no obvious trends in status for Risso’s dolphin (Baines & Evans, 2012). There has been an increase in abundance of squid in recent years in areas around the UK (Western Approaches, Channel, North Sea) which may lead to an increased presence of squid predators such as Risso’s dolphin (Evans and Bjørge, 2013). As a predominantly teuthophagous species (species that feed on cephalopods) that feeds in continental slope waters, Risso’s dolphin may be less vulnerable to the threat of overfishing as the main cephalopod species are not commercially important and most fishing occurs in shelf waters and targets bony fishes. There remains the risk that fisheries will target lower in the food web if populations of higher trophic level species are depleted (Pauly *et al*., 1998; Sala *et al*., 2004; Pauly and Palomares, 2005) which could reduce prey populations or disrupt food webs.

4.5.4.24 Known threats to Risso’s dolphin include bycatch (e.g. pelagic drift nets), sound disturbance and ingestion of plastic debris (Bearzi *et al.,* 2011). Small numbers of Risso’s dolphin have been observed entangled in pelagic drift gillnets, pelagic longlines, purse seines and pelagic pair trawls (Carretta *et al*., 2008; Waring *et al*., 2009), with high mortality for gillnets. Whilst studies of sound disturbance on Risso’s dolphin is limited, there are some studies that demonstrate resting behaviour of Risso’s dolphin was disrupted by whale watching boats in the Azores (Visser *et al*., 2006).

4.5.4.25 In terms of climate change, there is little good quality information on the impact on Risso’s dolphin, with the impact at a population level unknown (Bearzi *et al*., 2011). There is some evidence of fluctuations in community structure and species composition likely driven by climate change, for example short-finned pilot whale were replaced by Risso's dolphin in an area of southern California coinciding with El Nino events (Shane, 1994, 1995b) and during El Nino 1997 to 1998 and La Nina 1999 events species such as Risso's dolphin that were virtually absent at the surface became more conspicuous (Benson *et al*., 2002). As mentioned in 4.5.4.21, Risso's dolphin are also susceptible to POPs and PCBs.

4.5.4.26 The results of the most recent UK assessment of favourable conservation status shown that the future trend in the range of Risso's dolphin is overall stable (good) (JNCC, 2019d). As the current conservation status for range is favourable for this species, the future prospects are considered good (JNCC, 2019d). Therefore, the overall assessment of future prospects and conservation status for Risso's dolphin is unknown; this is due to there being insufficient data to establish current trends for these parameters (JNCC, 2019d).

Minke whale

4.5.4.27 No obvious status changes have been observed in minke whale in the Irish Sea since 2005 (Evans and Waggitt, 2020; Baines and Evans, 2012), but there may have been increases in relative abundance since the 1980s (Evans *et al*., 2003; Paxton and Thomas, 2010). Minke whale are regularly observed in the Irish Sea and Celtic Sea, but foraging behaviour is less well known. Volkenandt *et al*. (2015) found minke whale were predominantly observed in areas with herring *Clupea harengus* and sprat *Sprattus*, and less in areas with mackerel. Healy *et al.* (2007) also found a significant relationship between the presence of baleen whales with herring and sprat in the Celtic Sea, and these species had a preference for small schooling pelagic fish (similar to studies on minke whale stomach contents by Pierce *et al*. (2004) in Scotland).

4.5.4.28 Howe *et al.* (2018) also highlighted that minke whale appear to target two herring stocks in the Irish Sea, the Mourne stock and Manx stock, with minke whale appearing to mirror the Irish Sea herring in Manx waters. These prey species may be impacted by climate change and have knock-on potential effects on minke whale foraging. The results of analysis of minke whale stomach contents in Icelandic waters suggested minke whale may adapt their diet under changed environments (Víkingsson *et al*., 2013). The study showed a decrease in the proportion of sandeel and cold-water species in the diet and an increase in gadoids and herring, which may reflect responses of minke whale to a changed environment, possibly driven by a warming climate. Studies also suggest that minke whale are likely to shift their distribution as a response to the decrease in the abundance of the preferred prey species (Víkingsson *et al.*, 2015).

4.5.4.29 Major threats affecting minke whale in UK waters include direct and indirect interactions with fisheries. Entanglement is the primary source of anthropogenic mortality of minke whale in the northwest Atlantic (Van der Hoop *et al*., 2013). Gillnets and longlines and pots have high potential to entangle minke whale (Brown *et al.*, 2015), but not necessarily lethal encounters. Other potential impacts include boat strikes, exposure to anthropogenic sound, ingestion of contaminants and debris and the loss or degradation of critical habitat (Gill *et al*., 2000; Robinson and MacLeod, 2009; Robinson *et al*., 2009). Data from SCANS II and SCANS III suggested that the abundance of minke whale in the Celtic and Greater North Sea Management Unit (CGNS MU) is stable (IAMMWG, 2015; IAMMWG, 2021).

4.5.4.30 The results of the most recent UK assessment of favourable conservation status show that there is no evidence to suggest that minke whale range has changed since the last report on conservation status in 2013 and therefore it has been assessed, overall, as stable (good) (JNCC, 2019e). The OSPAR Intermediate Assessment (IA) suggests that minke whale abundance in the Greater North Sea is stable (OSPAR IA, 2017; JNCC, 2019e). However, although the pressures impacting minke whale population and available habitat are not thought to be increasing and there are no threats identified which are likely to impact in the next 12 years, due to insufficient data to establish current trends for this species, the future trend and consequently the future prospects for the population and habitat parameters are unknown (JNCC, 2019e). Therefore, the overall assessment of future prospects and conservation status for minke whale is unknown (JNCC, 2019e).

Grey seal

4.5.4.31 UK grey seal numbers are currently stable or increasing throughout their monitored range (SMRU, 2021), suggesting that their population status is not under threat. The overall UK pup production increased by <1.5% per annum between 2016 and 2019, but growth was mainly limited to North Sea colonies. There has been evidence of increased haul-out counts of grey seal within all MUs in the regional marine mammal study area (Wright and Sinclair, 2022), but this could be due to an increase in species reporting (SCOS, 2021). The only sizeable breeding colony in Wales that is monitored annually is on Skomer Island, where following a period of little population growth (1993–2011), pup production has increased by an average of 10% per annum between 2011 and 2015 (Bull *et al*., 2017).

4.5.4.32 Pinnipeds are vulnerable to impacts of climate change (Evans and Waggitt, 2022). SMRU explored potential habitat shifts of grey seal and harbour seal in two scenarios of climate change (from IPCC, 2014) in the North Atlantic. Overall compression of core habitat, with slight loss of habitat in the northern and extensive habitat loss in the southern edges of distribution was observed for grey seal in the low warming scenario whilst in the high warming scenario, there was a northward shift in core habitat. Furthermore, pinnipeds such as grey seal that haul-out or breed on low lying coastal areas are vulnerable to sea level rise and increased storm surges. This could become an issue in particular for seals in the southern North Sea (Evans and Bjørge, 2013; Zicos *et al*., 2018).

4.5.4.33 Warming sea temperatures may also lead to an increase in pathogen exposure or spread of novel infectious diseases (Evans and Waggitt, 2020). Climate change has the potential to increase pathogen development and survival rates, disease transmission, and host susceptibility (Harvel *et al*., 2002), whilst higher temperatures may stress organisms, increasing their susceptibility to some diseases (Lafferty *et al*., 2004). Furthermore, species such as seals that occupy near shore regions near human settlements and have a semi-aquatic lifestyle will likely be at increased risk of pathogen exposure or risk to both marine and terrestrial pathogens (Cohen *et al*., 2018; Kroese *et al*., 2018; Keroack *et al*., 2018; Lehnert *et al*., 2017; Sanderson *et al*., 2020; Jensen *et al*., 2010).

4.5.4.34 Impacts on the food chain may also occur due to climate change and reduced food availability. It has also been suggested that some potential effects of pollutants (e.g. disruption of the immune, reproductive or endocrine systems) could also be exacerbated by nutritional stress brought on by reduced food availability due to climate change (Jepson *et al*., 2005). Potential additive effects of pollutants on predators which are already under stress from habitat changes (e.g. climate change) and prey availability are poorly understood, but there are suggestions that warming temperatures will alter pathways and concentrations of pollutants (Mazzariol *et al*., 2018).

4.5.4.35 The results of the most recent UK assessment of favourable conservation status show that the future trend in the range of grey seal is, overall, stable (good) (JNCC, 2019f). Modelling of population size at the beginning of each breeding season between 1984 and 2017 demonstrated an increasing trend and although the rate of increase has declined, the abundance estimate is above historic estimates (JNCC, 2019f). As the current conservation status for range and population is favourable for this species, the future prospects for both parameters are considered good (JNCC, 2019f). The future trend of grey seal habitat has been assessed as overall stable (good) (JNCC, 2019f).

Harbour seal

4.5.4.36 UK harbour seal numbers have increased since the late 2000s and is close to the late 1990s level prior to the 2002 Phocine Distemper Virus (PDV) epizootic (SCOS, 2021) but population dynamics vary significantly between regions. Populations in western Scotland are either stable or increasing, with the Southwest Scotland MU (which is located in the regional marine mammal study area) increasing since the 1990s. The main harbour seal haul-out locations are concentrated in the northern region of the regional marine mammal study area, in the Southwest Scotland MU, with no information on the location of harbour seal hauled-out in the Wales and Northwest England MUs (Wright and Sinclair, 2022). Most harbour seal haul-out locations in Northern Ireland are located in the southeast of the country, with most harbour seal being counted at Carlingford Lough, Murlough SAC and Rathlin Island. Population estimates have increased since the 2011 to 2015 survey periods (SCOS, 2021), but remain lower than 2000 to 2006 and 2007 to 2009 estimates. Colonies on the east coast appear to have experienced more dramatic declines (Wilson *et al*., 2019).

4.5.4.37 Threats to harbour seal include competition with grey seal, predation from killer whale and exposure to toxins from harmful algal blooms (Blanchet *et al*., 2021; Wilson *et al*., 2019; Jones *et al*., 2017; Jensen *et al.*, 2015). Harbour seal in declining colonies have been shown to be significantly more exposed to harmful algal toxins (e.g. domoic acid and saxitoxins) which may be contributing to observed declines (Jensen *et al.*, 2015). Harbour seal are also under threat from bycatch, but seal predation and fishing gear damage is not monitored, and until recently seal shooting was still licenced when interacting with fishing equipment (under the 'netsman's defence'). However, in March 2021, amendments made to the Conservation of Seals Act 1970 (which is applicable in England, Wales and Scotland) by Schedule 9 of the Fisheries Act 2020 came into force and individual seals can no longer be killed intentionally or recklessly.

4.5.4.38 Harbour seal are expected to be impacted by climate change, including range changes and changes in haul-out patterns, which are influenced by water and air temperature due to thermoregulation being energetically costly (Simpkins *et al.*, 2003). Changes in prey communities can also impact predator foraging patterns and diet composition, and whilst harbour seal have been shown to switch to alternative preys when required, these may come at a fitness cost, such as when harbour seal switched from herring to gadoids and showed signs of fish-induced anaemia. As generalist top predators with a flexible and broad diet, harbour seal can shift between several trophic niches if needed to cope with the physical environment. However, shifts in pathogen ranges and survival due to warmer air and water (Fujii *et al*., 2006) may affect harbour seal populations by increasing risk of epidemic outbreaks. Past epizootic viral diseases have caused mass mortality of harbour seal in Europe, with 60% mortality in the North Sea harbour seal during an outbreak of PDV, followed by a subsequent outbreak in 2002 (Härkönen *et al*, 2006; Stokholm *et al*., 2019). Several pinniped-related parasites have begun to expand their range mainly northwards under the influence of environmental parameters (Jensen *et al*., 2009; Gibson *et al*., 2011). As discussed in section 4.5.4.33, those species that occupy both terrestrial and marine habitats may risk more exposure to pathogens.

4.5.4.39 The results of the most recent UK assessment of favourable conservation status show that future trend in the range of harbour seal is, overall, stable (good) (JNCC, 2019g). Although the UK population of harbour seal has increased since 2000, the long-term trend indicates that the UK population is still below population levels documented in the late 1990s and declines were recorded at many sites, including the east of Scotland. Therefore, the current UK harbour seal population estimate has been considered as unfavourable-inadequate. Given that there is not predicted to be any increase in management which would outweigh threats to the species, future prospects of harbour seal population in the UK were assessed as poor (JNCC, 2019g). Although the pressures impacting harbour seal habitats are not thought to be increasing, and there are no threats identified which are likely to impact in the next 12 years, due to insufficient data to establish a current trend for this species, the future trend and consequently the future prospects for the habitat parameter are unknown (JNCC, 2019g).

4.5.5 Data limitations

4.5.5.1 The marine mammal impact assessment was developed on the basis of the best available information at the time of writing. Baseline data used to underpin the assessment was drawn from broadscale sources and site-specific surveys which are subject to temporal and spatial variability and so are likely to influence marine mammal distribution and abundance. A summary of the limitations and uncertainties associated with the data is detailed in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).

4.5.5.2 The approach to the assessments of underwater sound on marine mammals was undertaken using an evidence-based approach based on a comprehensive review of the literature, including empirical data derived from field studies at other offshore wind farms. This makes the assumption that such data is applicable in a different region with a different environmental context. In addition, there is an assumption that responses may be similar across different species.

4.5.5.3 Whilst these data limitations and assumptions could lead to some level of uncertainty, this is overcome by adopting a precautionary approach at each stage of the assessment (see paragraph 4.9.2.37).

4.6 Impact assessment methodology

4.6.1 Overview

4.6.1.1 The marine mammals impact assessment has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental Statement. Specific to the marine mammals impact assessment, the following guidance documents have also been considered:

- Guidance for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater, Coastal and Marine (Chartered Institute of Ecology and Environmental Management (CIEEM), 2018) - these guidelines combine the Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition (2016) and the Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal (2010)

- Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC 2010a)
- JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys JNCC (2017)
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010b)
- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Judd, 2012).

4.6.1.2 In addition, the marine mammals impact assessment has considered the legislative framework as defined by:

- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended)
- The Environment (Wales) Act 2016 and The Wellbeing of Future Generations (Wales) Act 2015
- Marine and Coastal Access Act 2009
- The Planning Act 2008 (as amended) (relevant to the DCO application).

4.6.1.3 Full descriptions of relevant legislation are presented in Volume 1, Chapter 2: Policy and legislation of the Environmental Statement.

4.6.2 Impact assessment criteria

4.6.2.1 The assessment of significance relies on understanding the potential impacts arising from proposed activities and the effect that those impacts will have on ecological receptors. These are aligned to CIEEM Guidelines (CIEEM, 2018), and the following definitions are used for impact and effect throughout:

- 'Impact' – actions resulting in changes to an ecological feature. For example, elevated underwater sound from piling
- 'Effect' – outcome to an ecological feature from an impact. For example, the onset of auditory injury.

4.6.2.2 The criteria for determining the significance of potential effects follows a two-stage process that involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Volume 1, Chapter 5: EIA methodology of the Environmental Statement.

4.6.2.3 Magnitude of impact quantifies the amount of change arising from an activity that could lead to alteration in the environment (e.g. piling could lead to an elevation in underwater sound) and the associated outcome or effect on sensitive ecological receptors. The assessment describes the spatial extent over which potential impacts and potential effects could occur arising from a particular activity within the relevant geographic frame of reference (e.g. area of effect and associated number of animals in a MU population affected), how long animals are exposed to an activity that could cause an effect in the context of the life-history of a species (i.e. the duration), the frequency of the exposure that could lead to a change (i.e. continuous or intermittent) and whether or not the resultant change in either the receiving environment or features exposed is reversible. The criteria for defining magnitude in this chapter are outlined in Table 4.13 below and provides guidance to assessing magnitude for all impacts. This is not a wholly prescriptive approach, as the assessed magnitude is based upon expert judgement taking into account other factors such as the species life history, the wider population context and movement within the area to aid with defining magnitude.

Table 4.13: Definition of terms relating to the magnitude of an impact.

Magnitude of Impact	Definition
High	The magnitude of the impact would lead to large scale effects on the behaviour and distribution of the marine mammal IEF, with sufficient severity to affect the long-term viability of the population over a generational scale. (Adverse).
	Long-term, large-scale increases in the population trajectory over a generational scale. (Beneficial).
Medium	The magnitude of the impact would lead to temporary changes in behaviour and/or distribution of individuals at a scale that would result in potential reductions to lifetime reproductive success to some individuals, although not enough to significantly affect the population trajectory over a generational scale; and/or the impact would lead to permanent effects on individuals that may influence individual survival but not at a level that would alter population trajectory over a generational scale. (Adverse).
	Benefit to the habitat influencing foraging efficiency resulting in increased reproductive potential and increased population health and size. (Beneficial).
Low	The magnitude of the impact would result in some measurable change in attributes, quality or vulnerability (e.g. a threshold shift in hearing), or minor loss, or detrimental alteration to, one (maybe more) key characteristics, features or elements of the species at an individual level (e.g. interruption of feeding or breeding) but is unlikely to be measurable at a population level. (Adverse).
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute (e.g. enhance foraging opportunities) but is unlikely to be measurable at a population level, or a reduced risk of negative impact occurring. (Beneficial).
Negligible	The magnitude of the impact would result in a very minor, temporary loss or detrimental alteration to one or more characteristics, features or elements of the species at an individual level which would not affect the population. (Adverse).
	Very minor benefit to, or positive addition of one or more characteristics, features or elements of the species at an individual level but which would not benefit the species at a population level. (Beneficial).

4.6.2.4 The criteria for defining sensitivity in this chapter are outlined in Table 4.14 below. The sensitivity of marine mammal IEFs has been defined by an assessment of the ability of a receptor to adapt to a given impact, its resilience to that impact and its ability to recover back to pre-impact conditions.

4.6.2.5 Resilience is the ability to withstand a perturbation or disturbance by resisting damage. Recoverability is the ability of the same species to return to a state close to that which existed before the activity or event which caused change. It is dependent on the ability of the individuals to recover following cessation of the activity that causes the impact.

4.6.2.6 Information on these aspects of sensitivity of the marine mammal IEFs to given impacts has been informed by the best available evidence from scientific research on marine mammals (studies on captive animals as well as observations from field studies). In particular, evidence from field studies of marine mammals during the construction and operation of offshore wind farms (and analogous activities such oil and gas surveys) has been used to inform this impact assessment. The review of tolerance and recoverability of marine mammal IEFs has been combined to provide an overall evaluation of the sensitivity of a receptor to an impact as outlined in Table 4.14.

Table 4.14: Definition of terms relating to the sensitivity of the receptor.

Sensitivity of the Receptor	Description
Very High	No ability to adapt behaviour so that survival and reproduction may be affected. No resilience; effect is very likely to cause a change in both reproduction and survival of individuals. No ability for the animal to recover from the effect. A receptor is of very high sensitivity where adverse effects on multiple key ecological functions (e.g. feeding, breeding, nursing) could occur with no resilience and no potential for recovery such that reproduction and survival of individuals would be affected.
High	Limited ability to adapt behaviour so that survival and reproduction may be affected. Limited resilience; effect may cause a change in both reproduction and survival of individuals. Limited ability for the animal to recover from the effect. A receptor is of high sensitivity where adverse effects on multiple key ecological functions (e.g. feeding, breeding, nursing) could occur with limited resilience and limited potential for recovery such that reproduction or survival of individuals could be affected.
Medium	Ability to adapt behaviour so that reproduction may be affected but survival rates not likely to be affected. Some resilience; effect unlikely to cause a change in both reproduction and survival rates. Ability for the animal to recover from the effect. A receptor is of medium sensitivity where adverse effects on one or more key ecological functions (e.g. feeding, breeding, nursing) could be sustained beyond the duration of the impact (some resilience to the effect) but not at a level that would affect individual survival although reproductive success may be affected until the individual has recovered (ability to recover).
Low	Receptor is able to adapt behaviour so that survival and reproduction are not affected. Receptor is able to tolerate the effect without any impact on reproduction and survival rates. Receptor is able to return to previous behavioural states/activities once the impact has ceased. Low sensitivity is such that adverse effects on ecological functions (e.g. feeding, breeding, nursing) are likely to be very short term and would not affect reproductive success or individual survival.
Negligible	Very little or no effect on the behaviour of the receptor.

4.6.2.7 The significance of the effect upon marine mammals is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 4.15. Where a range of significance of effect is presented in Table 4.15, the final assessment for each effect is based upon expert judgement. As per Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018), significant effects are considered with regard to impacts on the structure and function of defined sites, habitats or ecosystems and the conservation status of habitats and species (including extent, abundance and distribution), where for a species "*the conservation status is determined by the sum of influences acting on the species concerned that may affect its abundance and distribution within a given geographical area*" (CIEEM, 2018). Assessment of potential significant effects provided in section 4.9 is quantified with reference to appropriate geographic scales (e.g. species-specific MUs).

4.6.2.8 In some cases, the matrix suggests a range for the significance of effect (i.e. the range is given as minor to moderate) (Table 4.15). In such cases the final significance is based upon the expert's professional judgement as to which outcome delineates the most likely effect, with an explanation as to why this is the case.

4.6.2.9 For the purposes of this assessment, any potential effects with a significance level of minor or less have been concluded to be not significant in terms of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. A level of effect of moderate or more will be considered significant in terms of the EIA Regulations.

Table 4.15: Matrix used for the assessment of the significance of the effect.

Sensitivity of Receptor	Magnitude of Impact			
	Negligible	**Low**	**Medium**	**High**
Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Minor	Minor or Moderate	Moderate or Major	Major
Very High	Minor	Moderate or Major	Major	Major

4.6.3 Designated sites

4.6.3.1 Where National Site Network sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the interest features of internationally designated sites as described within section 4.5.2 of this chapter (with the assessment on the site itself deferred to the HRA Stage 2 ISAA (Document Reference E1.3)). With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site (e.g. Sites of Special Scientific Interest (SSSIs) which have not been assessed within the HRA Stage 2 ISAA) only the international site has been taken forward for assessment. This is because potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken).

4.6.3.2 The HRA Stage 2 ISAA (Document Reference E1.3) has been prepared in accordance with Advice Note Ten: Habitats Regulations Assessment Relevant to Nationally Significant Infrastructure Projects (The Planning Inspectorate, 2022).

4.7 Key parameters for assessment

4.7.1 Maximum design scenario

4.7.1.1 The MDSs identified in Table 4.16 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Project Design Envelope provided in Volume 1, Chapter 3: Project description of the Environmental Statement. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 4.16: Maximum design scenario considered for the assessment of potential impacts on marine mammals.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential impact	Phase[a] C	O	D	Maximum design scenario	Justification
Injury and disturbance from underwater sound generated during piling	✓	×	×	**Construction phase:** **Maximum temporal scenario:** Single piling at up to 78 locations comprising: 64 wind turbine 4-legged jacket foundations, four OSP four-legged jacket foundations and up to 10 gravity based foundations (which require strengthening piles). Total of 113.5 days of piling (64 days for wind turbines, 37.5 days for Gravity Base Foundations (GBFs), and 12 days for OSPs) estimated as follows: • **Wind turbines**: – Installation of up to 64 four legged-jacket foundations (with one pile per leg) = a total of 256 piles – Each pile with a diameter of 3.8 m installed by impact piling – Maximum hammer energy of 4,400 kJ for 16 locations, and 3,000 kJ for 48 locations – Average duration of up to 4.5 hours piling per pile, with a maximum of one foundation (four piles) per day = cumulative total of 64 days (64 foundations x 4 legs x 1 pile per leg x 4.5 hours duration per pile = 1,152 hours). • **GBFs** – Installation of up to 32 gravity base foundations, up to 10 of which could require piling for ground strengthening, leading to a maximum of 150 piles. 15 piles per foundation, each with maximum 4 m diameter – Maximum hammer energy of up to 3,000 kJ (for up to 10 gravity base foundations that require piling). – Average duration 4 hours per pile, leading to a maximum cumulative total of up to 37.5 days (10 foundations x 15 piles x 4 hours duration per pile = 600 hours) (limited by 4 piles per day).	The **maximum temporal scenario** was assessed on the greatest number of days on which piling could occur based on the number of piles that could be installed within a 24-hour period (4 per day). Of the total of 96 wind turbine locations there would be a maximum of 64 jackets and the remaining 32 would be gravity bases, of which up to 10 may require piling to strengthen the foundations. Consecutive piling is assumed over a maximum period of 24 hours. For the **maximum spatial scenario** concurrent piling events would lead to the largest spatial extent of ensonification at any one time. The project has committed to not using the maximum hammer energy (4,400 kJ) for any concurrent piling and therefore only a 3,000 kJ + 3,000 kJ scenario has been modelled. Minimum spacing between **concurrent piling** represents the **highest risk of injury** to marine mammals as sound from adjacent foundations could combine to produce a greater radius of effect compared to a single piling event. Maximum spacing between concurrent piling represents the highest risk of potential behavioural effects to marine mammals as a larger area would be ensonified at any one time.

Potential impact	Phase[a] C	O	D	Maximum design scenario	Justification
				• **OSPs** – Installation of up to 4 OSPs with 4-legged jacket foundations, with three piles per leg = a total of 48 piles) – Each pile with a diameter of 3.5 m installed by impact piling – Maximum hammer energy of up to 4,400 kJ – Average duration of up to 4.5 hours piling per pile with a cumulative total of up to 216 hours; installation of OSP over 12 days (limited by 4 piles per day). **Maximum spatial scenario:** Concurrent piling with two vessels at a minimum distance of 1.4 km and a maximum distance of 15 km. Only concurrent piling at a maximum hammer energy of 3,000 kJ (i.e. no concurrent piling where a 4,400 kJ hammer is required). Concurrent piling will only occur at wind turbine jacket foundations; GBFs and OSPs will be installed using a single vessel. Total piling phase (foundation installation) of up to two years within a four-year construction programme.	
Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys	✓	×	×	**Construction phase** Geophysical site investigation activities include: • Multi-beam echo-sounder (MBES) - 200-500 kHz; 180-240 dB re 1μPa re 1 m (rms) • Sidescan Sonar (SSS) - 200-700 kHz; 216-228 dB re 1μPa re 1 m (rms) • Single Beam Echosounder (SBES) - 120-400 kHz; 180-240 dB re 1μPa re 1 m (rms) • Sub-Bottom Profilers (SBP) – Chirp 0.2-14 kHz, 200-240 chirp dB re 1μPa re 1 m (rms) – Pinger 2-7 kHz; 200-235 pinger dB re 1μPa re 1 m (rms) • Sparker (as an example of Ultra High Resolution Seismic (UHRS) (0.05 – 4 kHz; 182 dB re 1μPa^{2}s SEL)	Range of geophysical and geotechnical activities likely to be undertaken using equipment typically employed for these types of surveys. Parameters chosen resulted in the greatest range of impact (e.g. highest source sound level, fastest pulse rate, longest pulse duration) and as such were those that would lead to the greatest spatial extent for potential injury or disturbance effects.

Potential impact	Phase[a] C	O	D	Maximum design scenario	Justification
				Geotechnical site investigation activities include: • Boreholes • Cone penetration tests (CPTs) • Vibrocores Pre-construction site investigation surveys will involve the use of several geophysical/geotechnical survey vessels and take place over up to a period of up to eight months.	
Injury and disturbance from underwater sound from UXO detonation	✓	×	×	**Construction phase** • Clearance of up to 22 UXOs within the Mona Array Area or Offshore Cable Corridor and Access Areas. • A range of UXO sizes assessed from 25 kg up to 907 kg (absolute maximum) with 130 kg the most likely (common) size • For high order detonation donor charges of 1.2 kg (most common) and 3.5 kg (single barracuda blast charge) • Up to 0.5 kg NEQ clearance shot for neutralisation of residual explosive material at each location • Clearance during daylight hours only. MDS is for high order clearance but assessment also considered: • Low order clearance charge size of 0.08 kg • Low yield clearance configurations of 0.75 kg charges (up to 4 x 0.75 kg).	Maximum number and maximum size of UXOs encountered in the Mona Array Area and Mona Offshore Cable Corridor and Access Areas. Due to uncertainties in size of UXOs the assessment presents a range of UXO sizes assessed (from 25 kg up to an absolute maximum of 907 kg), highlighting 130 kg is the most likely (common) size. Most common (1.2 kg) and maximum donor charges (3.5 kg) assessed for high order detonation. Assumption of a clearance shot of up to 0.5 kg at all locations although noting that this may not always be required. For the assessment of low order/low yield clearance, charges are based on the maximum required to initiate clearance event.
Injury and disturbance from vessel use and other (non-piling) sound producing activities	✓	✓	✓	**Construction phase** ***Vessels*** • Up to a total of **96** construction vessels on site at any one time (**24** main installation and support vessels, **10** tug/anchor handlers, **14** cable lay installation and support vessels, **three** guard vessels, **nine** survey vessels, **12** seabed preparation vessels, **15** Crew Transfer Vessels (CTVs), **three** scour protection installation vessels, **four** cable protection installation vessels), **one** jack-up operations vessel, **one** cable barge grounding vessel.	The maximum design scenario considers the maximum number of vessels on site at any one time and greatest number of round trips during each phase of the Mona Offshore Wind Project. This represents the broadest range of vessel types and therefore sound signatures within the marine environment to affect marine mammal receptors. The maximum design scenario considers the maximum durations for which activities could be conducted.

<table>
<tr><th>Potential impact</th><th colspan="3">Phase[a]</th><th>Maximum design scenario</th><th>Justification</th></tr>
<tr><th></th><th>C</th><th>O</th><th>D</th><th></th><th></th></tr>
<tr><td></td><td></td><td></td><td></td><td>

Up to 2,199 installation vessel movements (return trips) during construction (553 main installation and support vessels, 106 tug/anchor handlers, 112 cable lay installation and support vessels, 84 guard vessel, 51 survey vessels, 43 seabed preparation vessels, 1,171 CTVs, 41 scour protection installation vessels, 22 cable protection installation vessels, 16 jack up operations, and 16 cable barge groundings)

Other activities:

Up to 100% of overall piles may require drilling (64 4-legged wind turbine jacket foundations with a diameter of 3.8 m and four four-legged OSP jacket foundations with a diameter of 3.5 m), up to two concurrent drilling vessels.
Burial of up to 325 km of inter-array cables, 50 km of interconnector cables and 360 km of offshore export cable via ploughing, trenching and jetting. Protection of up to 32.5 km of inter-array cables via rock dumping and mattressing.

Maximum offshore construction duration of up to 4 years.
Operations and maintenance phase

Up to a total of 21 operations and maintenance vessels on site at any one time (six CTVs/workboats, three jack-up vessels, four cable repair vessels, four Service Operation Vessels (SOV) or similar and four excavators/backhoe dredgers)
Up to 849 operations and maintenance vessel movements (return trips) each year (730 CTVs/workboats, 25 jack-up vessels, 8 cable repair vessels, 78 SOV or similar and 8 excavators/backhoe dredgers)

Operational lifetime of up to 35 years.
Decommissioning phase
Vessels used for a range of decommissioning activities such as removal of foundations (e.g. using cutting tools).
Sound from vessels assumed to be as per vessel activity described for construction phase above.
</td><td></td></tr>
</table>

Potential impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
Underwater sound from wind turbine operation	×	✓	×	**Operations and maintenance phase** Up to 64 foundations at the largest wind turbine size.	The maximum design scenario considers the largest size of potential wind turbines for the Mona Offshore Wind Project as wind turbine size is the main factor influencing the sound from operational wind farms and this represents the potential for highest underwater sound levels.
Injury due to increased risk of collision with vessels	✓	✓	✓	**Construction phase** As described for vessel disturbance above. **Operations and maintenance phase** As described for vessel disturbance above. **Decommissioning phase** As described for vessel disturbance above.	The maximum design scenario considers the maximum number of vessels on site at any one time and largest numbers of round trips during each phase of the Mona Offshore Wind Project. This represents the broadest range of vessel types and movements, and therefore greatest potential for collision risk.
Effects on marine mammals due to changes in prey availability	✓	✓	✓	**Construction phase** As described in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement for: • Temporary habitat loss/disturbance • Long term habitat loss • Increased suspended sediment concentrations (SSC) and associated sediment deposition. • Disturbance/remobilisation of sediment-bound contaminants • Underwater sound during the construction phase impacting fish and shellfish receptors. **Operations and maintenance phase** As described in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement for: • Temporary habitat loss/disturbance • Long term habitat loss • Increased SSC and associated sediment deposition • Disturbance/remobilisation of sediment-bound contaminants	As described in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement.

Potential impact	Phase[a] C	O	D	Maximum design scenario	Justification
				• Electromagnetic fields (EMF) from subsea electrical cabling • Colonisation of hard structures. **Decommissioning phase** As described in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement for: • Temporary habitat loss/disturbance • Long term habitat loss • Increased suspended sediment concentrations and associated sediment deposition • Disturbance/remobilisation of sediment-bound contaminants.	

4.8 Measures adopted as part of the Mona Offshore Wind Project

4.8.1.1 For the purposes of the EIA process, the term 'measures adopted as part of the project' is used to include the following measures (adapted from Institute of Environmental Management and Assessment (IEMA), 2016):

- Measures included as part of the project design. These include modifications to the location or design envelope of the Mona Offshore Wind Project which are integrated into the application for consent. These measures are secured through the consent itself throughout the description of the development and the parameters secured in the DCO and/or marine licence (referred to as primary mitigation in IEMA, 2016)
- Measures required to meet legislative requirements, or actions that are standard practice used to manage commonly occurring environmental effects and are secured through the DCO requirements and/or the conditions of the marine licences (referred to as tertiary mitigation in IEMA, 2016).

4.8.1.2 A number of measures (primary and tertiary) have been adopted as part of the Mona Offshore Wind Project to reduce the potential for impacts on marine mammals. These are outlined in Table 4.17 below. As there is a secured commitment to implementing these measures, they are considered inherently part of the design of the Mona Offshore Wind Project and have therefore been considered in the assessment presented in section 4.9 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

4.8.1.3 Where significant effects have been identified, further mitigation measures (referred to as secondary mitigation in IEMA 2016) have been identified to reduce the significance of effect to acceptable levels following the initial assessment. These are measures that could further prevent, reduce and, where possible, offset any adverse effects on the environment. These measures are set out in section 4.9 below.

4.8.1.4 The Mona Offshore Wind Project design has changed from the PEIR to the Environmental Statement including a reduction in the number of wind turbines from 107 to 96. The number of wind turbines has been reduced by approximately 10% subsequently reducing the number of foundations that require piling. Monopile foundations (as presented in the PEIR) have also been removed from the Project Design Envelope (PDE), and pin piles only have been considered in the Environmental Statement. As such, the maximum hammer of 5,500 kJ (presented in the PEIR for monopiles) has not been taken forward to the Environmental Statement. A proportion of hammer energy is converted into waterborne acoustic energy going into the water column and large hammer energies may result in increased peak sound levels received by marine mammals. As such, the removal of monopile foundations and the maximum hammer energy of 5,500 kJ from the design envelope has reduced the range at which instantaneous injury could occur to marine mammals from received SPL_{pk}.

Table 4.17: Measures adopted as part of the Mona Offshore Wind Project.

Measures adopted as part of the Mona Offshore Wind Project	Justification	How the measure will be secured
Primary measures: Measures included as part of the project design		
Development of and adherence to an Marine Mammal Mitigation Protocol (MMMP) which will be developed in accordance with the Outline MMMP (Document Reference J21) that requires implementation of an initiation stage of a piling soft start and ramp-up.	This measure will minimise the likelihood of injury from elevated underwater sound to marine mammal and fish species in the immediate vicinity of piling operations, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. Compliance with these guidelines will, in most cases, reduce the likelihood of injury to marine mammals to negligible levels.	MMMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.
Development and adherence to a MMMP (to be developed in accordance with the Outline MMMP (Document Reference J21)) which sets a maximum separation limit of 15 km for concurrent piling.	Commitments made around maximum separation during concurrent piling will minimise the likelihood of disturbance to marine mammal and fish species in the immediate vicinity of piling operations, by limiting the ensonified area during concurrent piling. Where piling occurs concurrently a maximum separation distance of 15 km is used to limit the ensonified area as there is greater overlap when closer together.	MMMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.
Development and adherence to a MMMP (to be developed in accordance with the Outline MMMP (Document Reference J21)) which sets a minimum separation limit of 1.4 km for concurrent piling.	Commitments made around minimum separation during concurrent piling will minimise the likelihood of injury to marine mammal and fish species in the immediate vicinity of piling operations, by limiting the spatial overlap of areas of ensonification during concurrent piling. Where piling occurs concurrently, a minimum separation distance of 1.4 km is used to minimise the potential for additive effects due to direct overlap of concurrent piling.	MMMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.
Development and adherence to a MMMP (to be developed in accordance with the Outline MMMP (Document Reference J21)) which sets the limit on maximum hammer energy used during concurrent piling at 3,000 kJ and during the single event piling at 4,400 kJ.	Commitments made around concurrent piling will minimise the likelihood of injury to marine mammal and fish species in the immediate vicinity of piling operations, by reducing the ensonified area during concurrent piling.	MMMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.

Measures adopted as part of the Mona Offshore Wind Project	Justification	How the measure will be secured
Development and adherence to a MMMP (to be developed in accordance with the Outline MMMP (Document Reference J21) that requires implementation of a mitigation hierarchy with regard to UXO clearance that follows: • Avoid UXO • Clear UXO with low order techniques • Clear UXO with high order techniques. Low order techniques or avoidance of confirmed UXO are not always possible and are dependent upon the individual situations surrounding each UXO.	Low order techniques generate less underwater sound than high order techniques and therefore present a lower risk to sound-sensitive receptors such as marine mammals during UXO clearance. Noting the position statement from statutory authorities on UXO clearance (DEFRA, 2021), the option to clear UXOs with low order techniques has been considered as a potential primary mitigation measure as part of this assessment. Note, however, that low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO. Given that it is possible that high order detonation may be used, the Outline MMMP includes mitigation to reduce the likelihood of injury from UXO clearance. Please see below. The Outline underwater sound management strategy (Document Reference J16) includes potential further mitigation options, should the measures in the MMMP (Document Reference J21) not reduce impacts, such that there will be no residual significant effect from the project. Please see below.	MMMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Development of and adherence to a MMMP, which will be developed in accordance with the Outline MMMP (Document Reference J21) included as part of the application. The Outline MMMP (Document Reference J21) presents appropriate mitigation for activities that could potentially lead to injurious effects on marine mammals including: piling, UXO clearance and some types of geophysical activities. <u>Piling</u>: for the purpose of developing the MMMP (Document Reference J21) as an annex of the Underwater sound management strategy (Document Reference J16), a mitigation zone will be defined based on the maximum predicted injury range from the dual metric sound modelling for the maximum spatial scenario (pin piles) and across all marine mammal species. The Outline MMMP (Document Reference J21) sets out the measures to apply in advance of and during piling activity including the use of:	The implementation of an approved MMMP will mitigate for the risk of physical or permanent auditory injury to marine mammals within a pre-defined 'mitigation zone' for each activity. The mitigation zone is determined considering the largest injury zone across all species for each relevant activity. The use of an approved MMMP will also minimise the potential for collision risk, or potential injury to, marine mammals and other marine megafauna (e.g. basking shark). The MMMP will include visual and acoustic monitoring as a minimum over the defined mitigation zones to ensure animals are clear before the activity commences. Additional measures to deter animals from injury risk zones may be applied in some instances (e.g. ADDs or soft start charges).	MMMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.

Measures adopted as part of the Mona Offshore Wind Project	Justification	How the measure will be secured
• Marine Mammal Observers (MMOs) • Passive Acoustic Monitoring (PAM) • Acoustic Deterrent Devices (ADD) Therefore following the latest JNCC guidance (JNCC, 2010a). <u>UXO clearance</u>: Measures including visual and acoustic monitoring, the use of an ADD and soft start charges will be applied to deter animals from the mitigation zone as defined by sound modelling for the largest possible UXO following the latest JNCC guidance (JNCC, 2010b). <u>Geophysical surveys</u> Mitigation for injury during high resolution geophysical surveys using a sub-surface sensor from a conventional vessel will involve the use of MMOs and PAM to ensure that the risk of injury over the defined mitigation zone is reduced in line with JNCC guidance (JNCC, 2017). Soft start is not possible for SBP equipment but will be applied for other high resolution surveys where possible. Note also, some multi-beam surveys in shallow waters (<200 m) are not subject to the Development of and adherence requirements of mitigation.	The MMMP will be developed on the basis of the most recent published statutory guidance and in consultation with key stakeholders.	
Development of and adherence to an Underwater Sound Management Strategy that includes consideration of Noise Abatement Systems (NAS) as part of mitigation options, which will be developed in accordance with the Outline underwater sound management strategy (Document Reference J21), will be made as part of a stepped strategy post consent and following the mitigation hierarchy - avoid, reduce, mitigate.	To mitigate for the likelihood of physical or permanent auditory injury to marine mammals.	Underwater sound management strategy secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.
Development of and adherence an Offshore EMP including measures to minimise disturbance to marine mammals and rafting birds from transiting vessels (Document Reference J17), requiring them to: • Not deliberately approach marine mammals as a minimum • Avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride, where appropriate and possible taking into account all technical considerations. The Offshore EMP will include a commitment that the site induction processes will incorporate the principles of the Wildlife Safe (WiSe) Scheme to ensure that key personnel are aware of the need to follow	To minimise the potential for collision risk, or potential injury to, marine mammals and megafauna.	Offshore EMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.

Measures adopted as part of the Mona Offshore Wind Project	Justification	How the measure will be secured
the WiSe Code of Conduct. The WiSe Scheme [redacted] which is a UK national training scheme for minimising disturbance to marine life, key measures from the scheme will reduce the disturbance of vessel transits on marine mammals and rafting birds visible at the water surface, or as otherwise agreed with the Statutory Nature Conservation Bodies (SNCBs).		
Development of, and adherence to an offshore EMP that will include a MPCP which will include planning for accidental spills, address all potential contaminant releases and include key emergency details.	To ensure that the potential for release of pollutants during construction, operations and maintenance, and decommissioning phases are minimised. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and takes containing hazardous substances, and storage of these substances in impenetrable bunds. The MPCP will ensure that in the unlikely event that a pollution event occurs, that plans are in place to respond quickly and effectively to ensure any spillage is minimised and potential effects on the environment are ideally avoided or minimised. Implementation of these measures will ensure that accidental release of contaminants from vessels will be avoided or minimised, thus providing protection for marine life across all phases of the Mona Offshore Wind Project.	Offshore EMP secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.
Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004. A Decommissioning Programme is required under the provisions of the Energy Act 2004 and this must be approved by the Secretary of State before works commence.	The aim of this plan is to adhere to the existing UK legislation and guidance. Overall, this will ensure the legacy of the Mona Offshore Wind Project will result in the minimum amount of long-term disturbance to the environment. While this measure has been committed to as part of the Mona Offshore Wind Project, the MDS for the decommissioning phase has been considered in each of the impact assessments presented in section 4.9.	Decommissioning Programme secured as a requirement in Schedule 2 of the draft DCO and is a requirement of the Energy Act 2004.

4.9 Assessment of significant effects

4.9.1 Overview

4.9.1.1 The potential impacts of the construction, operations and maintenance, and decommissioning phases of the Mona Offshore Wind Project were assessed on marine mammals. The potential impacts arising from the construction, operations and maintenance and decommissioning phases of the Mona Offshore Wind Project are listed in Table 4.16, along with the MDS against which each impact has been assessed.

4.9.1.2 A description of the potential effect on marine mammal receptors caused by each identified impact is given below.

4.9.2 Underwater sound and marine mammals

4.9.2.1 Marine mammals, in particular cetaceans, are capable of generating and detecting sound (Au *et al.,* 1974; Bailey *et al*., 2010). They are dependent on sound for many aspects of their lives (i.e. prey identification; predator avoidance; communication and navigation). Increases in anthropogenic sound may consequently lead to a potential effect within the marine environment (Parsons *et al*., 2008; Bailey *et al*., 2010), and potential effects on marine mammals.

4.9.2.2 Four zones of influence have been described by Richardson *et al*. (1995), and these vary with the distance from the source, including: audibility (sound is detected); masking (interfere with detection of sounds and communication); responsiveness (behavioural or physiological response) and injury/hearing loss (tissue damage in the ear). This assessment considers the zones of injury (auditory) and disturbance (i.e. responsiveness). There is insufficient scientific evidence to properly evaluate masking and no relevant threshold criteria to enable a quantitative assessment. The relevant thresholds for onset of potential effects, and the evidence base from which they are derived, are given below.

Injury

4.9.2.3 Auditory injury in marine mammals, which is often described in terms of a hearing threshold shift, can either be temporary (TTS) where an animal's auditory system can recover or permanent (PTS) where there is no hearing recovery in the animal. The 'onset' of TTS is deemed to be where there is a temporary elevation in the hearing threshold by 6 dB and is "*the minimum threshold shift clearly larger than any day to day or session to session variation in a subject's normal hearing ability*", and which "*is typically the minimum amount of threshold shift that can be differentiated in most experimental conditions*" (Southall *et al*., 2007). Since it is considered unethical to conduct experiments measuring PTS in animals, the onset of PTS was extrapolated from early studies on TTS growth rates in chinchillas (Henderson and Hamernick, 1986) and is conservatively considered to occur where there is 40 dB of TTS (Southall *et al*., 2007). Whether such shifts in hearing would lead to loss of fitness will depend on several factors including the frequency range of the shift and the duty cycle of impulsive sounds. For example, if a shift occurs within a frequency band that lays outside of the main hearing sensitivity of the receiving animal there may be a 'notch' in this band, but potentially no effect on the animal's ability to survive. Further discussion on the sensitivity of marine mammals to hearing shifts is provided later in this assessment.

4.9.2.4 Potential auditory injury is assessed in terms of PTS given the irreversible nature of the effect, unlike TTS which is temporary and reversible. Animals (particularly highly mobile species) exposed to sound levels that could induce TTS are likely to respond by moving away from (fleeing) the ensonified area and therefore avoiding potential injury. It is considered there is a behavioural response (disturbance) that overlaps with potential TTS ranges. Since derived thresholds for the onset of TTS are based on the smallest measurable shift in hearing, TTS thresholds are likely to be very precautionary and could result in overestimates of TTS ranges.

4.9.2.5 In addition, the assumptions and limitations of underwater sound modelling (e.g. equal energy rule, reduced sound levels near the surface, conservative swim speeds, and use of impulsive sound thresholds at large ranges; see paragraph 4.9.2.39) also lead to an overestimation of ranges. Notably, Hastie *et al*. (2019) found that during pile driving there were range dependent changes in signal characteristics with received sound losing its impulsive characteristics at ranges of several kilometres, especially beyond 10 km. As such, TTS is not considered a useful predictor of the potential effects of underwater sound on marine mammals where ranges exceed more than c. 10 km and therefore, where this is the case (i.e. piling and UXO clearance), TTS is not included in the assessment of significance for injury. To support this reasoning a synthesis of the use of impulsive sound thresholds at large ranges is presented Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement. Ranges for TTS were, however, modelled for completeness for all potential sound-related impacts and are presented in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement.

4.9.2.6 For marine mammals, injury thresholds are based on both peak sound pressure levels (SPL_{pk}) (i.e. un-weighted) and marine mammal hearing-weighted cumulative sound exposure level (SEL_{cum}) as per the latest guidance (Southall *et al.*, 2019) (Table 4.18). The marine mammal hearing-weighted categories are based on the frequency characteristics (bandwidth and sound level) for each group within which acoustic signals can be perceived and therefore assumed to have potential auditory effects (Table 4.18).

4.9.2.7 To calculate distances using the SEL_{cum} metric the sound modelling assessment made a simplistic assumption that an animal would be exposed over the duration of the piling activity and that there would be no breaks in activity during this time. It was assumed that an animal would swim away from the sound source at the onset of activity at a constant rate and subsequently, conservative species-specific swim speeds were incorporated into the model (further detail in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement, summarised in Table 4.19.

Table 4.18: Criteria for assessing injury to marine mammals from impulsive and non-impulsive sound based on different hearing groups.

Hearing Group	Species	Parameter	Impulsive	Non-impulsive
Low Frequency (LF) cetaceans	Baleen whales	Peak, unweighted	219	-
		SEL, LF weighted	183	199
High Frequency (HF) cetaceans	Dolphins, toothed whales and beaked whales	Peak, unweighted	230	-
		SEL, HF weighted	185	198
Very High Frequency (VHF) cetaceans	True porpoises, sperm whales and some oceanic dolphins	Peak, unweighted	202	-
		SEL, VHF weighted	155	173

Hearing Group	Species	Parameter	Impulsive	Non-impulsive
Pinnipeds in water (PCW)	True seals	Peak, unweighted	218	-
		SEL, PCW weighted	185	201

Table 4.19: Assessment swim speeds of marine mammals that are likely to occur within the Irish Sea for the purpose of exposure modelling for Mona Offshore Wind Project.

Species	Hearing group	Swim speed (m/s)	Source reference
Harbour seal	PCW	1.8	Thompson *et al.* (2015)
Grey seal			
Harbour porpoise	VHF	1.5	Otani *et al.* (2000)
Bottlenose dolphin	HF	1.52	Bailey *et al.* (2010)
Short-beaked common dolphin			
Risso's dolphin			
Minke whale	LF	2.3	Boisseau *et al.* (2021)

Disturbance

4.9.2.8 Beyond the zone of injury, sound levels are such that auditory or physical injury is less likely to occur but can result in disturbance to marine mammal behaviour. A marine mammal's response to disturbance will depend on the individual and the context; previous experience and acclimatisation will affect whether an individual exhibits an aversive response to sound, particularly in an area with high sound levels related to human activities. The United States (US) NMFS (NMFS, 2005) define strong disturbance in all marine mammals as Level B harassment and for impulsive sound suggests a threshold of 160 dB re 1 µPa (root mean square (rms)). This threshold meets the criteria defined by JNCC (2010a) as a 'non-trivial' (i.e. significant) disturbance and is equivalent to the Southall *et al*., (2007) severity score of five or more on the behavioural response scale. Beyond this threshold the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al*., 2007)). The NMFS guidelines suggest a precautionary level of 140 dB re 1 µPa (rms) to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound (NMFS, 2005), although this is not considered likely to lead to a 'significant' disturbance response.

4.9.2.9 This NMFS (2005) guidance is based on thresholds above which strong or mild disturbance could occur and has been widely applied to UK offshore wind farm assessments. However, there have been further studies using empirical evidence from data gathered in the field which demonstrate a proportional disturbance response of animals corresponding to decreasing levels of received sound moving further away from the source.

4.9.2.10 Therefore both proportional response and evidence-based threshold approaches have been applied to the assessment and these are discussed in more detail below.

Proportional response ('dose response')

4.9.2.11 Empirical evidence from monitoring at offshore wind farms during construction suggests that pile driving is unlikely to lead to 100% avoidance of all individuals exposed, and that there will be a proportional decrease in avoidance at greater distances from the pile driving source (Brandt *et al*., 2011). This was demonstrated at Horns Rev Offshore Wind Farm, where 100% avoidance occurred in harbour porpoise at up to 4.8 km from the piles, whilst at greater distances (10 km plus) the proportion of animals displaced reduced to <50% (Brandt *et al*., 2011). Similarly, Graham *et al*. (2019) used empirical evidence collected during piling at the Beatrice Offshore Wind Farm (Moray Firth, Scotland) to demonstrate that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the sound source. Importantly, Graham *et al*. (2019) demonstrated that the response of harbour porpoise to piling diminished over the piling phase such that, for a given received sound level or at a given distance from the source, there were more detections of animals at the last piling location compared to the first piling location (Figure 4.5). Therefore 'dose response' curves can be more representative of actual animal response in the field compared to an approach of assuming that all animals within a given area respond in the same way.

4.9.2.12 Similarly, a telemetry study undertaken by Russell *et al*. (2016) investigating the behaviour of tagged harbour seal during pile driving at the Lincs Offshore Wind Farm in the Wash found that there was a proportional response at different received sound levels. Dividing the study area into a 5 km x 5 km grid, the authors modelled SEL_{ss} levels and matched these to corresponding densities of harbour seal in the same grids during non-piling versus piling periods to show change in usage. The study found that there was a significant decrease in usage (abundance) during piling at predicted received SEL levels of between 142 dB and 151 dB re 1 μPa^2s.

4.9.2.13 More recently, a study by Whyte *et al.* (2020) used tracking data from 24 harbour seal to estimate the potential effects of pile driving sounds on this species. Predicted cumulative sound exposure levels (SEL_{cum}) experienced by each seal were compared to different auditory weighting functions and thresholds for TTS and PTS. The study used predictions of seal density during pile driving made by Russell *et al*. (2016) compared to distance from the wind farm and predicted single-strike sound exposure levels (SEL_{ss}) by multiple approaches. Predicted seal density significantly decreased within 25 km or SEL_{ss} (averaged across depths and pile installations) above 145 dB re 1 μPa^2s. Predictions of seal density, and changes in seal density, during piling was given in Table V in Whyte *et al*. (2020), averaged across all water depths and piling events.

Application to assessment

4.9.2.14 A dose response curve derived from this study (Figure 4.6) was therefore applied to the seal assessment to determine the number of animals that may potentially respond behaviourally to received sound levels during piling. Unweighted sound exposure level single strike (SEL_{ss}) contours were plotted in 5 dB isopleths in decreasing increments from 180 dB to 120 dB re 1 μPa^2 using the highest modelled received sound level. Other studies have shown similar avoidance reactions for both grey seal and harbour seal to the same sound source (e.g. Gotz and Janik, 2010; Aarts *et al.* 2017), and therefore provides justification that harbour seal dose response curves could be used as a proxy for grey seal.

4.9.2.15 To adopt the most representative approach, the dose response contours were plotted in Geographical Information System (GIS) for all modelled locations. For each species the location taken forward for assessment was that which resulted in the greatest number of animals affected, thereby representing the maximum adverse scenario. For cetaceans (where an average density was used to estimate the number of animals) this was represented by the location with the largest modelled contours, whilst for seal species (where the number was derived from the at-sea density map (Carter *et al.,* 2022)) it was the modelled contour that coincided with higher density areas. The areas within each 5 dB isopleth were calculated from the spatial GIS map and a proportional expected response, derived from the dose response curve for each isopleth area, was used to calculate the number of animals potentially disturbed. The number of animals predicted to respond was based on species-specific densities as agreed with statutory consultees (Table 4.5). These numbers were subsequently summed across all isopleths to estimate the total number of animals disturbed during piling.

4.9.2.16 For harbour porpoise, as a representative approach, the dose-response curve was applied from the first location modelled as shown by Graham *et al*. (2017) where the probability of response approaches zero at c. 120 dB SEL_{SS}. In the absence of species-specific data for other cetacean species the same dose response curve was assumed to apply to all cetacean IEFs in this assessment (Figure 4.5), and represents a precautionary approach to assessment as other cetacean species are likely to be less sensitive than harbour porpoise to behavioural disturbance as noted in the literature (e.g. Tougaard *et al*., 2021).

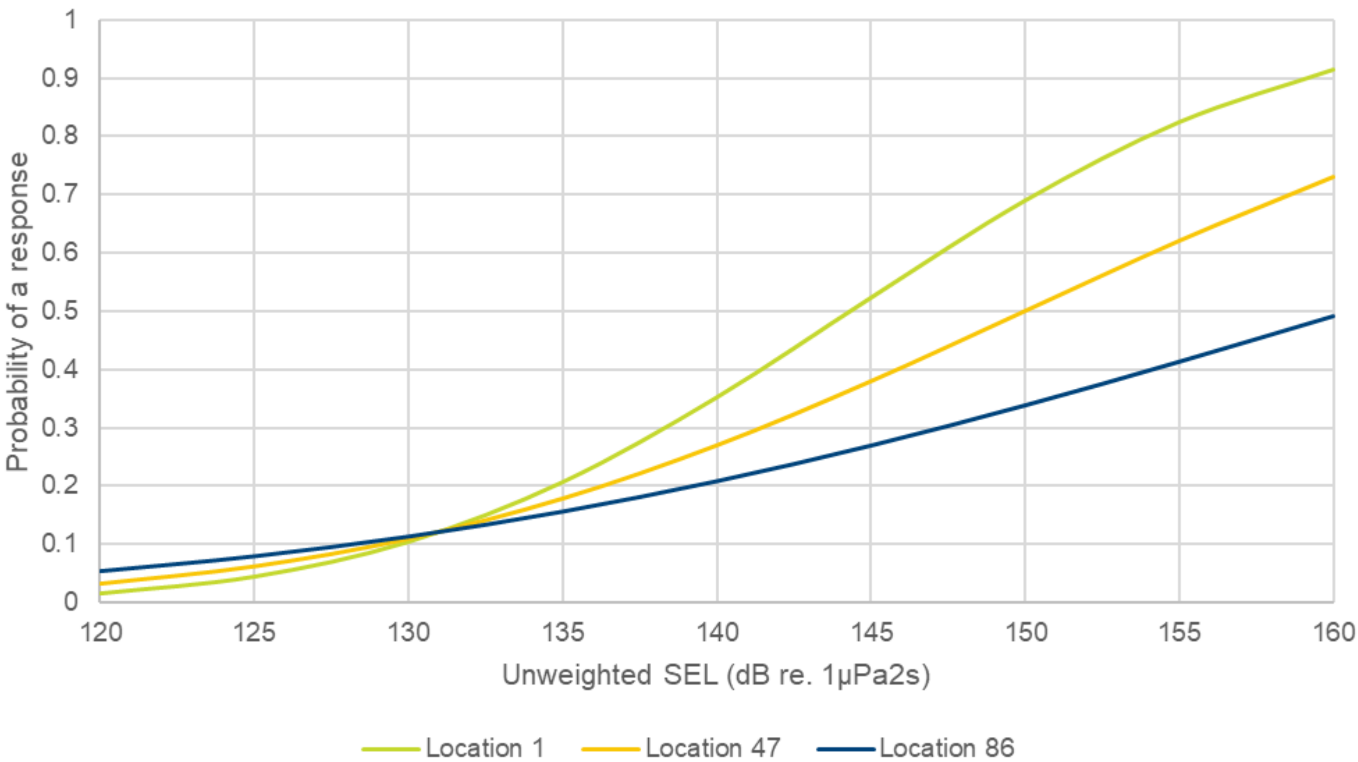


Figure 4.5: The probability of a harbour porpoise response (24 hr) in relation to the partial contribution of unweighted received single-pulse SEL for the first location piled (green line), the middle location (yellow line) and the final location piled (blue line). Reproduced from Graham *et al*. (2019).

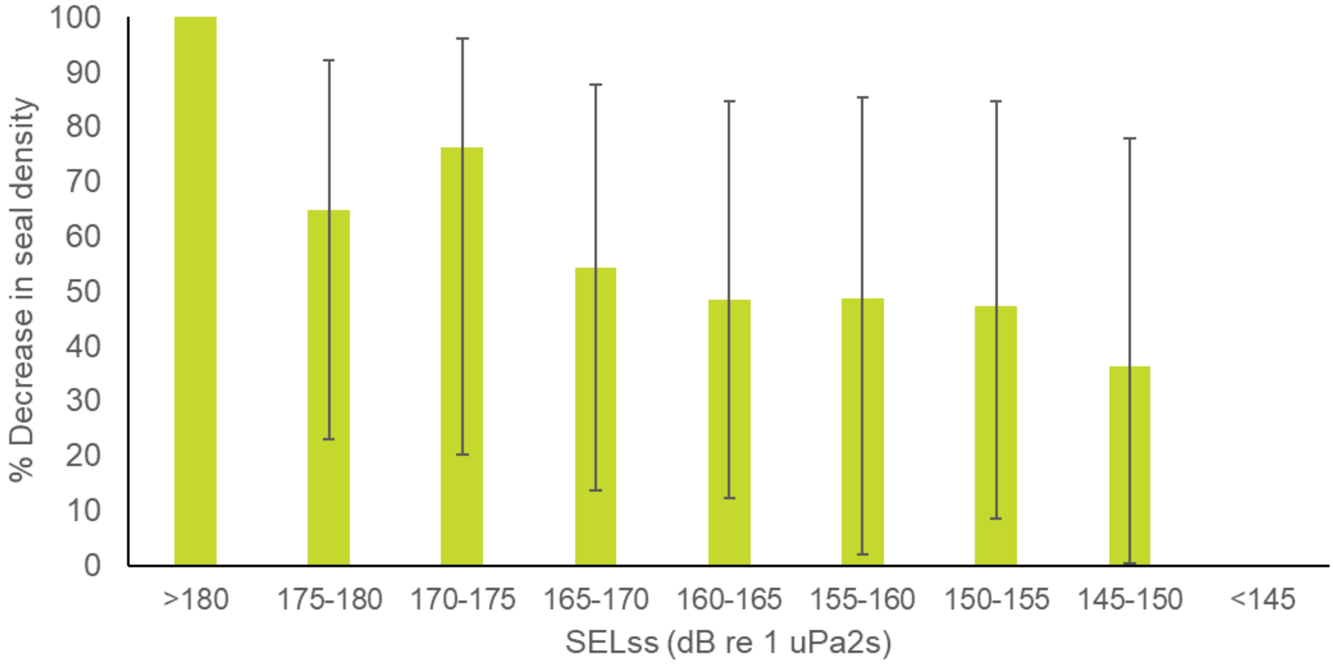


Figure 4.6: Predicted decrease in seal density as a function of estimated sound exposure level, error bars show 95% CI (from Whyte *et al.,* 2020).

4.9.2.17 For harbour seal and grey seal the most appropriate dose response curve was derived from the Whyte *et al*. (2020) study which has been recently applied to Awel y Môr Offshore Wind Farm, after consultation with NRW. It has been assumed that all seals are displaced at sound exposure levels above 180 dB re 1 μPa^{2}s. This is a conservative assumption since there was no data presented in the study at this level. Furthermore, it is important to note that the percentage decrease in response to 170 < 175 and 175<180 dB re 1 μPa^{2}s are slightly anomalous due to the small number of spatial cells included in the analyses for these categories (n = 2 and 3 respectively). The harbour seal curve has been applied to grey seal disturbance also, as no corresponding data for grey seal is available, and it is considered to be an appropriate proxy for grey seal given both species are within the same hearing group (PCW).

4.9.2.18 Dose response is an available approach to understanding the potential behavioural effects from piling and has been applied at other UK offshore wind farms (for example Awel y Môr (RWE, 2022), Seagreen (Seagreen Wind Energy Ltd, 2012) and Hornsea Project Three (Orsted, 2018). The application of a dose response curve allows for more realistic assumptions about animal response varying with sound exposure (which is supported by a growing number of studies e.g. Thompson *et al.* 2013b; Graham *et al*. 2017; Graham *et al*. 2019; Russell and Hastie 2017; Whyte *et al.* 2020). Dose response approaches are derived from site-specific studies, and account for the probability of behavioural response to varying sound levels, allowing for a more representative assessment of realistic animal responses (compared to a fixed threshold for example). As discussed in paragraph 4.9.2.16, data on dose response in other cetaceans (e.g. bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale) is lacking, and therefore limits the reliability of this method for the different hearing ranges and sensitivities between species. However, given harbour porpoise is VHF and likely to be more sensitive to underwater sound than other key species, applying a dose response curve from a more sensitive species to a less sensitive species provides a precautionary approach to assessment (likely to result in overestimates of disturbance).

4.9.2.19 There is, however, a caveat to the application of dose response curves developed from a single specific scenario (i.e. with project-specific piling metric) in a single geographic region (with characterising substrate and bathymetry) and applied more widely across projects with different piling characteristics and in different geographic locations. Distance from an impulsive sound source is a strong predictor of a behavioural response. Sound propagation can result in changes in waveform, whereby waveform elongates with distance (which reflects the current understanding of the transition from impulsive to continuous sound). Higher frequencies of the sound are attenuated more due to molecular absorption, whilst very low frequencies cannot propagate in shallow water. Therefore characteristics of the sound far from the source are very different to the characteristics of the sound at source, and therefore likely to affect how a marine mammal perceives and reacts to sound (rather than just using sound level alone).

4.9.2.20 The harbour porpoise dose response curve was derived from measurements taken at the Beatrice offshore wind farm and was based on piling at a much smaller hammer energies (average of ~1,000 kJ; Beatrice Offshore Wind Farm, 2018) with modelled effect ranges (to 120 dB SEL_{ss}) not exceeding 60 km. In contrast, the maximum hammer energy modelled for Mona was either 3,000 kJ or 4,400 kJ with the furthest modelled effect range (to 120 dB SEL_{ss}) out approximately 145 km for both hammer energies. Additionally, the distance at which a 50% response was measured for the Beatrice offshore wind farm (144.3 dB re 1 µPa^{2}s unweighted SEL_{ss} in the 24-hour period after piling) was 7.4 km at the first location piled (Graham *et al*., 2019) whilst for Mona the 50% response corresponded to ranges of 27 to 42 km (depending on the transect).

4.9.2.21 Therefore, whilst the assessment applies the dose response as the best available estimate of proportional responses, it is considered to be highly conservative due to the propagation distances predicted for the Mona Offshore Wind Project which for a given sound level will not be equivalent in characteristics to those found at the Beatrice offshore wind farm. This is because the frequency content (as well as impulsivity, i.e. time based characteristics) will have a bearing on the response. At these much larger ranges the original impulse has dispersed to such an extent that the different frequencies of sound all arrive at different times and the pulse is spread out and is more akin to continuous sound. Thus, most of the sound within the peak hearing sensitivity of harbour porpoise will have dissipated, leaving primarily low frequency sound which they are less sensitive to, and may not even be able to hear.

4.9.2.22 To provide further context in respect of dose response over large ranges the dose response quantitative assessment was presented in a risk-based framework. A staged approach was used to derive the number of disturbed animals.

4.9.2.23 First, the probability of response was calculated for SEL_{ss} using the formula:

$$\boldsymbol{P_{resp}(SEL_{ss}) = \frac{1}{1+e^{-(a+B\times SEL_{ss})}}} \quad ,$$

where a = −21.3947 and B = 0.1482 for harbour porpoise;

and a = −43.5 and B = 0.3 for grey seal.

4.9.2.24 This formula for probability of disturbance is taken from Framework for Assessing Ecological and Cumulative Effects (Kader Ecologie en Cumulatie) (KEC) 4.0 (Heinis *et al.* 2022) and is based upon dose response relationship (rather than discrete thresholds as in previous KECs), allowing differences in the probability of disturbance of animals that are close to piling location compared to those further away to be accounted for. For harbour porpoise, this dose response relationship is based upon piling activities in Netherlands, Germany and Scotland (Geelhoed *et al.* 2018, Brandt *et al.* 2018 and Graham *et al.* 2019) and for seals is based upon Kastelein *et al.* (2011), Russell *et al.* (2016), Whyte *et al.* (2020) and Aarts *et al.* (2018) (and assumes from these studies responses of grey seals and harbour seals are comparable). The formula in paragraph 4.9.2.23 is used to calculate a probability of disturbance map to give an 'effective disturbance area', and then the probability of disturbance can be multiplied by the marine mammal density for each cell to give number of animals disturbed in that cell. For harbour porpoise for example, a mean density from the Welsh Marine Atlas was used (0.27773 animals per km^2) and for grey seals, densities for each cell were taken from the Carter *et al.* (2022) maps. The probability of response maps demonstrate that the likelihood of disturbance on marine mammals reduces considerably as distance from the pile increases.

Fixed threshold approach

4.9.2.25 The US NMFS (NMFS, 2005) define strong disturbance in all marine mammals as Level B harassment and for impulsive sound suggests a threshold of 160 dB re 1 µPa (root mean square (rms)). This threshold meets the criteria defined by JNCC (2010a) as a 'non-trivial' (i.e. significant) disturbance and is equivalent to the Southall *et al*., (2007) severity score of five or more on the behavioural response scale. Beyond this threshold the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al*., 2007)). The NMFS guidelines suggest a precautionary level of 140 dB re 1 µPa (rms) to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound (NMFS, 2005), although this is not considered likely to lead to a 'significant' disturbance response.

4.9.2.26 For non-impulsive sound sources (such as underwater sound from vessels, sonar, drilling, borehole etc) NMFS provides a precautionary threshold of 120 dB re 1 µPa (rms) for disturbance, with no distinction made between 'strong' and 'mild' in this case (NMFS, 2005).

Application to assessment

4.9.2.27 An unweighted sound threshold value of 143 dB re 1µPa^2s single strike sound exposure level (SEL_{ss}) (Brandt *et al.* 2018; Heinis *et al.* 2019) for harbour porpoise only was also recommended in NRW's position statement on assessing behavioural disturbance of harbour porpoise from underwater sound (NRW, 2023). In particular, the fixed sound threshold is relevant to the HRA as area-based approach and in this respect is similar to the Natural England and JNCC guidance on the use of EDRs which have also been applied to the HRA in reference to harbour porpoise SACs only.

4.9.2.28 The unweighted sound value threshold of 143 dB re 1µPa^2s is the modelled average of six different studies of full-scale pile driving operations and thereby represents a large amount of empirical data (Tougaard *et al.* 2021) (Table 4.20). Brandt *et al.* (2018) performed a combined statistical analysis of passive acoustic monitoring data of harbour porpoise from construction of seven different offshore wind farms in the German Bight. Acoustic recordings of the pile driving sound was utilised alongside porpoise monitoring to derive a threshold for porpoise reactions to the sound from pile driving. Declines were found at sound levels exceeding an unweighted single pulse SEL of 143 dB re 1 µPa^2s and up to 17 km from piling. This means that harbour porpoises may react with avoidance only when exposure exceeds a threshold value of

143 dB re 1 µPa²s (Brandt *et al.,* 2018) (or a weighted threshold for VHF of 103 dB re. 1µPa calculated as root mean squared level over 125 milliseconds (Tougaard *et al.,* 2021)).

Table 4.20: Summary of VHF-weighted thresholds for behavioural responses to sound from pile driving derived from six different studies (adapted from Tougaard, 2021).

[1]Note that the difference between a VHF-weighted SPL_{rms} and an unweighted SEL is approximately 40 dB.

Threshold[1]	Study	Description
100 -115 dB re 1µPa	Dähne *et al.* (2013)	Based on reaction distance between 10-25 km at Alpha Ventus offshore wind farm
95 -101 dB re 1µPa	Kastelein *et al.* (2013)	Playback of underwater sound from pile driving in captivity
95 dB re 1µPa	Tougaard *et al.* (2015)	Generalised threshold based on data from pile driving and ADDs
103 dB re 1µPa	Brandt *et al.* (2018)	Modelled threshold based on six offshore wind farms in the German Bight
110 dB re 1µPa	Graham *et al.* (2019)	Audiogram-weighted threshold from pile driving at Beatrice offshore wind farm
< 100 dB re 1µPa	Kastelein *et al.* (2021)	Playback of low-pass filtered underwater sound from pile driving in captivity

4.9.2.29 The results above and derived threshold presented by Tougaard (2021) was reported for harbour porpoise and there are limited studies to support the derivation of similar thresholds for other marine mammal species. For minke whales, for example, based on limited evidence from sonar studies (Kvadsheim *et al.,* 2017, Sivle *et al.,* 2015, Tougaard *et al.,* 2021) evidence suggests that response thresholds are higher than for harbour porpoise (by 40-50 dB) suggesting lower sensitivity to underwater sound. However, given that minke whales are thought to have better hearing at lower frequencies the reaction distances may be similar (Tougaard *et al.,* 2021). This is also the case for seal species, where a higher threshold combined with greater sensitivity at low frequencies may lead to similar response distances to harbour porpoise (Tougaard *et al.* 2021). Given the paucity of information for species other than harbour porpoise, the NMFS (2005) threshold was considered to be more appropriate (with the emphasis on the 160 dB re 1µPa SPL_{rms} strong disturbance threshold) and was agreed with the marine mammal EWG.

Summary of criteria for assessing behavioural disturbance

4.9.2.30 This assessment adopted the dose-response approach for assessing disturbance to marine mammal species from piling and follows the published advice from NRW (NRW, 2023). In their S42 response, NRW also advised the application of a fixed sound threshold value to inform area-based assessments as required for the HRA as per their guidance (NRW, 2023). Thus, the unweighted 143 dB re 1 µPa²s threshold has been presented alongside the dose-response approach in this EIA to be carried forward to the HRA. This threshold was developed for harbour porpoise but has been applied across other marine mammal species as it was considered to be sufficiently precautionary (Table 4.21).

4.9.2.31 For underwater sound sources other than piling the assessment adopted the NMFS (2005) published guidance on impulsive and non-impulsive sound sources (Table 4.21). In the absence of published thresholds on potential behavioural effects of underwater sound arising from UXO clearance, the assessment adopted the use of the TTS threshold as a proxy for a disturbance as this is considered to represent a ‘fleeing’ animal (i.e. behaviourally displaced) (Table 4.21). Further detail is provided under each impact header in the following sections.

Table 4.21: Summary of criteria used in assessment of behavioural disturbance for different marine mammal species.

Sound source	Species	Approach	Source
Pile driving	Harbour porpoise	Dose-response (harbour porpoise) Unweighted threshold 143 dB re 1 µPa²s SEL_{ss}	Graham *et al.* (2019) Tougaard *et al*. (2021)
Pile driving	Minke whale, bottlenose dolphin, Risso’s dolphin, short-beaked common dolphin.	Dose-response (harbour porpoise) Unweighted threshold 160 dB re 1 µPa (rms) (strong disturbance) Unweighted threshold of 140 dB re 1 µPa (rms) (mild disturbance)	Graham *et al.* (2019) NMFS (2005)
Pile driving	Grey seal, harbour seal	Dose-response (harbour seal) Unweighted threshold 160 dB re 1 µPa (rms) (strong disturbance) Unweighted threshold of 140 dB re 1 µPa (rms) (mild disturbance)	Whyte *et al*, (2020) NMFS (2005)
UXO	All marine mammal species	Unweighted SPL_{pk} and hearing weighted SEL_{cum} for TTS as a proxy for disturbance (‘fleeing’ response).	Southall *et al.* (2019)
Vessel sound	All marine mammal species	Unweighted threshold of 120 dB re 1 µPa (rms) dB re 1 µPa (rms) (strong disturbance)	NMFS (2005)
Site-investigation surveys (impulsive)	All marine mammals species	Unweighted threshold of 160 dB re 1 µPa (rms) (strong disturbance) Unweighted threshold of 140 dB re 1 µPa (rms) (mild disturbance)	NMFS (2005)
Site-investigation surveys (non-impulsive)	All marine mammals species	Unweighted threshold of 120 dB re 1 µPa (rms)	NMFS (2005)

Importance of context

4.9.2.32 By applying these criteria the magnitude of effect can be quantified with respect to the spatial extent of disturbance, and subsequently the number of animals potentially disturbed based on available density information. There is, however, a note of caution associated with this approach. Southall *et al*. (2021) highlight that the challenges for developing a comprehensive set of empirically derived criteria for such a diverse group of animals are significant. Extensive data gaps have been identified (e.g. measurements of the potential effects of elevated sound on baleen whales) which mean that extrapolation from other species has been necessary. Sounds that disturb one species may, however, be irrelevant or inaudible to other species since there are broad differences in hearing across the frequency spectrum for different marine mammal hearing groups. Variance in responses even within a species are well documented to be context and sound-type specific (Ellison *et al*., 2012). In addition, the potential interacting and additive effects of multiple stressors (e.g. reduction in prey, sound and disturbance, contamination, etc.) is likely to influence the severity of responses (Lacy *et al*., 2017).

4.9.2.33 For these reasons, neither a threshold approach nor a dose-response function was provided in the original guidance (Southall *et al*., 2007) and subsequently the recent recommendations by Southall *et al*. (2021) also steer away from a single overarching approach. Instead, Southall *et al*. (2021) propose a framework for developing probabilistic response functions for future studies. The paper suggests different contexts for characterising marine mammal responses for both free-ranging and captive animals with distinctions made by sound sources (i.e. active sonar, seismic surveys, continuous/industrial sound and pile driving). Three parallel categories have been proposed within which a severity score from an acute (discrete) exposure can be allocated:

- Survival – defence, resting, social interactions and navigation
- Reproduction – mating and parenting behaviours
- Foraging – search, pursuit, capture and consumption.

4.9.2.34 Even where studies have been able to assign responses to these categories based on acute exposure there is still limited understanding of how longer term (chronic) exposure could translate into potential population-level effects. The potential for behavioural disturbance to lead to population consequences has been considered for this assessment using the iPCoD approach and is described in detail below (paragraph 4.9.3.13). To explore potential population-level effects, Southall *et al*. (2021) reported observations from long term whale watching studies and suggested that there were differences in the ability of marine mammals to compensate for long term disturbance which related to their breeding strategy. For example, mysticetes are ‘capital breeders’ – accumulating energy in their feeding grounds and transferring this to calves in their breeding ground, whilst other species such as harbour porpoise, bottlenose dolphin and harbour seal are ‘income breeders’ – they balance the costs of pregnancy and lactation by increased food intake, rather than depending on fat stores. Reproductive strategy can impact the energetic consequences of disturbance, and cause variation in an individual’s vulnerability to disturbance based on both its reproductive strategy and stage (Harwood *et al*., 2020). Furthermore, their ability to compensate for chronic exposure to sound will also depend on a range of ecological factors.

4.9.2.35 Such factors include the relative importance of the disturbed area and prey availability within their wider home range, the distance to and quality of other suitable sites, the relative risk of predation or competition in other areas, individual exposure history, and the presence of concurrent disturbances in other areas of their range (Gill *et al.,* 2001). Animals may be able to compensate for short-term disturbances by feeding in other areas, for example, which would reduce the likelihood of longer-term population consequences. Booth (2020) highlighted that foraging behaviour (intensity) and diet (largely target prey size) in harbour porpoise informs vulnerability to disturbance, and if animals can find suitable high energy-density prey they may be capable of recovering from some lost foraging opportunities due to disturbance. Christiansen and Lusseau (2015) studied the effect of whale watching on minke whale in Faxafoi Bay, Iceland and found no significant long-term effects on vital rates, although years with low sandeel density led to increased exposure to whale watching as whales were forced to move into disturbed areas to forage. Odontocetes, however, may be more vulnerable to whale watching compared to mysticetes due to their more localised, and often, coastal home ranges. Bejder *et al*. (2006) documented a decrease in local abundance of bottlenose dolphin which was associated with an increase in whale watching in a tourist area compared to a control area. If, however, there is no suitable habitat nearby animals may be forced to remain in an area despite the disturbance, regardless of whether or not it could affect survival or reproductive success (Gill *et al.*, 2001).

4.9.2.36 The marine mammal species considered in this assessment vary biologically and therefore have different ecological requirements that may affect their sensitivity to disturbance. This point is illustrated by the differences between the two seal species identified as key biological receptors in the baseline. Grey seal are capital breeders and often make long foraging trips from haul-outs. In contrast, harbour seal are income breeders (feeding throughout the pupping season) and make shorter foraging trips from haul-outs.

4.9.2.37 In summary, Southall *et al.* (2021) clearly highlight the caveats associated with simple, one-size-fits-all, threshold approaches that could lead to errors in disturbance assessments. Recognising this inherent uncertainty in the quantification of potential effects the assessment has adopted a precautionary approach at all stages of assessment including:

- Conservative assumptions in the marine mammal baseline (e.g. use of seasonal density peaks for harbour porpoise and grey seal, offshore and inshore densities for pinniped species)
- Conservative assumptions in the MDS for the project parameters (Table 4.16)
- Conservative assumptions in the underwater sound modelling (see summary below) (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

4.9.2.38 Relevant assumptions have been described throughout this chapter and demonstrate that such layering of conservatism is likely to lead to a very precautionary assessment.

Conservatism in the underwater sound modelling approach

4.9.2.39 A number of conservative assumptions were adopted in the underwater sound model that resulted in a precautionary assessment (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). These are summarised here:

- The modelling assumed that the maximum hammer energy would be reached and maintained at all locations, whereas this is unlikely to be the case based on examples from other offshore wind farms, e.g. Beatrice Offshore Wind Farm, where the mean actual hammer energy averages were considerably lower than the maximum assessed in the Environmental Statement and only six out of 86 asset locations reached maximum hammer energy (Beatrice, 2018)
- The soft start procedure simulated does not allow for short pauses in piling (e.g. for realignment) and therefore the modelled SEL_{cum} is likely to be an overestimate since, in reality, these pauses will reduce the sound exposure that animals experience whilst moving away.
- The modelling assessment assumed that animals swim directly away from the sound source at constant and conservative average speeds based on published values. Whilst this buffers the uncertainty with respect to the directionality of their movement, nonetheless it may lead to overestimates of the potential range of effect as animals are likely to exceed these speeds. For example, Otani *et al.* (2000) note that horizontal speed for harbour porpoise can be significantly faster than vertical speed and cite a maximum speed of 4.3 m/s.

Similarly, Leatherwood *et al.* (1988) reported harbour porpoise swim speeds of approximately 6.2 m/s. For minke whale speeds of up to 4.2 m/s have been reported during acoustic deterrent exposure experiments on free ranging animals (McGarry *et al.*, 2017).

- The use of the SEL_{cum} metric is described as an equal energy rule where exposures of equal energy are assumed to produce the same sound-induced threshold shift regardless of how the energy is distributed over time. This means that for intermittent sound, such as piling, the equal-energy rule overestimates the potential effects since the quiet periods between sound exposures will allow some recovery of hearing compared to continuous sound.
- Modelling of concurrent piling assumes piling will occur at exactly the same time and strike piles simultaneously, whereas in reality this is highly unlikely and could lead to overestimates in the injury and/or disturbance ranges.
- Modelling of consecutive piling over 24 hours assumes no pause between piling events moving from one pile to the next which is considered to be highly precautionary and likely to lead to overestimates as, in practice, there would be a period of time (hours) between each piling event as the equipment is moved to a different location (i.e. MDS is for just one foundation per 24 hours allowing for a pause in piling between foundations).
- Due to a combination of factors (e.g. dispersion of the waveform, multiple reflections from sea surface and seafloor, and molecular absorption of high frequency energy), impulsive sounds are likely to transition into non-impulsive sounds at distance from the sound source with empirical evidence suggesting such shifts in impulsivity could occur markedly within 10 km from the sound source (Hastie *et al.,* 2019) (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). Since the precise range at which this transition occurs is unknown (not least because the transition also depends on the response of the marine mammals' ear) sound models still adopt the impulsive thresholds at all ranges and this is likely to lead to an overly precautionary estimate of injury ranges at larger distances (tens of kilometres) from the sound source. The transition cross-over point from impulsive to non-impulsive sound is discussed in detail in paragraphs 1.5.5.26 to 1.5.5.29 of annex 3.1: Underwater sound technical report of the Environmental Statement and defining this transition range is an active area of research and scientific debate, with a number of other potential methods being investigated (see paragraph 1.5.5.28 of Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

4.9.2.40 These layers of conservatism highlight that both PTS and TTS onset ranges predicted using the SEL_{cum} threshold are likely to lead to overestimates in the ranges and therefore should be interpreted with caution.

4.9.3 Injury and disturbance from elevated underwater sound during piling

4.9.3.1 During the construction phase sound emissions from the piling of foundations may lead to auditory injury and disturbance of marine mammals. The MDS is represented by two scenarios (temporal and spatial) and is summarised in Table 4.16.

Summary of piling scenarios

4.9.3.2 Pile driving during the construction phase of the Mona Offshore Wind Project has the potential to result in elevated levels of underwater sound that are detectable by marine mammals above background levels and could result in auditory injury and/or potential behavioural effects on marine mammal IEFs. A detailed underwater sound modelling assessment was carried out to investigate the potential for such effects to occur, using the latest assessment criteria (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

4.9.3.3 For piling, with respect to the SPL_{pk} metric, the soft start initiation is the most relevant period, as this is when animals may potentially experience injury from underwater sound emitted by the initial strike of the hammer, after which point it is assumed that they will move away from the sound source. However, SPL_{pk} at full hammer energy was also modelled to provide additional context (particularly given the limitations of the assessment for SEL_{cum}; see paragraph 4.9.2.40).

4.9.3.4 The SEL_{cum} metric was modelled over a single installation sequence for pin piles. Following consultation, the SEL_{cum} metric was also applied to a scenario of consecutive piling of single piles over 24 hours (i.e. assuming piles are installed with no break in between and is therefore considered to be highly precautionary).

4.9.3.5 The scenarios modelled were based on the absolute maximum hammer energies (of 4,400 kJ or 3,000 kJ, see Table 4.16), for the longest possible duration, noting that piling is unlikely to reach and maintain the absolute maximum hammer energy of at all locations. (Table 4.16). The piling campaign was developed with the lowest achievable hammer energy, slow initiation phase, followed by a soft start and ramp up to reduce the potential likelihood of auditory injury (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

4.9.3.6 The assessment of potential effects on marine mammals from piling considered a maximum spatial and maximum temporal scenario for pin pile foundations (Table 4.16). Maximum spatial scenarios assume concurrent piling of pin piles (leading to the largest area of effect at any one time) whilst maximum temporal scenarios are for single piling (leading to the greatest number of days of piling).

4.9.3.7 For the concurrent piling scenarios, two separate assumptions were identified to determine the MDS, as follows:

- Minimum separation distance of 1.4 km (the minimum distance between foundations) as a maximum adverse scenario for potential injury
- Separation distance of up to 15 km as a maximum adverse scenario for potential disturbance.

4.9.3.8 Underwater sound modelling modelled concurrent piling at:

- Concurrent piling at 3,000 kJ for two wind turbines jacket foundations only (noting that the project has committed to reducing potential spatial effects by not piling concurrently where a 4,400 kJ hammer may be required, secured within the Outline MMMP (Document Reference J21).

4.9.3.9 Locations selected for the concurrent scenarios were different depending on species since the assessment adopted a precautionary approach selecting those locations which were likely to overlap with sensitive areas for a given species (e.g. areas of high density). As detailed in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement, these modelling points are as follows:

- Southwest boundary to assess potential impact on the North Anglesey Marine harbour porpoise SAC to the west (as well as herring spawning off east coast of Isle of Man) and grey seals at Calf of Man
- Southeast boundary of the Mona Array Area to allow for assessment of potential impact on the seals at Hilbre Point
- North/northwest boundary of the Mona Array Area to capture grey seals at Calf of Man (and herring spawning off east coast of Isle of Man).

4.9.3.10 Concurrent piling locations for each of those three locations was then chosen based upon a 15 km separation distance (representative of the maximum adverse scenario in terms of separation distance and bathymetry) (further details given in Volume 5, Annex 3.1: Underwater Sound Technical Report of the Environmental Statement). As described previously modelling of cumulative exposure assumed installation of single piles (by each vessel) with breaks between installation and also consecutive piling over 24 hours assuming no break in piling (although noting the latter is very precautionary).

4.9.3.11 For the maximum temporal scenario the assessment focussed on the longest duration of piling and the greatest number of days over which piling could occur. The longest duration of piling for wind turbines or OSPs is 4.5 hours per pile and for gravity base foundations is 4 hours per pile. Piling would occur over a maximum of 113.5 days (rounded up to 114) using a single vessel (with the assumption of one foundation installed per 24 hours) (64 days for wind turbines, 12 days for OSPs and 38 days for GBFs).

4.9.3.12 A summary of the scenarios assessed is provided in Table 4.22.

Table 4.22: Summary of piling scenarios assessed for marine mammals at wind turbine and the OSP foundations for single piling and concurrent piling (duration of consecutive piling over 24 hrs also modelled for single piling).

[1]Only where hammer energy is 3,000 kJ and for wind turbine jacket foundations (not GBFs)

Structure	Number of piled locations	Number of legs	Piles per leg	Number of piles	Maximum hammer energy (kJ)	Max piles per day	Number of vessels	Max piling days
Maximum temporal scenario (no concurrent piling)								
Wind turbine (jacket foundation)	48	4	1	192	3,000	4	1	48.0
Wind turbine (jacket foundation)	16	4	1	64	4,400	4	1	16.0
OSP	4	4	3	48	4,400	4	1	12.0
Wind turbine (GBF)	10	1	15	150	3,000	4	1	37.5
Total	**78**	**-**	**-**	**454**	**-**	**-**	**-**	**113.5**
Maximum spatial scenario (partial concurrent piling at subset of wind turbines[1])								
Wind turbine (jacket foundation)	48	4	1	192	3,000	4	2	24.0
Wind turbine (jacket foundation)	16	4	1	64	4,400	4	1	16.0
OSP	4	4	3	48	4,400	4	1	12.0
Wind turbine (GBF)	10	1	15	150	3,000	4	1	37.5
Total	**78**	**-**	**-**	**454**	**-**	**-**	**-**	**89.5**

Summary of interim population consequences of disturbance (iPCoD) modelling

4.9.3.13 To understand the potential for long-term population level effects on marine mammal species resulting from piling activities only at the Mona Offshore Wind Project population modelling using the iPCoD model was undertaken.

4.9.3.14 There is limited understanding of how behavioural disturbance and auditory injury affect survival and reproduction in individual marine mammals and consequently how this translates into potential effects at the population level. The iPCoD model was developed using a process of expert elicitation to determine how physiological and behavioural changes affect individual vital rates (i.e. the components of individual fitness that affect the probability of survival, production of offspring, growth rate and offspring survival).

4.9.3.15 Expert elicitation is a widely accepted process in conservation science whereby the opinions of many experts are combined when there is an urgent need for decisions to be made but a lack of empirical data with which to inform them. In the case of iPCoD, the marine mammal experts were asked for their opinion on how changes in hearing resulting from PTS and behavioural disturbance (equivalent to a score of 5* or higher on the 'behavioural severity scale' described by Southall *et al*. (2007)) associated with offshore renewable energy developments affect calf and juvenile survival and the probability of giving birth (Harwood *et al*., 2014). Experts were asked to estimate values for two parameters which determine the shape of the relationships between the number of days of disturbance experienced by an individual and its vital rates, thus providing parameter values for functions that form part of the iPCoD models (Harwood *et al*., 2014). The relationship between disturbance and survival/reproduction assumes that individual animals would have a limited ability to alter their activity budget to compensate for a reduction in e.g. time spent feeding (Houston *et al*., 2012; King *et al*., 2015). The individual's ability to provision/care for young, evade predation or resist disease would likely be affected, and it is expected that any potential effects would be reflected in changes to vital rates. It is important to note, however, that this relationship is highly simplified (Harwood *et al*., 2014), and an individual's response to disturbance will depend on factors including the context of the disturbance, the individual's existing condition and its exposure history (Ellison *et al*. 2011). The iPCoD framework applies simulated changes in vital rates to infer the number of animals that may be affected by disturbance as a means to iteratively project the size of the population.

4.9.3.16 The iPCoD model simulates the mean population difference over time for an impacted versus an unimpacted population to provide comparison of the type of changes that could occur resulting from natural environmental variation, demographic stochasticity and human-induced disturbance. It can be assumed that disturbance occurs only on the day (24 hours) that piling takes place (Graham *et al*., 2019; Brandt *et al*., 2011). However, residual disturbance has conservatively been set at one day, meaning that the model assumes that disturbance occurs on the day of piling and persists for a period of 24 hours after piling has ceased (Appendix A). The results are summarised in relation to the forecasted population size over time with forecasts made at certain timepoints (e.g. two, six, 13, 19 and 25 years) after piling commences. In addition, the model calculates the median ratio of the un-impacted to the impacted population size at these timepoints[2]. A caveat of the iPCoD framework, however, is that the models do not account for density dependence and therefore the forecasts may be unrealistic as they assume that vital rates in the population will not alter as a result of density-dependent factors (e.g. competition).

4.9.3.17 Whilst there are many limitations to expert elicitation-based iPCoD modelling, this approach was requested by statutory consultees as part of the offshore EIA Scoping process as it represents the best available approach for the species considered in this assessment at this time (Table 4.5). Alternative approaches to assessing the iPCoD include (i) matrix models, which allow for an assessment of a population, with and without disturbance (e.g. Caswell *et al*., 2001) and (ii) data-driven, state-dependent behavioural approaches in lieu of expert elicitation (e.g. McHuron *et al.,* 2017). Nonetheless, uncertainties in the iPCoD framework have been offset as far as possible by adopting a precautionary approach at all stages of the assessment from the maximum design parameters in the project envelope, conservatism in the underwater sound model and adoption of precautionary estimates to represent the densities of key

[2] If the median of the ratio of impacted to un-impacted population size equals one, this represents a situation where the median impacted population size is no different to the median un-impacted population size. If the median of the ratio of impacted to un-impacted population size is less than one, this represents a situation where the median impacted population size is smaller than the median un-impacted population size.

species. Thus, the result from the iPCoD modelling undertaken for the Mona Offshore Wind Project is considered to be inherently cautious and should be interpreted as such.

4.9.3.18 Population modelling using iPCoD was carried out for the following species (agreed through the EWG meetings) due to the potential number of animals affected relative to the relevant MU populations:

- Harbour porpoise
- Bottlenose dolphin
- Minke whale
- Grey seal.

4.9.3.19 Bottlenose dolphin models incorporated two fertility rates to build conservatism into the simulations and to capture a range of population trajectories. These were based upon consultation with NRW (NRW *pers. Comm*. 21.10.22) and estimates developed by Arso Civil *et al*. (2017), and were set at 0.30 and 0.22, respectively.

4.9.3.20 Grey seal models also incorporated a dual approach by using two baseline populations, derived from monitoring programmes in the Irish Sea (n = 12,910), alongside the population estimate for OSPAR Region III interim MU (n = 60,780). This was particularly relevant for the cumulative effects assessment (section 4.11) given the spatial coverage of OSPAR Region III population in the context of cumulative projects. Full details of these populations are presented in Appendix A.

4.9.3.21 Harbour seal was not included due to the very small number of animals potentially behaviourally disturbed and therefore very low likelihood of a population level effect occurring for this species.

4.9.3.22 The expert elicitation required to inform the transfer functions that are integral to the iPCoD modelling process has not yet considered short-beaked common dolphin or Risso's dolphin. As a consequence, the iPCoD framework does not currently facilitate population modelling for these two species, and they have therefore not been included.

Construction phase

Magnitude of impact

Auditory Injury

4.9.3.23 The maximum spatial effect was predicted for pin piles with a hammer energy of 4,400 kJ. At hammer initiation (first strike) instantaneous injury leading to PTS, based on SPL_{pk}, could occur out to a maximum range of 136 m across all species, with the maximum range predicted for harbour porpoise (Table 4.23). Using the same metric the maximum range of injury was predicted at 662 m at full hammer (although this assumes animals do not move away at the start of piling, which is unlikely).

4.9.3.24 Potential spatial effects were smaller (for the full hammer energy only) for the 3,000 kJ pin piles with a maximum range across all species of 136 m for instantaneous injury (at hammer initiation) and 525 m for full hammer energy (Table 4.23).

4.9.3.25 Considering cumulative exposure using the SEL_{cum} metric the risk of PTS was predicted to occur out to a maximum range of 7,420 m, as predicted for minke whale assuming single piling at a hammer energy of 4,400 kJ (Table 4.24). Modelling of consecutive piling predicted a slightly larger injury range (7,520 m) although noting that this is considered unrealistic as it assumes no breaks in piling.

4.9.3.26 The maximum temporal effect was predicted as the longest duration of piling. Whilst the effect of PTS is considered to result in permanent injury to animals, the risk of animals being exposed to sound levels leading to auditory injury would occur during piling only. As shown in Table 4.22 piling will be intermittent over a two-year piling phase and will occur up to a maximum of 114 days.

4.9.3.27 Tertiary mitigation in the form of a MMMP (Document Reference J16) (as an annex of the Underwater sound management strategy (Document Reference J21), discussed in paragraph 4.9.3.167 and 4.9.3.168) will be implemented to reduce the likelihood of PTS. Such mitigation will include deployment of an ADD as recommended in the JNCC guidelines (2010). The efficacy of ADD as a mitigation tool was subsequently undertaken as part of this assessment with respect to both SPL_{pk} and SEL_{cum} ranges applying a 30-minute deployment time prior to hammer initiation (see paragraph 4.9.3.29 *et seq.*). The exact duration of ADD activation will, however, be discussed and agreed with consultees post-consent and in respect of any refinements in the project design envelope that may be available at a later stage and included within the draft MMMP (Document Reference J16).

4.9.3.28 The assessment of magnitude with respect to auditory injury is presented below (paragraph 4.9.3.35) on a species-specific basis, where the maximum adverse scenario is identified for each species.

Table 4.23: Summary of SPL_{pk} PTS injury ranges and areas of effect for marine mammals for single pin pile installation (N/E = threshold not exceeded).

Species	Threshold (Unweighted Peak)	Hammer energy level	3,000 kJ Maximum hammer energy		4,400 kJ Maximum hammer energy	
			Range of effect (m)	Area of effect (km²)	Range of effect (m)	Area of effect (km²)
Porpoise (VHF)	202 dB re 1 µPa (pk)	Initiation (first strike)	136	0.06	136	0.06
		Full energy (maximum)	525	0.87	662	1.38
Bottlenose, Risso's, Common dolphin (HF)	230 dB re 1 µPa (pk)	Initiation (first strike)	N/E	0.00	N/E	0.00
		Full energy (maximum)	33	0.00	41	0.01
Minke (LF)	219 dB re 1 µPa (pk)	Initiation (first strike)	25	0.00	25	0.00
		Full energy (maximum)	98	0.03	123	0.05
Phocids (Grey seal and harbour seal) (PCW)	218 dB re 1 µPa (pk)	Initiation (first strike)	28	0.00	28	0.00
		Full energy (maximum)	108	0.04	136	0.06

Table 4.24: Summary of SEL_{cum} PTS injury ranges and areas of effect for marine mammals for pin pile installation (4,400 kJ and 3,000 kJ) (N/E = threshold not exceeded).

Species	Threshold (SEL weighted)	Scenario	Hammer energy	Range of effect (m)	Area of effect (km^2)
Harbour porpoise (VHF)	PTS – 155 dB re 1 µPa^2s	Single	4,400 kJ	N/E	0.00
			3,000 kJ	N/E	0.00
		Concurrent	3,000 kJ + 3,000 kJ	N/E	0.00
		Consecutive	4,400 kJ	N/E	0.00
			3,000 kJ	N/E	0.00
Bottlenose dolphin, Short-beaked common dolphin, Risso's (HF)	PTS – 185 dB re 1 µPa^2s	Single	4,400 kJ	N/E	0.00
			3,000 kJ	N/E	0.00
		Concurrent	3,000 kJ + 3,000 kJ	N/E	0.00
		Consecutive	4,400 kJ	N/E	0.00
			3,000 kJ	N/E	0.00
Minke (LF)	PTS – 183 dB re 1 µPa^2s	Single	4,400 kJ	7,420	172.96
			3,000 kJ	4,230	56.21
		Concurrent	3,000 kJ + 3,000 kJ	5,710	102.44
		Consecutive	4,400 kJ	7,520	177.66
			3,000 kJ	4,290	57.82
Phocids (Grey seal and harbour seal) (PCW)	PTS – 185 dB re 1 µPa^2s	Single	4,400 kJ	N/E	0.00
			3,000 kJ	N/E	0.00
		Concurrent	3,000 kJ + 3,000 kJ	N/E	0.00
		Consecutive	4,400 kJ	N/E	0.00
			3,000 kJ	N/E	0.00

MMMP (Tertiary mitigation)

4.9.3.29 Due to the potential injury ranges predicted for marine mammals, mitigation will be required in the form of an ADD to deter animals from the area of impact. The type of ADD and approach to mitigation (including activation time and procedure) is included in the Outline MMMP (Document Reference J21) (as an annex of the Outline underwater sound management strategy, Document Reference J16) and will be discussed and agreed with relevant stakeholders.

4.9.3.30 ADDs have commonly been used in marine mammal mitigation at UK offshore wind farms to deter animals from potential injury zones prior to the start of piling. The JNCC (2010a) draft guidance for piling mitigation recommends their use, particularly in respect of periods of low visibility or at night to allow 24-hour working. With a number of research projects on ADDs commissioned via the Offshore Renewables Joint

Industry Programme (ORJIP), the use of ADDs for mitigation at offshore wind farms has gained momentum. For the Beatrice Offshore Wind Farm, the use of ADDs was accepted by the regulators (Marine Scotland) as the only mitigation tool applied pre-piling as it was thought to be more effective at reducing the potential for injury to marine mammals compared to actions informed by standard monitoring measures (Marine Mammal Observers (MMOs) and PAM) which, as mentioned previously, has limitations with respect to effective detection over distance (Parsons *et al*., 2009; Wright and Cosentino, 2015).

4.9.3.31 There are various ADDs available with different sound source characteristics (see McGarry *et al*., 2020) and a suitable device will be selected based on the key species requiring mitigation for the Mona Offshore Wind Project. The selected device will typically be deployed from the piling vessel and activated for a pre-determined duration to allow animals sufficient time to move away from the sound source whilst also minimising the additional sound introduced into the marine environment.

4.9.3.32 Sound modelling was carried out to determine the potential efficacy of using this device to deter marine mammals from the injury zone for a selected duration of 30 minutes (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

4.9.3.33 Assuming conservative swim speeds, it was demonstrated that activation of an ADD for 30 minutes would deter all animals beyond the maximum injury zone predicted using SPL_{pk} at hammer initiation (and full hammer energy) for both the 4,400 kJ and 3,000 kJ hammer energy (Table 4.25). This corroborates findings of other studies that reported that ADDs deter different marine mammals over several hundreds of metres or indeed several kilometres from the source (reviewed in McGarry *et al*., 2020).

Table 4.25: Summary of peak pressure (SPLpk) injury ranges at hammer initiation and max hammer energy (in parentheses) for marine mammals due to single piling of pin piles at 4,400 kJ and 3,000 kJ hammer energy, showing whether the individual can move beyond the injury range during the 30 minutes of ADD activation.

Species	Threshold	Injury range (4,400 kJ) (m)	Injury range (3,000 kJ) (m)	Swim Speed (m/s)	Swim distance (m)	Move away?
Minke whale	219 dB re 1 µPa (pk)	25 (123)	25 (98)	2.3	4,140	Yes
Bottlenose dolphin, Risso's dolphin, white-beaked dolphin	230 dB re 1 µPa (pk)	N/E (41)	N/E (33)	1.52	2,736	Yes
Harbour porpoise	202 dB re 1 µPa (pk)	136 (662)	136 (525)	1.5	2,700	Yes
Grey seal, harbour seal	218 dB re 1 µPa (pk)	28 (136)	28 (108)	1.8	3,240	Yes

4.9.3.34 For all species except minke whale, use of an ADD for 30 minutes prior to commencement of piling of pin piles reduces the likehood of PTS occurring as sound levels are predicted not to be greater than the relevant threshold values, during single, concurrent and consecutive piling for all species (Table 4.26). The exception was minke whale where there was a small residual risk of injury to animals based on the

SEL_{cum} metric only (Table 4.27), as distances at which sound levels are predicted to remain above the relevant threshold values is reduced compared to not using an ADD.

Table 4.26: Injury ranges (SEL_{cum}) for marine mammals due to single, concurrent and consecutive piling (24 hours) of pin piles (3,000 kJ and 3,000 kJ) with and without 30 minutes of ADD (N/E = threshold not exceeded).

Species	PTS Threshold (SEL weighted)	Scenario	Hammer energy	Without ADD	With ADD
Minke whale (LF)	183 dB re 1 µPa²s	Single	4,400 kJ	7,420	3,290
			3,000 kJ	4,230	264
		Concurrent	3,000 kJ + 3,000 kJ	5,710	1,575
		Consecutive	4,400 kJ	7,520	3,370
			3,000 kJ	4,290	327
All other marine mammal species	HF – 185 dB re 1 µPa²s VHF – 155 dB re 1 µPa²s PCW – 185 dB re 1 µPa²s	Single	4,400 kJ	N/E	N/E
			3,000 kJ	N/E	N/E
		Concurrent	3,000 kJ + 3,000 kJ	N/E	N/E
		Consecutive	4,400 kJ	N/E	N/E
			3,000 kJ	N/E	N/E

Table 4.27: Potential number of animals predicted to be injured (PTS) using SEL_{cum} metric as a result of different piling scenarios.

Species	Scenario	Hammer energy	Without ADD		With ADD	
			Number of animals	% of Reference population	Number of animals	% of Reference population
Minke whale (LF)	Single	4,400 kJ	3	0.015%	<1	0.003%
		3,000 kJ	<1	0.005%	<1	0.00002%
	Concurrent	3,000 kJ + 3,000 kJ	2	0.009%	<1	0.007%
	Consecutive	4,400 kJ	4	0.015%	<1	0.003%
		3,000 kJ	2	0.005%	<1	0.00003%
All other marine mammal species	Single	4,400 kJ	0	0%	0	0%
		3,000 kJ	0	0%	0	0%
	Concurrent	3,000 kJ + 3,000 kJ	0	0 %	0	0 %
	Consecutive	4,400 kJ	0	0 %	0	0 %
		3,000 kJ	0	0 %	0	0 %

Harbour porpoise

4.9.3.35 For harbour porpoise, with primary and tertiary mitigation applied, no animals would be affected by peak pressure (SPL_{pk}) as they would move away at first strike (see table (see Table 4.25). Similarly, cumulative exposure (SEL_{cum}) would not result in injury to any individuals (Table 4.26).

4.9.3.36 Even without the use of an ADD the modelling suggested that there would be no risk of injury from cumulative exposure (SEL_{cum}), however peak pressure leading to be injury would be experienced out to 136 m (at hammer initiation) and 662 m (at full hammer).

4.9.3.37 The injury range is predicted to be localised to within the Mona Array Area and therefore there is no potential for spatial overlap with the North Anglesey Marine/Gogledd Môn Forol SAC, the closest site designated for harbour porpoise, which is located at a distance of ~23 km (Table 4.11).

4.9.3.38 Harbour porpoise typically live between 12 and 24 years and give birth once a year (Fisher and Harrison, 1970). The duration of piling is up to 113 days, within a two-year piling programme (as defined in Table 4.22), and therefore could potentially overlap with a maximum of two breeding cycles. The duration of the effect in the context of the life cycle of harbour porpoise is classified as medium term, as the risk (albeit very small) is meaningful in the context of the lifespan of this species.

4.9.3.39 The impact (elevated underwater sound arising during piling) is predicted to be of local spatial extent with respect to the ranges over which PTS could occur, medium term duration, intermittent and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Without mitigation PTS could affect a small number of animals leading to measurable changes at an individual level but this is unlikely to affect the wider population. Since injury is assumed to be fully mitigated via primary and tertiary mitigation, in the context of the associated assumptions described above, there is considered to be no residual risk of injury; the magnitude was therefore considered to be **negligible**.

Dolphin species

4.9.3.40 For bottlenose dolphin, short-beaked common dolphin and Risso's dolphin, with primary and tertiary mitigation applied, no animals would be affected by peak pressure (SPL_{pk}) as they would move away at first strike (see Table 4.25). Similarly, cumulative exposure (SEL_{cum}) would not result in injury to any individuals (Table 4.27).

4.9.3.41 Even without the use of an ADD the modelling suggested that there would be no risk of injury from cumulative exposure (SEL_{cum}), however peak pressure leading to be injury would be experienced out to 41 m (at full hammer energy) (the threshold was not exceeded at first strike hammer energy) (Table 4.25).

4.9.3.42 The impact (elevated underwater sound arising during piling) is predicted to be of local spatial extent with respect to the ranges over which PTS could occur, medium term duration, intermittent and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Since injury will be fully mitigated via primary and tertiary mitigation there would be no residual risk of injury; the magnitude was therefore considered to be **negligible**.

Minke whale

4.9.3.43 For minke whale, with primary and tertiary mitigation applied, and based on the largest predicted range of m (i.e. using the SEL_{cum} metric for consecutive piling at 4,400 kJ), the maximum number of individuals that could be potentially injured calculated using the density value of 0.0173 animals per km^2 (Table 4.12) is no more than one animal (Table 4.27). No animals would be affected by peak pressure (SPL_{pk}) as they would move away at first strike (see Table 4.25). The injury range is therefore localised to within the Mona Array Area and there are no designated sites for minke whale in the vicinity.

4.9.3.44 Without the use of an ADD modelling demonstrated up to four animals may be at risk of injury using the SEL_{cum} metric for consecutive piling at 4,400 kJ (Table 4.27). Instantaneous injury would be experienced out to 25 m at first strike hammer energy (123 m at full hammer energy) (Table 4.25).

4.9.3.45 Minke whale typically live up to 60 years and the gestation period is believed to be around ten months. Females may give birth to a calf every one to two years and calves are weaned over five to 10 months, thus the two-year duration of the piling phase could potentially overlap with key breeding/nursing cycles. For an individual female, the risk (albeit small) could interrupt at least one key breeding period with additional risk to mother calf pairs during nursing. This is meaningful in the context of the lifetime of an individual and therefore is classed as medium term.

4.9.3.46 The impact (elevated underwater sound arising during piling) is predicted to be of local spatial extent with respect to the ranges over which PTS could occur, medium term duration, intermittent and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. PTS could affect a small number of animals leading to measurable changes at an individual level but this is unlikely to affect the wider population. The residual number of animals predicted to experience PTS were carried forward to the iPCoD modelling assessment alongside disturbance to understand the implications at a population level and the model demonstrated that there would be no long-term effect (see paragraph 4.9.3.88). The magnitude is therefore considered to be **low**.

Pinnipeds

4.9.3.47 For both grey seal and harbour, with primary and tertiary mitigation applied, no animals would be affected by peak pressure (SPL_{pk}) as they would move away at first strike (see Table 4.25). Similarly, cumulative exposure (SEL_{cum}) would not result in injury to any individuals (Table 4.27).

4.9.3.48 Even without the use of an ADD the modelling suggested that there would be no risk of injury from cumulative exposure (SEL_{cum}), however peak pressure leading to be injury would be experienced out to 28 m (at first strike) and 136 m (at full hammer) (Table 4.25).

4.9.3.49 Both species of seal typically live between 20 to 30 years with gestation lasting between ten to 11 months (SCOS, 2015; SCOS, 2018), thus the duration of piling (albeit intermittent) could potentially overlap with up to two breeding cycles. Considering the above, the duration of the effect in the context of life cycle of harbour seal and grey seal is classified as medium term.

4.9.3.50 The impact (elevated underwater sound arising during piling) is predicted to be of local spatial extent, medium term duration, intermittent and although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Since injury will be fully mitigated via primary and tertiary mitigation there is no residual risk of injury but taking a precautionary approach the magnitude is therefore considered to be **negligible**.

Behavioural disturbance

4.9.3.51 Disturbance during piling was predicted to have far-reaching potential effects across the northern part of the Irish Sea, noting however, that the extent of the contours are likely to be an overestimate as it assumes that the sound from piling maintains its impulsive characteristics at large distances, which is considered unlikely to be the case. It is noted that there is no agreed approach to modelling the cross-over point from impulsive to continuous sound and this is an ongoing active area of research (see paragraph 4.9.2.5 and 4.9.2.39, and paragraphs 1.5.5.26 to 1.5.5.29 of Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement for detailed discussion). For this reason, the quantitative assessment should be interpreted with caution and subject to the caveats highlighted by Southall *et al.* (2021) with respect to environmental context (paragraph 4.9.2.32), as assuming impulsive characteristics by comparing predicted sound levels for the whole contour range with impulsive related thresholds is likely to overestimate predicted impact distances.

4.9.3.52 As discussed in paragraph 4.9.2.16 and 4.8.2.13 dose response curves are obtained from animal reactions in field observations whereby animals react to the underwater sound they receive at their location. The limitations of this applying a dose response curve developed for harbour porpoise responses to piling at lower hammer energies and in a different region have been highlighted above and suggest this approach is likely to be very precautionary given the difference in predicted ranges (paragraph 4.9.2.19). In addition, the application of the harbour porpoise dose response curve (in the absence of species-specific data for other cetacean species) (paragraph 4.8.2.11) represents a precautionary approach to assessment of HF and LF cetaceans, as other cetacean species are likely to be less sensitive than harbour porpoise to behavioural disturbance as noted in the literature (e.g. Tougaard *et al*., 2021). For minke whale, some limited evidence available from studies investigating the effects of sound from naval sonar devices, indicates that they are less sensitive than harbour porpoise by about 40 to 50 dB (Kvadsheim *et al*., 2017; Sivle *et al*., 2015). However, sound energy of pile driving is highest in the low frequency range and overlaps more with the hearing range of minke whale for example than harbour porpoise.

4.9.3.53 With all the above in mind, the estimated numbers of animals predicted to experience potential disturbance as a result of different piling scenarios is presented in Table 4.28. To provide additional context and allow an area-based assessment (for HRA purposes) the quantitative effect on marine mammal species has also been presented for relevant fixed thresholds (Table 4.21) .

4.9.3.54 The estimated numbers of animals potentially disturbed are based on the maximum adverse piling scenario which describe the maximum potential effect for each species. This has been defined with reference to either the extent of the effect, or spatial overlap with abundance hotspots (e.g. areas near the coast). For harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin and Risso's dolphin a quantitative assessment of the number of animals predicted to experience disturbance was undertaken by multiplying the density values (Table 4.12) with the areas within each 5 dB isopleth and correcting the value using the relevant proportional response from Graham *et al.* (2019) for the unweighted SEL_{ss} level (Figure 4.5).

4.9.3.55 For grey seal and harbour seal the quantitative assessment was undertaken by overlaying the unweighted SEL_{ss} contours on at-sea density maps produced by Carter *et al*. (2022). The number of animals in each 5 km x 5 km grid cell was summed for each isopleth and corrected using the proportional response as per Whyte *et al*. (2020) (Figure 4.6).

Table 4.28: Potential number of animals predicted to be disturbed within weighted SEL_{ss} sound contours (dose response approach) as a result of different piling scenarios. The modelling location with the most number of animals impacted is presented here.

Species	Scenario		Number of Animals	% Reference Population (MU)	Reference population
Harbour porpoise	Single	4,400 kJ	971	1.55%	CIS MU
	Single	3,000 kJ	803	1.28%	
	Concurrent	3,000 kJ + 3,000 kJ	1142	1.83%	
Bottlenose dolphin	Single	4,400 kJ	6	2.03%	IS MU
	Single	3,000 kJ	5	1.68%	
	Concurrent	3,000 kJ + 3,000 kJ	7	2.39%	
Short-beaked common dolphin	Single	4,400 kJ	3	0.002%	CGNS MU
	Single	3,000 kJ	2	0.002%	
	Concurrent	3,000 kJ + 3,000 kJ	3	0.002%	
Risso's dolphin	Single	4,400 kJ	110	0.89%	
	Single	3,000 kJ	91	0.74%	
	Concurrent	3,000 kJ + 3,000 kJ	129	1.05%	
Minke whale	Single	4,400 kJ	61	0.30%	
	Single	3,000 kJ	51	0.25%	
	Concurrent	3,000 kJ + 3,000 kJ	72	0.35%	
Grey seal	Single	4,400 kJ	26	0.20%/0.04%	GSRP/OSPAR Region III
	Single	3,000 kJ	17	0.13%/0.03%	
	Concurrent	3,000 kJ + 3,000 kJ	31	0.23%/0.05%	
Harbour seal	Single	4,400 kJ	<1	0.01%	GSRP
	Single	3,000 kJ	<1	0.01%	
	Concurrent	3,000 kJ + 3,000 kJ	<1	0.01%	

Harbour porpoise

4.9.3.56 The most conservative estimate of disturbance (using dose-response) led to up to 1,142 animals (based on density from Evans and Waggitt, 2023) predicted to experience potential disturbance from concurrent piling of pin piles (at the North location) (Table 4.28, Figure 4.8). This equates to 1.83% of the Celtic and Irish Seas (CIS) MU population.

4.9.3.57 The probability of response map presented in the Figure 4.9 illustrates the likelihood of disturbance to harbour porpoise reduces as distance from the piling source increases, based upon the dose response function (see paragraphs 4.9.2.11 to 4.9.2.24 for detail). At the highest sound level around the piles there is the greatest probability of response from animals, but this decreases with distance from the piling source towards the coastal areas to a much lower probability of response.

4.9.3.58 The estimated numbers of individuals potentially impacted are based on conservative densities and on the assumption that the maximum hammer energies are reached at all piling locations. Although the distribution of harbour porpoise across the Mona marine mammal study area was found to be uneven (see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement for further detail), it was assumed that the density of 0.27773 animals per km^2 (Table 4.12) is uniformly distributed within all sound contours to provide a precautionary assessment. It is also a higher density than those obtained from site-specific surveys from Mona aerial surveys.

4.9.3.59 As described in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, there are 14 SACs and ten MNRs within the regional marine mammal study area. The North Anglesey Marine/Gogledd Môn Forol SAC is located in closest proximity to the Mona Array Area (23.67 km) and is designated for harbour porpoise. North Anglesey Marine/Gogledd Môn Forol SAC, Langness MNR, Baie Ny Carrickey MNR, Calf and Wart Bank MNR, North Channel SAC, Rockabill to Dalkey Island SAC are also designated for harbour porpoise. Since the underwater sound modelling for dose-response mapped sound levels out to as low as 120 dB re 1µPa^{2}s (SEL_{ss}) and therefore sound disturbance contours extend over large distances there is potential for overlap of contours with these designated sites. Lying outside the disturbance contours, West Wales Marine/Gorllewin Cymru Forol SAC, Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC, Port Erin Bay MNR, Niarbyl MNR, West Coast MNR and Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC are also designated for harbour porpoise. Whilst not directly within the region of disturbance mapped, given that harbour porpoise can travel over large distances, there is a possibility that a small number of individuals from these SAC populations may be occasionally present within the mapped disturbance contours.

4.9.3.60 Using the area-based approach single strike sound exposure level (SEL_{ss}) (4.9.2.25) for the unweighted sound threshold of 143 dB re 1µPa^{2}s disturbance contours were presented for single piling at 3,000 kJ, 4,400 kJ and concurrent piling at 3,000 kJ plus 3,000 kJ and at each location (Figure 4.10 for the north location, Figure 4.11 for the southeast location and Figure 4.12 for the southwest location). This approach, which focuses more on a measurable disturbance response within a known threshold, showed that contours extended to North Anglesey SAC which is designated for harbour porpoise. The piling at the southwest location resulted in the largest overlap with the SAC (4.33%) for the single piling scenario with hammer energy of 4,400 kJ due to proximity. The area-based 143 dB contours did not extend as far as IoM waters and therefore there was no overlap with MNRs designated for harbour porpoise (Langness, Little Ness, Laxey Bay, Bale Ny Carrickey, Calf and Wart Bank, Port Erin, Niarbyl and West Coast) suggesting that a measurable disturbance would not occur within these protected sites around the IoM.

4.9.3.61 The different approaches described above suggest that close to the piling the disturbance response is likely to be measurable and the probability of such a response is high such that individuals could change their baseline behaviour or in some cases actively avoid disturbed areas. Moving further away from the piling source behavioural response are likely to decrease with some individuals (proportional to the distance from the source) tolerating the increase in elevated underwater sound. At a ranges beyond the received level of 143 dB re 1µPa^{2}s (SEL_{ss}) the disturbance is likely to be ‘mild’ with less likelihood of active avoidance.

4.9.3.62 Piling within a two-year piling phase (albeit with intermittent piling) could coincide with key breeding periods of harbour porpoise and is considered to be meaningful in the context of the lifespan of this species (paragraph 4.9.3.38). As discussed during the third marine mammal EWG consultation (Table 4.5), population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time (which has been suggested to exhibit a declining trend of approximately 4% per annum (IAMMWG, 2021)) and to provide additional certainty in the predictions of the assessment of potential effects. Results of the iPCoD modelling for harbour porpoise against the MU population showed that the median ratio of the impacted population to the unimpacted population at both six and 25 years was 0.9999 for the maximum temporal scenario, and 0.9999 at six years and 1.0000 at 25 years for the maximum spatial scenario, which means there is no significant difference between the population trajectories for an unimpacted population and the impacted population (Appendix A). Small changes in the impacted population size over time are similar to those predicted for an un-impacted population, as can be seen in Figure 4.7. Here, the maximum temporal scenarios have been presented as the simulated effect on population size (40 animals fewer in the impacted scenario than the unimpacted scenario, equivalent to approximately 0.064% of the CIS MU population estimate) is marginally greater than the maximum spatial scenario (35 animals fewer in the impacted scenario than the unimpacted scenario, equivalent to approximately 0.056% of the CIS MU population estimate).

4.9.3.63 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. A small proportion (up to 1.83%) of the CIS reference population would be affected during piling and the results of the iPCoD modelling suggest that over the duration of the impact and up to 25 years after the start of piling the impacted population may be up to 40 individuals smaller than the unimpacted population, corresponding to approximately 0.064% of the MU,. In the context of a population that is predicted to decline (IAMMWG, 2021) it is considered that there would be no potential long-term effects on the harbour porpoise population resulting from elevated underwater sound arising during piling The magnitude is therefore considered to be **low**.

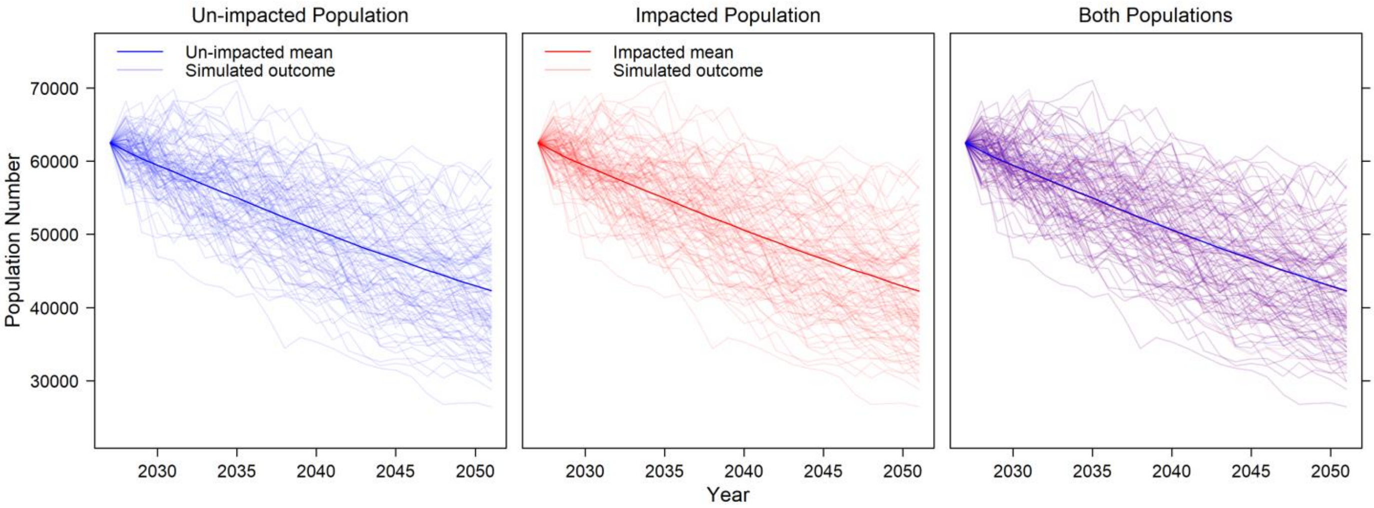


Figure 4.7: Simulated harbour porpoise population sizes for both the baseline (unimpacted) and the impacted populations under the maximum temporal scenario.

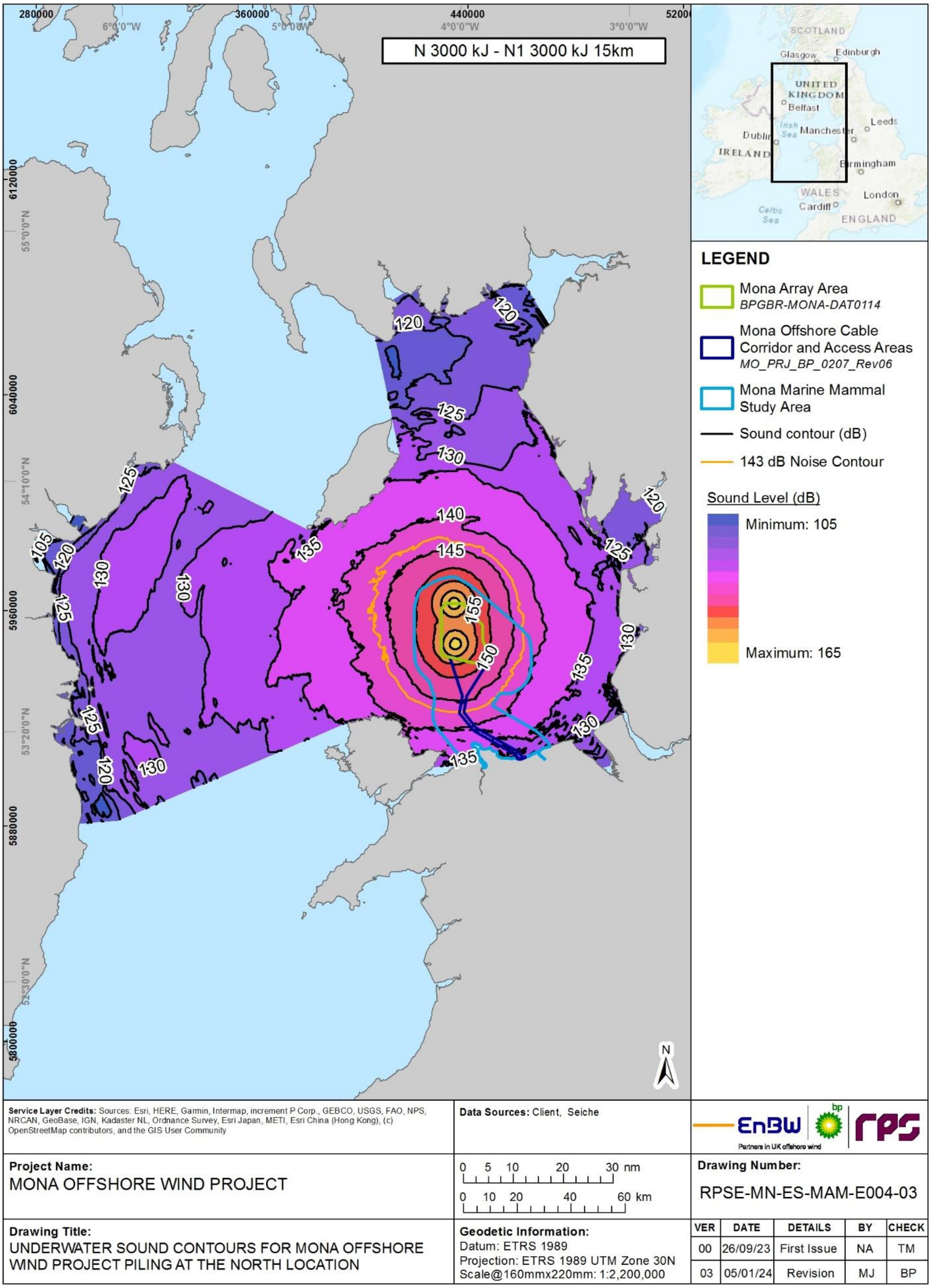


Figure 4.8: Concurrent piling of pin piles at a maximum hammer energy of 3,000 kJ and 3,000 kJ at the greatest spatial extent (with 15 km maximum separation distance) showing SELss contours in 5 dB isopleths (for North modelled location).

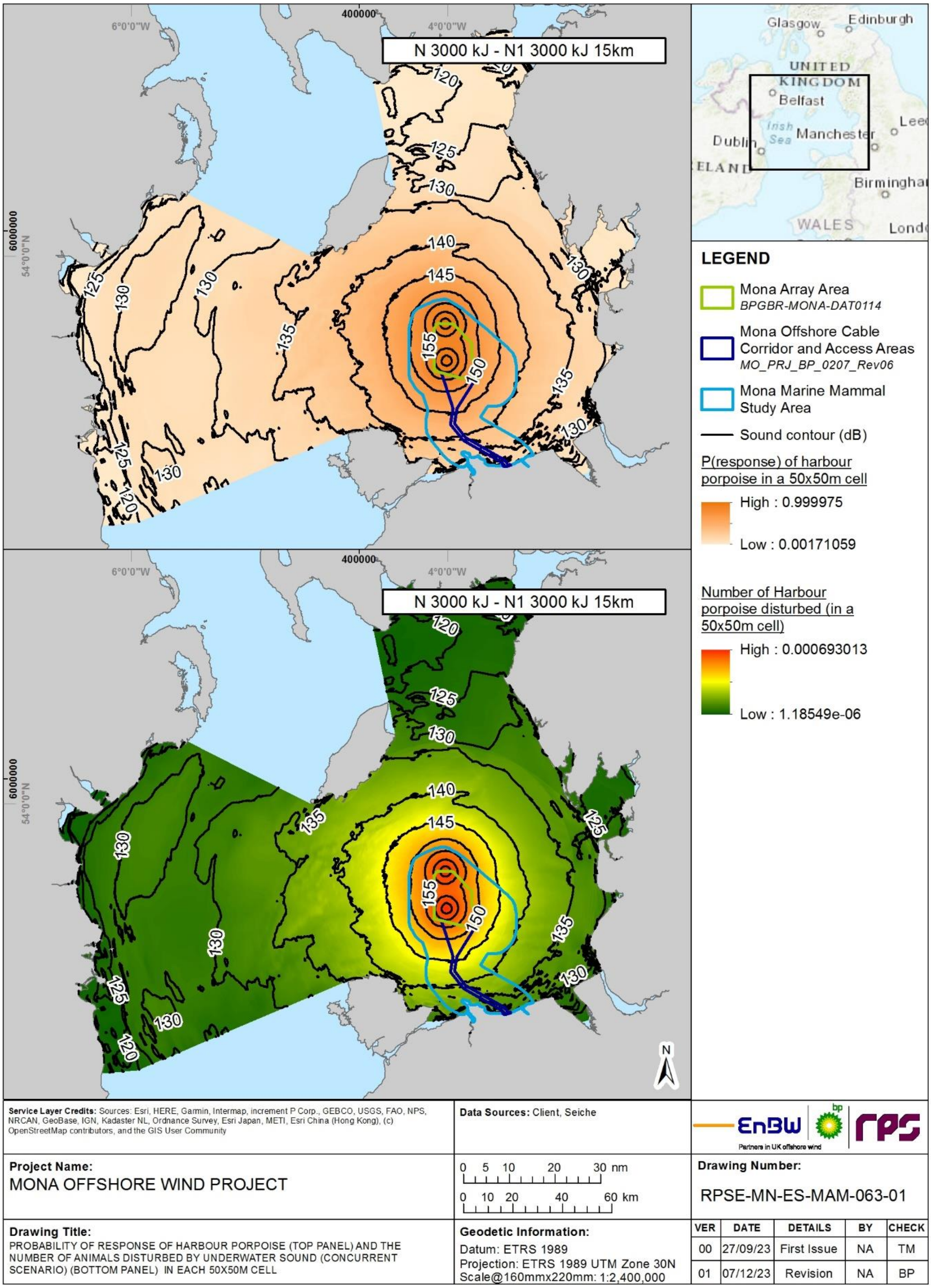


Figure 4.9: Probability of response mapping for harbour porpoise. Top panel presents the probability of response ((P(response)) which shows the percentage of disturbed harbour porpoise per grid cell. Bottom panel demonstrates number of harbour porpoise disturbed per cell.

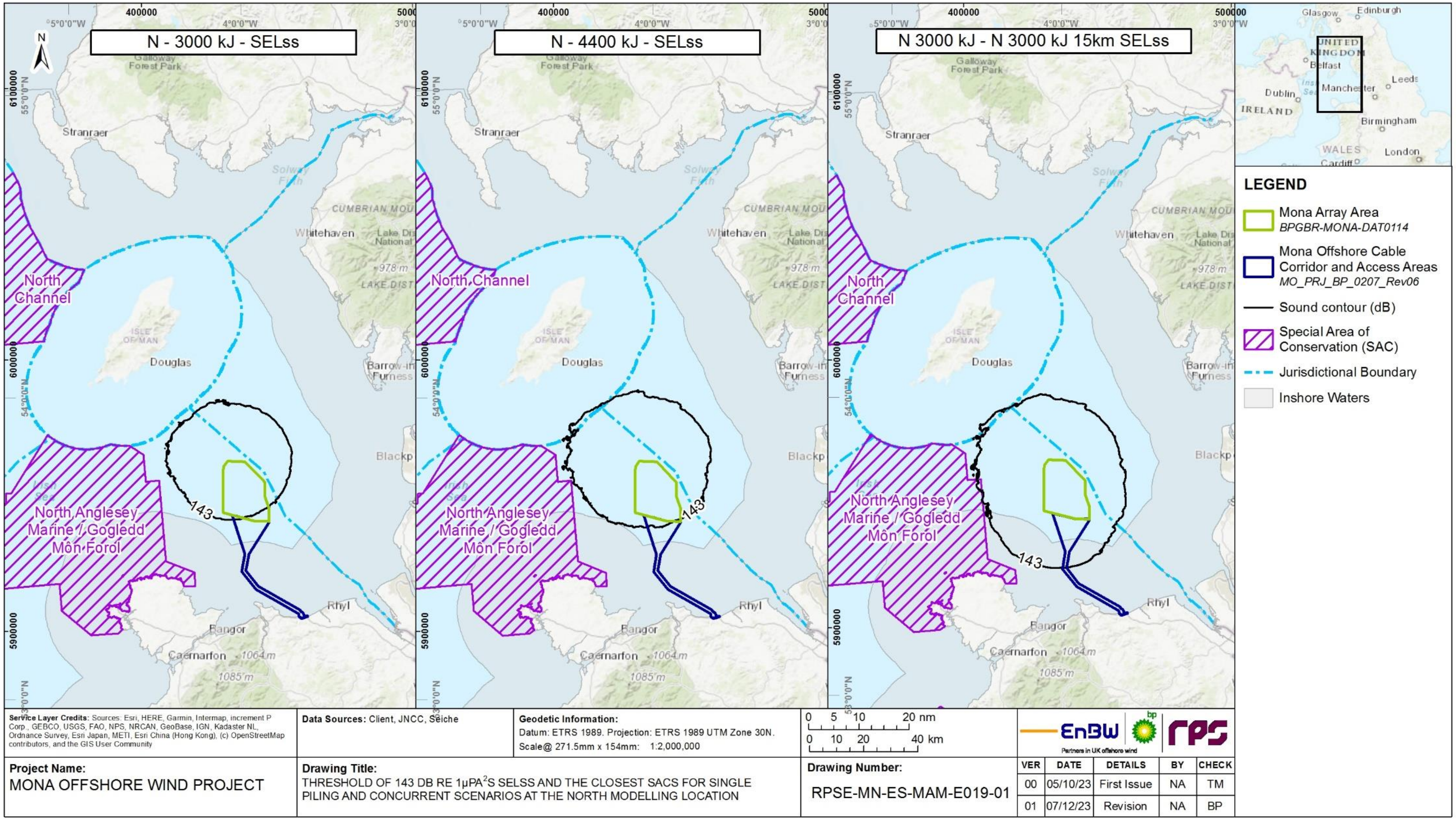
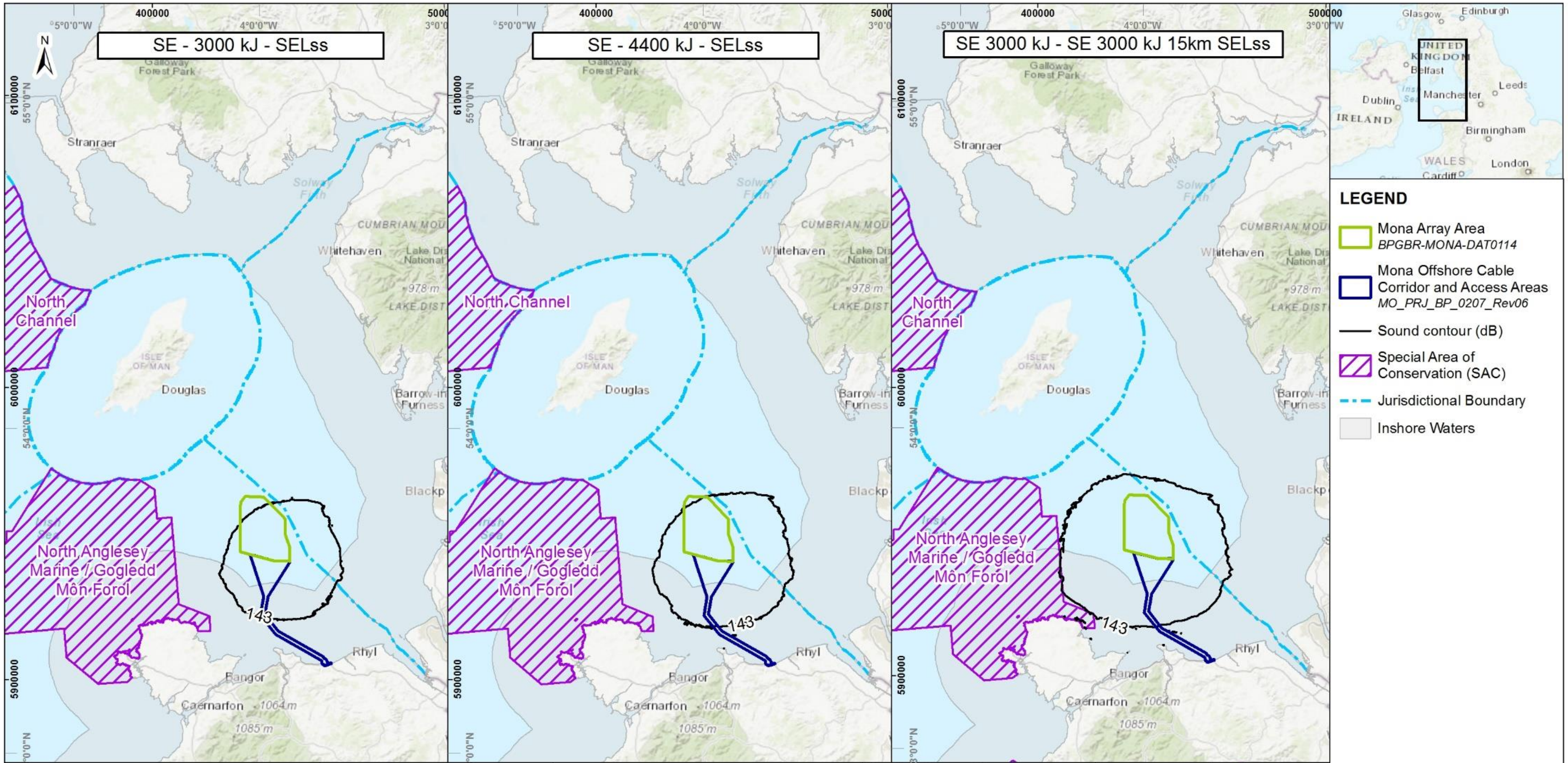


Figure 4.10: Threshold of 143 dB re 1µPa²s single strike sound exposure level (SEL$_{ss}$) and the closest SACs (designated for harbour porpoise) for single piling and concurrent scenarios (at north modelling location).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC, Seiche

Geodetic Information: Datum: ETRS 1989. Projection: ETRS 1989 UTM Zone 30N. Scale@ 271.5mm x 154mm: 1:2,000,000

0 5 10 20 nm
0 10 20 40 km

Project Name: MONA OFFSHORE WIND PROJECT

Drawing Title: THRESHOLD OF 143 DB RE 1µPA^{2}S SELSS AND THE CLOSEST SACS FOR SINGLE PILING AND CONCURRENT SCENARIOS AT THE SOUTHEAST MODELLING LOCATION

Drawing Number: RPSE-MN-ES-MAM-E020-01

VER	DATE	DETAILS	BY	CHECK
00	05/10/23	First Issue	NA	TM
01	07/12/23	Revision	NA	BP

Figure 4.11: Threshold of 143 dB re 1µPa^{2}s single strike sound exposure level (SEL_{ss}) and the closest SACs (designated for harbour porpoise) for single piling and concurrent scenarios (at southeast modelling location).

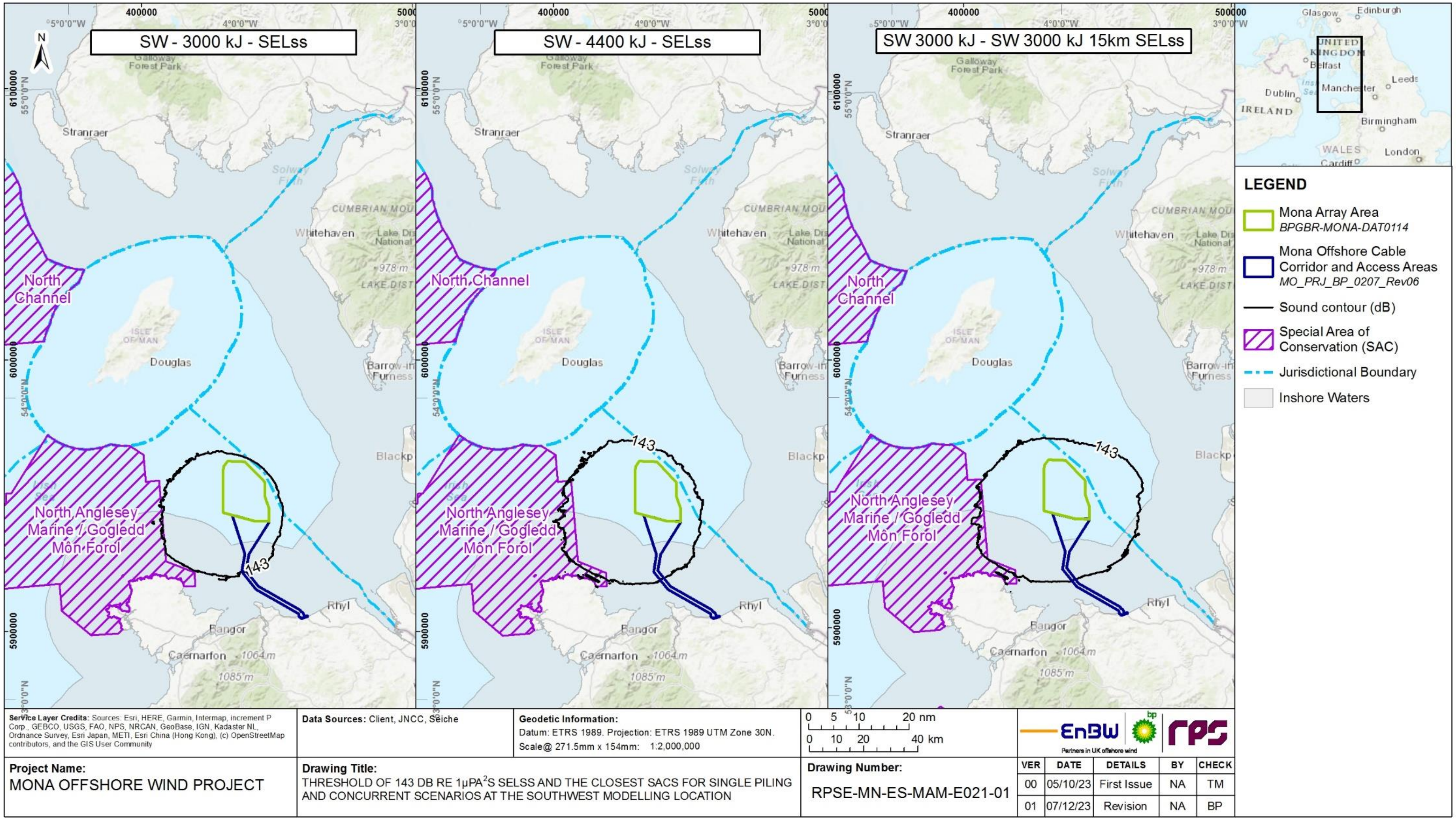


Figure 4.12: Threshold of 143 dB re 1µPa²s single strike sound exposure level (SEL_{ss}) and the closest SACs (designated for harbour porpoise) for single piling and concurrent scenarios (at southwest modelling location).

Bottlenose dolphin

4.9.3.64 The most conservative estimate of disturbance (using dose-response) led to up to seven animals predicted to experience potential disturbance from concurrent piling at a maximum hammer energy of 3,000 kJ (Figure 4.8, Table 4.28). This equates to 2.39% of the Irish Sea MU population.

4.9.3.65 This is a conservative estimate using a single density derived from the Mona Array Area from the Welsh Marine Mammal Atlas across the Irish Sea and assumes a uniform distribution throughout the area. The density is applied across the contours which includes the waters around the Isle of Man (Figure 4.8). As discussed in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, there is evidence of bottlenose dolphin moving between Cardigan Bay and Manx waters. These animals are part of the same population moving seasonally between the two areas, and therefore are treated as one population with high connectivity across the marine mammal study area for assessment. The coastal area where the inshore ecotype is likely to inhabit (e.g. 6 km area from the coast (Feingold and Evans, 2014) lies ~22 km from the nearest boundary of the Mona Array Area and at this distance the received level from piling will have lost much of the impulsive characteristics (paragraph 4.9.2.6 and 4.9.2.39). However, the outermost sound contours reaches the coastal areas and therefore areas of mild disturbance may overlap with the key inshore distribution of inshore-ecotype bottlenose dolphin in the IS MU (Figure 4.8).

4.9.3.66 As described in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, there are 14 SACs and nine Marine Nature Reserves (MNRs) within the regional marine mammal study area. Douglas Bay MNR is the closest MNR to the Mona Array Area and there is potential for overlap of sound disturbance contours with this designated site. Further away is the Pen Llŷn a`r Sarnau/Llŷn Peninsula and the Sarnau SAC and the Cardigan Bay/Bae Ceredigion SAC both designated for bottlenose dolphin. The Cardigan Bay population has been estimated to consist of around 125 individuals (JNCC, 2022a), with inshore areas being used for both feeding and reproduction and given that bottlenose dolphin can travel over large distances, there is a possibility that a small number of individuals from these SAC populations may be occasionally present within the disturbance contours.

Application of the NMFS (2005) area-based threshold of 160 dB re 1 µPa SPL_{rms} (strong disturbance) indicated no overlap of disturbance contours with any SAC or MNR designated for bottlenose dolphin in the marine mammal study area. There was, however, an overlap with the IoM MNRs designated for bottlenose dolphin (Little Ness, Douglas Bay, Laxey Bay, Bale Ny Carrickey) for the larger contour predicted for the 140 dB re 1 µPa SPL_{rms} (mild disturbance) threshold although noting that this would be unlikely to displace animals from the area and would suggest mild disruption of behaviour (Figure 4.13). Therefore, there would not be anticipated to be strong disturbance of individuals within protected sites although individuals originating from these sites could range as far as the ensonified areas. Further assessment of the potential effects on SACs is provided in the ISAA (Document Reference E1.3).

Barrier effects

4.9.3.67 Since the outer dose-response contours reach areas occupied by the coastal bottlenose dolphin population, the potential for barrier effects, e.g. restricting animals from moving along the coast, must also be considered for both single and concurrent piling scenarios. Received sound levels within the coastal region (~6 km buffer from the coastline) are predicted to reach maximum SEL_{ss} levels of 135 dB (including along the coast of the Isle of Man) (Figure 4.8). This is broadly equivalent to 145 re 1 µPa SPL_{rms} and below the NMFS (2005) threshold for strong disturbance (=160 re 1 µPa SPL_{rms}) and therefore likely to elicit less severe disturbance reactions. The modelled contours for the NMFS area-based threshold of 160 re 1 µPa SPL_{rms} are illustrated in Figure 4.13 and show that strong disturbance would not occur in coastal habitats. The area-based modelled contours for mild disturbance (140 re 1 µPa SPL_{rms}) do, however, extend further and could overlap coastal habitats. According to the behavioural response severity matrix suggested by Southall *et al*. (2021) such low level disturbance (scoring between 0 to 3 on a 0 to 9 scale) could lead to mild disruptions of normal behaviours, but prolonged or sustained behavioural effects, including displacement are unlikely to occur. Further discussion on the sensitivity of bottlenose dolphin is provided in paragraph 4.9.3.119 but for the purposes of assessing magnitude, it is considered that animals are unlikely to be excluded from the coastal areas given the low level disturbance and therefore unlikely to lead to barrier effects.

4.9.3.68 Bottlenose dolphin typically live between 20 and 30 years and females reproduce every three to six years. Gestation takes 12 months followed by calves suckling for 18 to 24 months, thus the two-year duration of the piling phase could potentially overlap with key breeding/nursing cycles (although noting that piling would occur intermittently over this period). For an individual female, the risk (albeit very small) could interrupt at least one key breeding period with additional risk to mother-calf pairs during nursing. This is considered to be meaningful in the context the lifetime of an individual and therefore is classed as medium-term. The magnitude of the impact could also result in a small but measurable alteration to the distribution of marine mammals during piling only and may affect the fecundity of some individuals over the medium term.

4.9.3.69 Population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of potential effects. Results of the iPCoD modelling for bottlenose dolphin against the MU population showed that the difference between the impacted and unimpacted populations after 25 years was a maximum of one animal (approximately 0.341% of the IS MU population estimate) for both the maximum temporal and maximum spatial scenarios, for both fertility rates. In the maximum temporal model parameterised with a higher fertility rate of 0.30, this difference increased to two animals (approximately 0.683% of the IS MU population estimate) at three and four years. The median ratio of the impacted population to the unimpacted population was 1.0000 at both six years and 25 years for both the maximum temporal and maximum spatial scenarios (Appendix A), for both fertility rates. However, mean ratios were marginally lower, at 0.9970 for both six and 25 years for the maximum temporal scenario and for the maximum spatial scenario 0.9977 at six years and 0.9976 at 25 years (based on a fertility rate of 0.22). The corresponding ratios for the models parameterised with a fertility rate of 0.30 were 0.9968 at six years and 0.9972 at 25 years for the maximum temporal scenario, and 0.9966 at six years and 1.0000 at 25 years for the maximum spatial scenario.

4.9.3.70 Small differences (i.e. one to two animals) in the population size over time between the impacted and unimpacted population fall within the natural variance of the population, and would not be expected to change the population trajectory as can be seen in Figure 4.14 and Figure 4.15. Therefore, given the scale of differences between impacted and unimpacted populations (i.e. two animals is 0.683% of the IS MU population estimate), it was considered that there is no potential for a long-term effect on this species from elevated underwater sound arising during piling. It is important to highlight that whilst any model is sensitive to input parameters (as evidenced in Appendix A), the parameters (recommended by NRW through the Evidence Plan

Process) used in the iPCoD model represent a conservative assessment of population changes.

4.9.3.71 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium-term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. Whilst 2.39% of the reference population (IS MU) would be affected during piling the results of the iPCoD modelling suggest that over the duration of the impact and up to 25 years after the start of piling there would be no long-term potential population level effects on the bottlenose dolphin population. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however, there would be no population-level consequences of disturbance. The magnitude is therefore considered to be **low**.

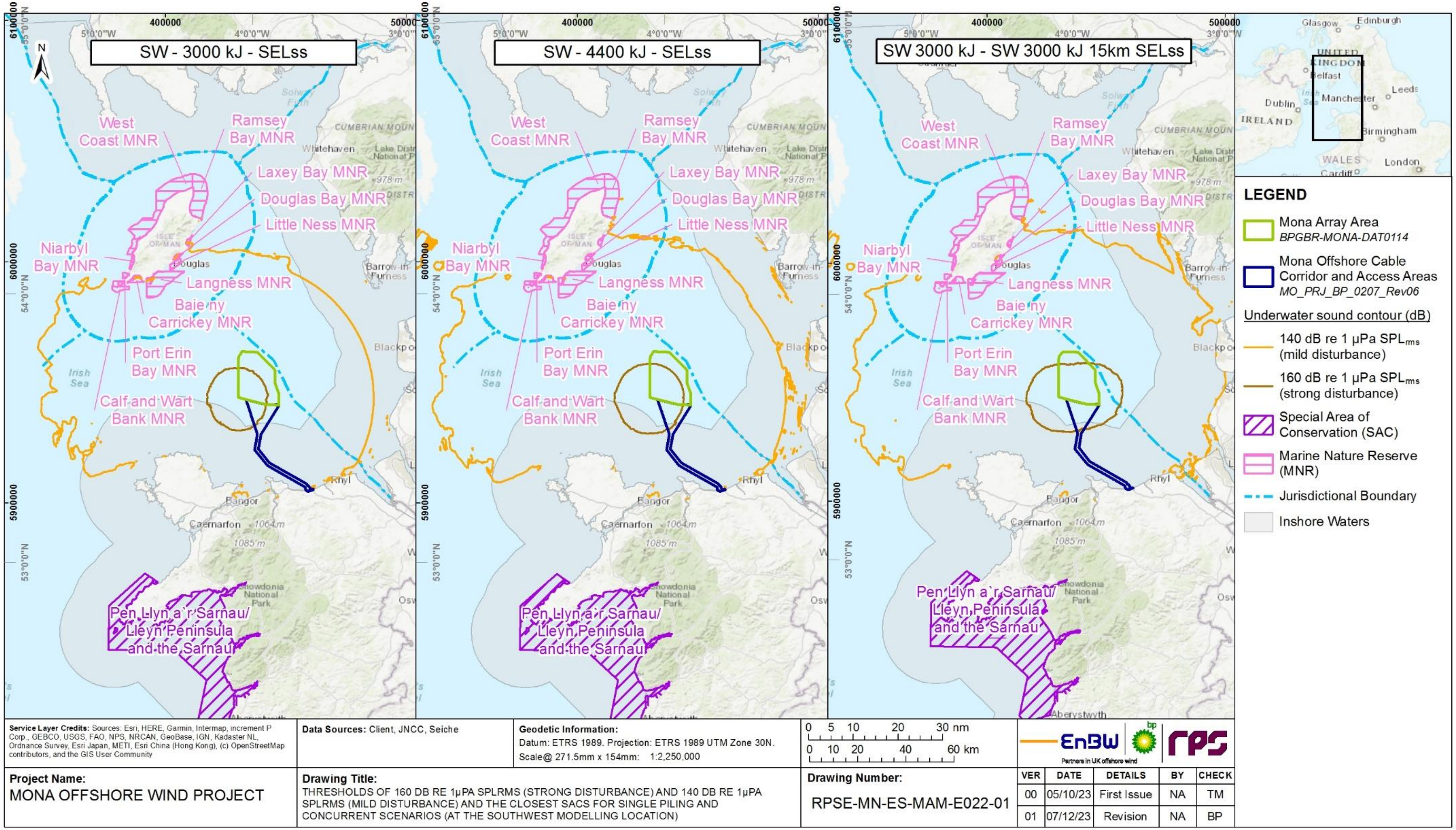


Figure 4.13: Thresholds of 160 dB re 1µPa SPL_{rms} (strong disturbance) and 140 dB re 1µPa SPL_{rms} (mild disturbance) and the closest SACs (for bottlenose dolphin) for single piling and concurrent scenarios (at southwest modelling location).

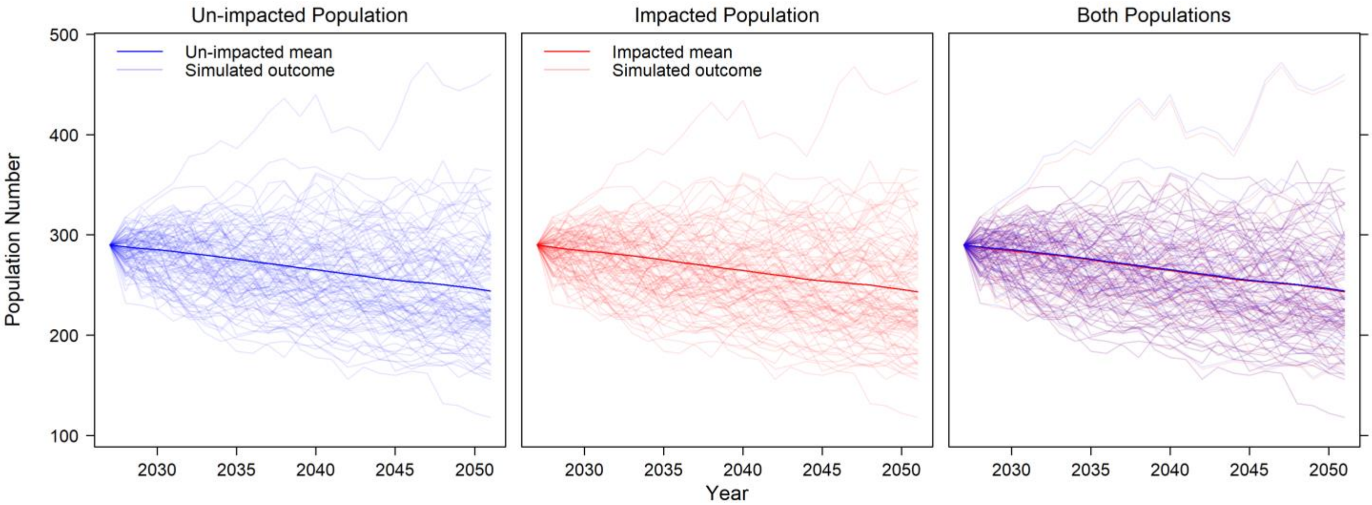


Figure 4.14: Simulated bottlenose dolphin population sizes for both the baseline (unimpacted) and the impacted populations under the maximum temporal scenario, with the lower fertility rate of 0.22.

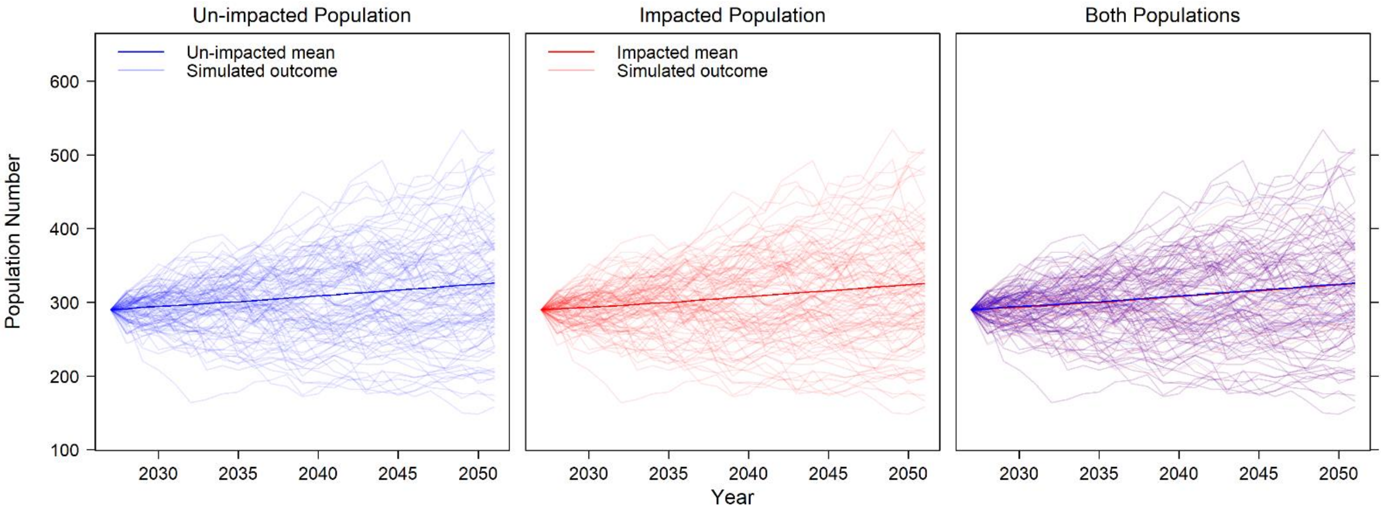


Figure 4.15: Simulated bottlenose dolphin population sizes for both the baseline (unimpacted) and the impacted populations under the maximum temporal scenario, with the higher fertility rate of 0.30.

Short-beaked common dolphin

4.9.3.72 For short-beaked common dolphin, the most conservative estimate of disturbance (using dose-response) led to up to three animals predicted to experience potential disturbance from concurrent piling of pin piles (Figure 4.8) at a maximum hammer energy of 3,000 kJ. This equates to 0.003% of the CGNS MU population.

4.9.3.73 The maximum numbers presented in Table 4.28 are based on densities from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023). There were no short-beaked common dolphin reported for SCANS-III surveys for the blocks overlapping the Mona marine mammal study area and two years of site-specific data from aerial surveys of Mona did not record any short-beaked common dolphin.

4.9.3.74 The extent of the area-based thresholds (strong and mild disturbance) are illustrated in Figure 4.13 for the southwest piling location. There are no protected areas designated for this species within the regional marine mammal study area.

4.9.3.75 Short-beaked common dolphin has a gestation period of 10 to 11 months, weaned at around 19 months old, and then the mother generally has a resting period of approximately four months before her next pregnancy, so calving intervals are generally a minimum of two to three years. For an individual female, the risk (albeit very small) could interrupt at least one key breeding period with additional risk to mother calf pairs during nursing. This is considered to be meaningful in the context the lifetime of an individual and therefore is classed as medium-term.

4.9.3.76 The use of iPCoD was discussed during the third EWG (Table 4.5), and since iPCoD did not facilitate modelling for short-beaked common dolphin no population modelling was carried out for this species.

4.9.3.77 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude of the impact could result in a small but measurable alteration to the distribution of marine mammals during piling only leading to possible displacement or interrupting key survival strategies (i.e. feeding or breeding) of some individuals (up to 0.003% of the CGNS MU population) over the medium term. The area of effect is however very small in relation to the extensive distribution of the population for this species (CGNS MU) and there is predicted to be no population consequences of the impact. The magnitude is therefore considered to be **low**.

Risso's dolphin

4.9.3.78 For Risso's dolphin, the most conservative estimate of disturbance (using dose-response) led to up to 129 animals predicted to experience potential disturbance from concurrent piling of pin piles (Figure 4.8) at a maximum hammer energy of 3,000 kJ and 3,000 kJ. This equates 1.05% of the CGNS MU population.

4.9.3.79 The maximum numbers presented in Table 4.28 were considered to be conservative as the estimate assumed uniform distribution which is unlikely to be the case. In addition, the calculation was based on the SCANS-III densities (0.0313 animals per km^2) for block E to the south of the Mona Array Area (since there were no reported densities for Block F overlapping the Mona marine mammal study area). Site-specific survey data from Mona digital aerial surveys only recorded two Risso's dolphin in November 2020. Therefore, the number of Risso's dolphin that may be disturbed as a result of all piling scenarios should be interpreted with caution as these animals are likely to be present in lower densities.

4.9.3.80 The extent of the area-based thresholds (strong and mild disturbance) are illustrated in Figure 4.13 for the southwest piling location. The sound contour for strong disturbance (160 dB re 1µPa SPL_{rms}) did not extend as far as the MNRs designated for Risso's dolphin around IoM waters (Langness, Little Ness, Douglas Bay, Bale Ny Carrickey, Calf and Wart Bank) although there was an overlap with the predicted extent for mild disturbance (140 dB re 1µPa SPL_{rms}).

4.9.3.81 Risso's dolphin have a gestation period of 13 to 14 months, giving birth to a single calf. Weaning is between 12 and 18 months, with intervals between calves averaging at 2.4 years. Therefore, the two-year duration of the piling phase could potentially overlap with at least one breeding cycle for an individual female. This is considered to be meaningful in the context the lifetime of an individual and therefore is classed as medium term.

4.9.3.82 Since iPCoD does not facilitate modelling for Risso's dolphin, no population modelling was carried out for this species. However, contours of 135 dB re 1µPa SEL_{ss} (= 140 dB re 1µPa SPL_{rms}, mild disturbance) reached the Isle of Man population around the south of the Island (Figure 4.8) and (based on the density estimate of 0.0313 animals per km^2) up to 21 Risso's dolphin may be present within this entire contour band (0.17% of the MU). Around the Isle of Man, Risso's are likely to be present here in summer months thus may experience some temporary displacement if piling is carried out during this season, noting they are highly mobile species and can move away from the area of ensonification.

4.9.3.83 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium-term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude of the impact could also result in a small but measurable alteration to the distribution of marine mammals during piling only leading to possible displacement or interrupting key survival strategies (i.e. feeding or breeding) of some individuals (up to 1.17% of the CGNS MU population) over the medium term. The area of effect is however small in relation to the extensive distribution of the population for this species (CGNS MU) and there is predicted to be no population consequences of the potential impact. The magnitude is therefore considered to be **low**.

Minke whale

4.9.3.84 Based on SCANS III block E minke whale density estimates (0.0173), up to 72 animals have the potential to be disturbed as a result of concurrent piling (Figure 4.8) at a maximum hammer energy of 3,000 kJ and 3,000 kJ, which equates to 0.35% of the CGNS MU.

4.9.3.85 The maximum numbers presented in Table 4.28 were considered to be conservative as these are based on the SCANS III Block E densities (carried out during summer months) and assume uniform distribution. Minke whale exhibit a temporal distribution in the Irish Sea, present from late April to early August. There is also a high degree of seasonality to Manx waters, as detailed in the Manx Marine Environmental Statement, with presence between June and November (Howe, 2018). Howe (2018) also noted a clear spatial aspect to the distribution of Minke whale sightings in Manx waters, with the majority of summer sightings on the west coast of the island, whereas in the autumn most sightings are on the east coast. As mentioned, two herring stocks in the Irish Sea (the Mourne Stock and the Manx Stock) may drive this pattern, with the Manx herring stock spawning off the east coast of the island in September to October (Bowers 1969), and Mourne stock are found together off the west coast of the island (Bowers 1980). Therefore, density values, and subsequently predicted numbers to be disturbed for minke whale will be overly conservative for piling activities should they occur during winter months.

4.9.3.86 As described in more detail in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, site-specific survey data from aerial surveys of Mona Aerial Survey Area did not record any minke whale. Therefore, the number of minke whale disturbed as a result of all piling scenarios should be interpreted with caution as these animals are likely to be present in lower densities.

4.9.3.87 The extent of the area-based thresholds (strong and mild disturbance) are illustrated in Figure 4.13 for the southwest piling location. No sites are designated for minke whale.

4.9.3.88 Piling within a two-year piling phase (albeit with intermittent piling) could coincide with key breeding periods of minke whale and is considered to be meaningful in the context of the lifespan of this species (paragraph 4.9.3.45). Population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of potential effects. Results of the iPCoD modelling for minke whale against the MU population showed that the median ratio of the impacted population to the unimpacted population at six years was 0.9976 and at 25 years was 0.9959 for the maximum temporal scenario and 0.9983 at six years and 0.9969 at 25 years for the maximum spatial scenario (Appendix A). Small differences in the population size over time between the impacted and unimpacted population (up to 38 individuals over 25 years in the maximum spatial scenario) fall within the natural variance of the population, and would not be expected to elicit a change in the population trajectory, as can be seen in Figure 4.16.

4.9.3.89 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium-term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly and a small proportion (up to 0.36%) of the CGNS reference population would be affected during piling. The results of the iPCoD modelling suggest that over the duration of the impact, six years post impact and up to 25 years after the start of piling there would be a small difference in the size of the impacted population, relative to the unimpacted population. The impacted population was predicted to be up to 25 individuals smaller after six years (corresponding to approximately 0.124% of the CGNS MU population estimate) and up to 38 individuals smaller (corresponding to approximately 0.189% of the CGNS MU population estimate) after 25 years. This is expected to result in no potential long-term effects on the minke whale population. Whilst the potential impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding) there would be no population-level consequences of disturbance. The magnitude is therefore considered to be **low**.

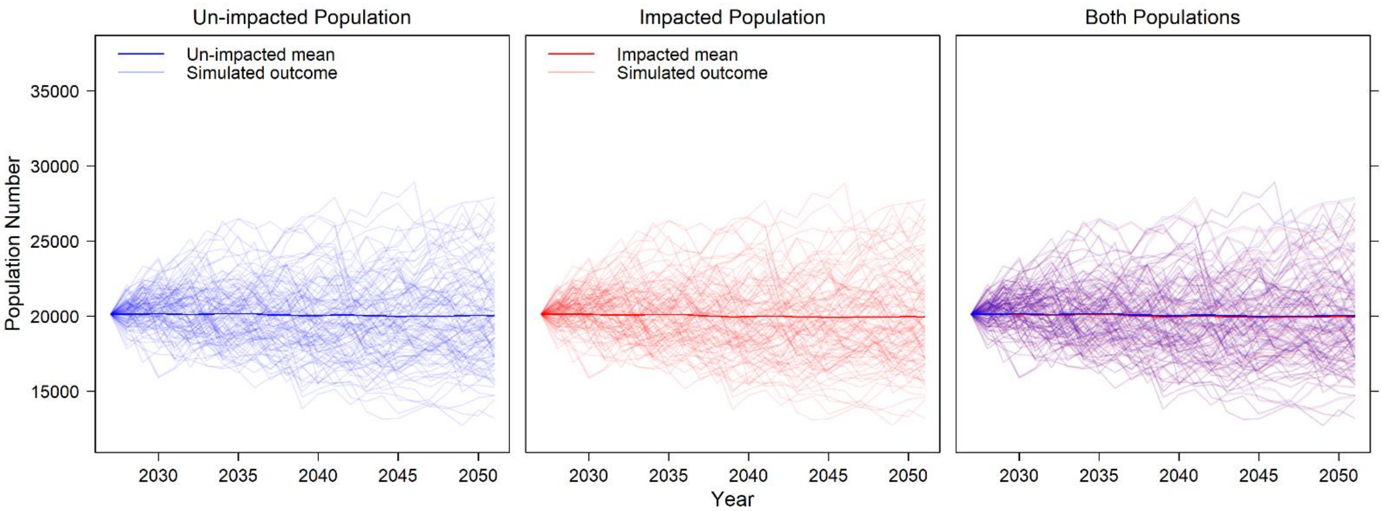


Figure 4.16: Simulated minke whale population sizes for both the baseline (unimpacted) and the impacted populations under the maximum spatial scenario.

Grey seal

4.9.3.90 For grey seal, the most conservative estimate of disturbance (using dose-response) led to up to 31 animals (Carter *et al.*, 2022 densities) predicted to experience potential disturbance from concurrent piling of pin piles at a maximum hammer energy of 3,000 kJ and 3,000 kJ (from the SE location, see Figure 4.17). This equates to 0.23% of the GSRP (as described in Table 4.12) or 0.07% of the OSPAR Region III population. Telemetry studies (presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement) demonstrate that grey seal move extensively across the Irish Sea with connectivity between key haul outs and the Mona marine mammal study area. Therefore, population estimates for all relevant management units have been summed to give one reference population against which to assess potential disturbance. In addition, further to consultation at the third marine mammal EWG (Table 4.5) the number of animals disturbed was assessed with reference to the OSPAR III population.

4.9.3.91 The probability of response map presented in Figure 4.18 illustrates the likelihood of disturbance to grey seal reduces as distance from the piling source increases, based upon the dose response function (see paragraphs 4.8.2.10 to 4.8.2.21 for detail). At the highest sound level around the piles there is the greatest probability of response from animals, but this decreases with distance from the piling source towards the coastal areas to a much lower probability of response.

4.9.3.92 As identified in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, ten sites designated for protection of grey seal are located within the regional marine mammal study area (Pen Llŷn a`r Sarnau/Llŷn Peninsula and the Sarnau SAC, Lambay Island SAC, Cardigan Bay/Bae Ceredigion SAC, Pembrokeshire Marine/Sir Benfro Forol SAC, Saltee Islands SAC and Lundy SAC, Langness MNR, Ramsey Bay MNR, Niarbyl MNR, West Coast MNR). Telemetry tracks presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement demonstrated high levels of connectivity between designated sites and therefore there is potential that some of the animals within the impacted area may be associated with wider SACs.

4.9.3.93 Similarly, applying the area-based unweighted sound threshold of 160 dB re 1 µPa SPL_{rms} (strong disturbance) predicted no overlap with any SAC or MNR designated for grey seal in the marine mammal study area. There was, however, an overlap with two of the IoM MNRs with grey seal a feature (Langness and Ramsey Bay) for the larger contour predicted for the 140 dB re 1µPa SPL_{rms} (mild disturbance) threshold although noting that this would be unlikely to displace animals from the area as received sound levels would elicit mild disruptions in behaviour (Figure 4.13). Therefore, there would not be anticipated to be strong disturbance of individuals within protected sites although individuals originating from these sites could range as far as the ensonified areas. Further assessment of the potential effects on SACs is provided in the ISAA (Document Reference E1.3).

Barrier effects

4.9.3.94 The potential for barrier effects (i.e. the ability to move between key areas such as haul-out sites and foraging areas offshore) was considered for both concurrent and single piling scenarios. The level at which a measurable response is predicted to occur in seal species is at a maximum received sound level of 145 dB re 1µPa SEL_{ss} (broadly equivalent to 155 re 1µPa SPL_{rms}) (Whyte *et al.,* 2020). Animals exposed to lower sound levels in the outer disturbance contours are likely to experience mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement, are unlikely to occur (Southall *et al*., 2021). The contours presented Figure 4.17 at the SE location (the location closest to areas of high grey seal density and therefore most likely overlap in area of ensonification) show those for a measurable response for seal species (Whyte *et al.,* 2020), and these contours do not reach the high density areas in the Dee Estuary.

4.9.3.95 With respect to the above, it was considered that grey seal close to the coast could experience very mild disturbance but that this would be unlikely to lead to barrier effects, (i.e. preventing animals from using the foraging grounds in waters along the coast) as animals are unlikely to be excluded from the coastal areas. Furthermore, grey seal has a large foraging range (up 448 km reported in Carter *et al*., 2022) and could therefore move to alternative foraging grounds during piling. Note, however, that animals would be likely to avoid offshore areas where received levels during piling exceed thresholds for strong disturbance. In addition, there may be an energetic cost associated with longer foraging trips and alternative habitat may be sub-optimal in terms of abundance of key prey species.

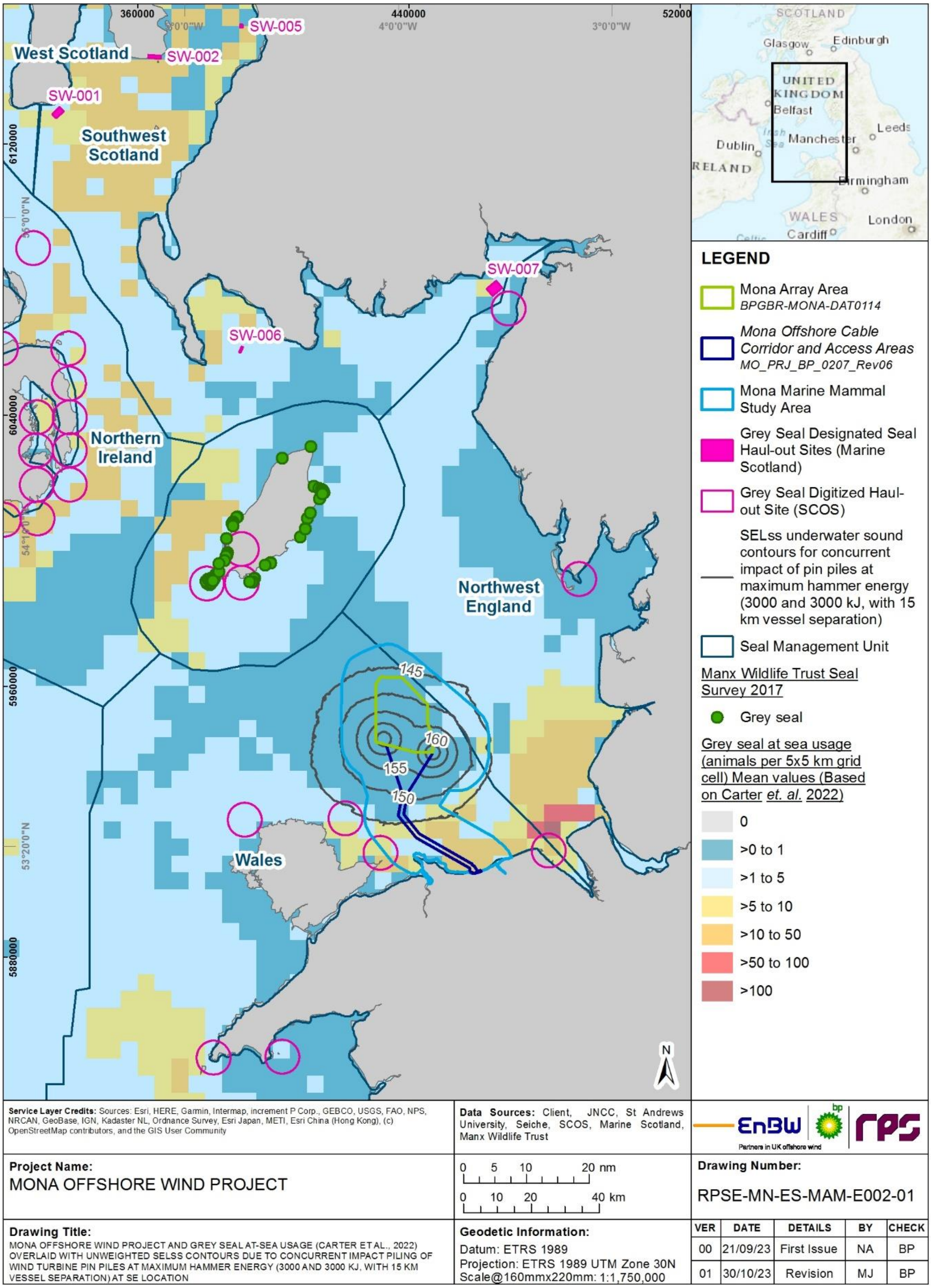
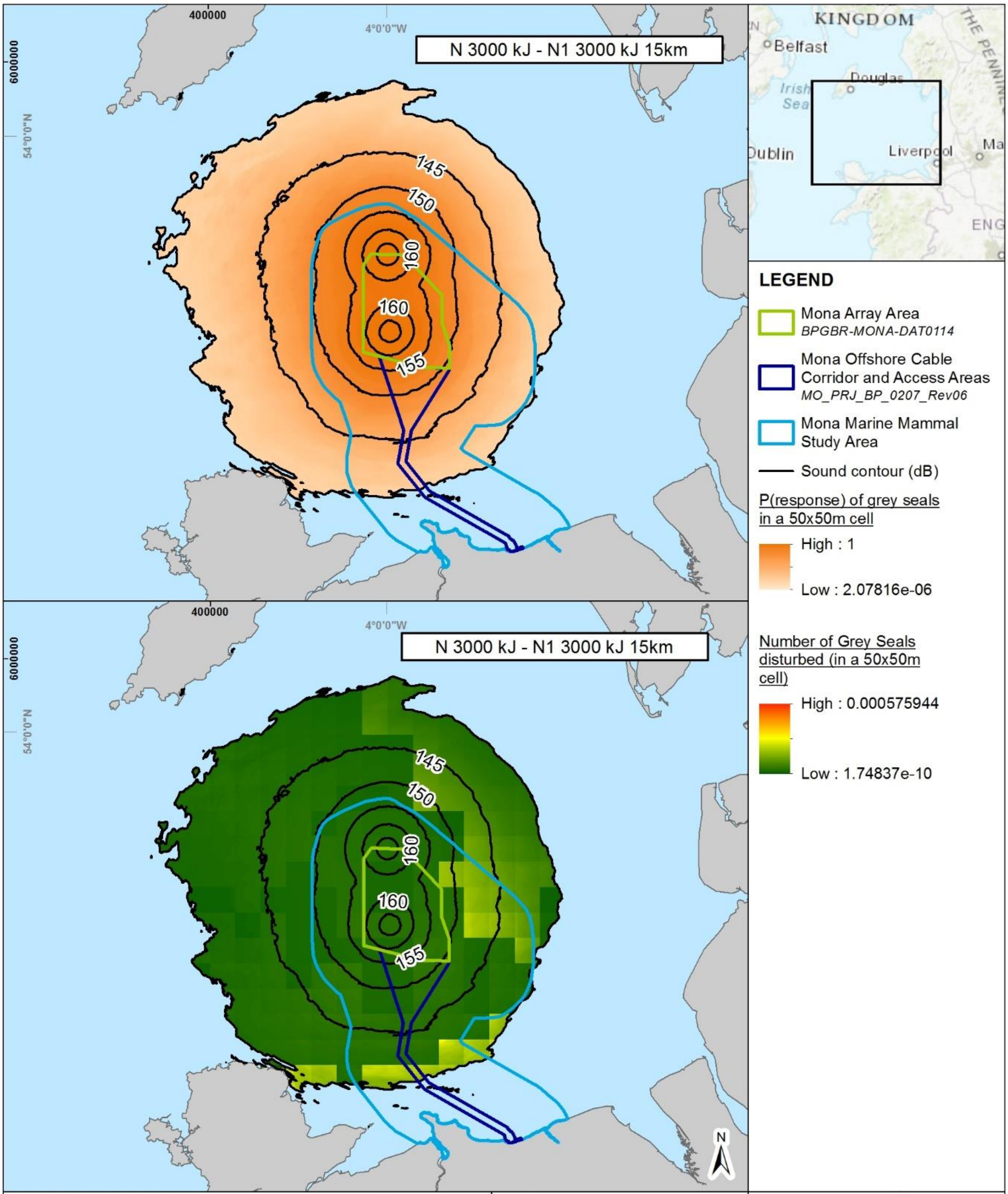


Figure 4.17: Mona offshore wind project and grey seal at-sea usage (Carter *et al*., 2022) overlaid with unweighted SELss contours due to concurrent impact piling of foundations for wind turbine pin piles at maximum hammer energy (3,000 and 3000 kJ with 15 km vessel separation) at the southeast concurrent modelling location.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Seiche

Project Name:
MONA OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MN-ES-MAM-062-01

Drawing Title:
PROBABILITY OF RESPONSE OF GREY SEALS (TOP PANEL) AND THE NUMBER OF ANIMALS DISTURBED BY UNDERWATER SOUND (CONCURRENT SCENARIO) (BOTTOM PANEL) IN EACH 50X50M CELL

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,250,000

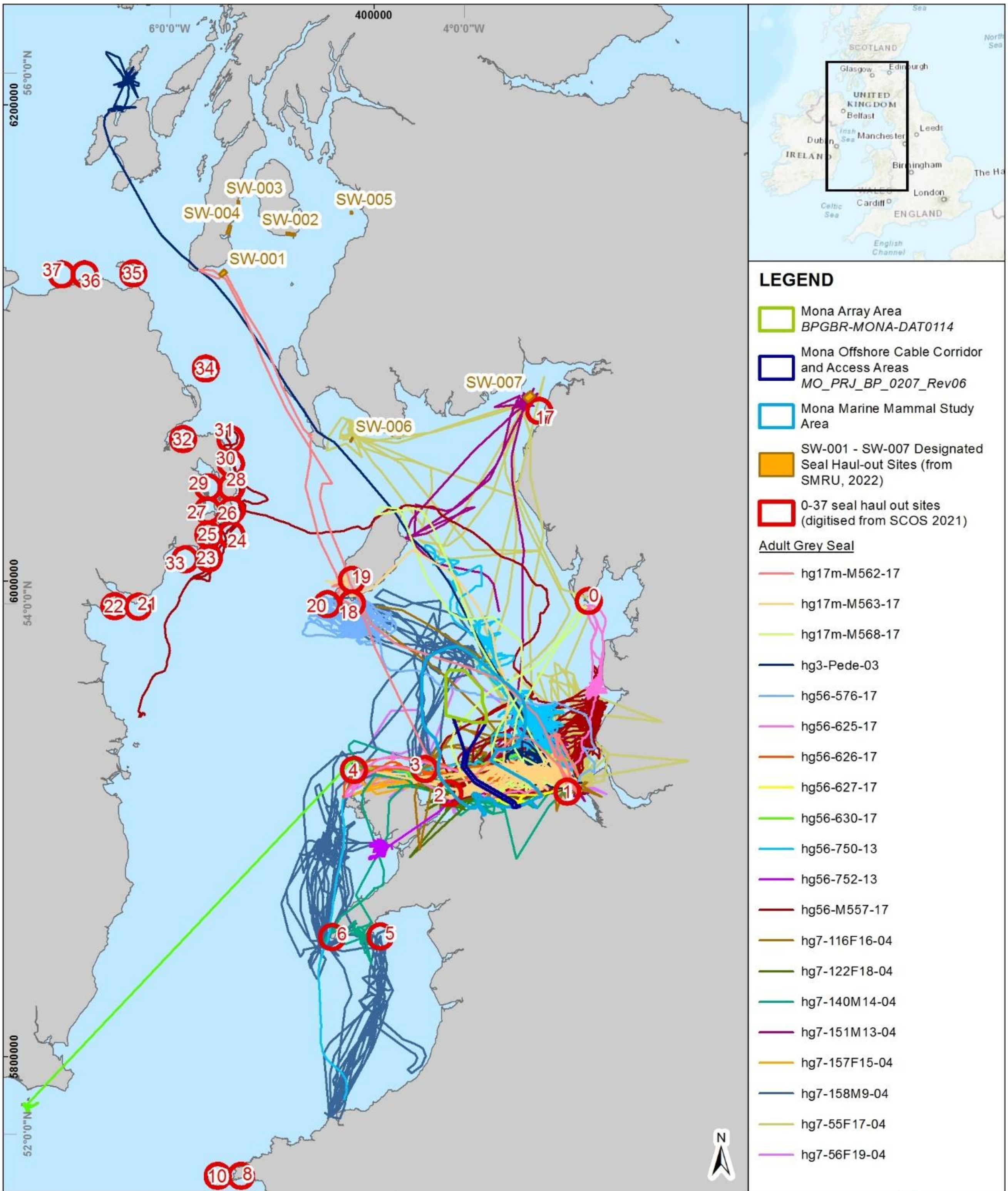
VER	DATE	DETAILS	BY	CHECK
00	27/09/23	First Issue	NA	TM
01	07/12/23	Revision	NA	BP

Figure 4.18: Probability of response mapping for grey seal. Top panel presents the probability of response (P(response)) which shows the percentage of grey seal disturbed per grid cell. Bottom panel demonstrates number of grey seal disturbed per cell using Carter *et al.* (2022) densities.

Impact on grey seal haul out sites

4.9.3.96 To assess the impact on grey seal haul out sites, connectivity of grey seal tracks from haul-out sites to the Mona marine mammal study area was considered. Telemetry data for adult and pup grey seals (provided in Appendix B in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement) was presented and seals that visited within a 5 km buffer of a haul out site (from SCOS, 2021) were recorded. Carter *et al.* (2022) aggregated counts from haul out site to 5 km grid cells known as ‘haulout cells’, and although Hornsea 4 (Orsted, 2021) used a 1 km buffer around haul out sites, a 5 km buffer was used in a precautionary approach for assessment. Results of connectivity are presented in Figure 4.19 for adult grey seals and Figure 4.20 for pups.

4.9.3.97 The assessment clearly showed that there is a high level of connectivity between the Mona marine mammal study area and haul out sites within the Irish Sea for adult seals (Figure 4.19). One adult grey seal visited nine haul out sites across the Irish Sea area (Figure 4.19, Figure 4.20). On average adult grey seals visited 4.1 haul out sites within the four seal MUs that cover the Irish Sea, but these are much wider spread across the regional marine mammal study area. Two grey seal pups (seal hg27-04-09 and hg29-19-10, Figure 4.20) visited three haul out sites within close proximity to each other, whilst one pup (hg29-11-10) visited six haul out sites at further distances in the Irish Sea from the Mona marine mammal study area.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU, SCOS, Marine Scotland

Project Name:
MONA OFFSHORE WIND PROJECT

0 5 10 20 30 40 nm
0 10 20 40 60 80 km

Drawing Number:
RPSE-MN-ES-MAM-060-02

Drawing Title:
GREY SEALS HAUL-OUT SITES AND ADULT GREY SEALS TELEMETRY TRACKS THAT GO THROUGH THE MONA MARINE MAMMAL STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,700,000

VER	DATE	DETAILS	BY	CHECK
00	15/09/23	First Issue	NA	BP
02	05/01/24	Revision	MJ	BP

Figure 4.19: Adult Grey seal tracks from SMRU that transverse the Mona marine mammal study area and haul out sites (digitised from SCOS, 2021).

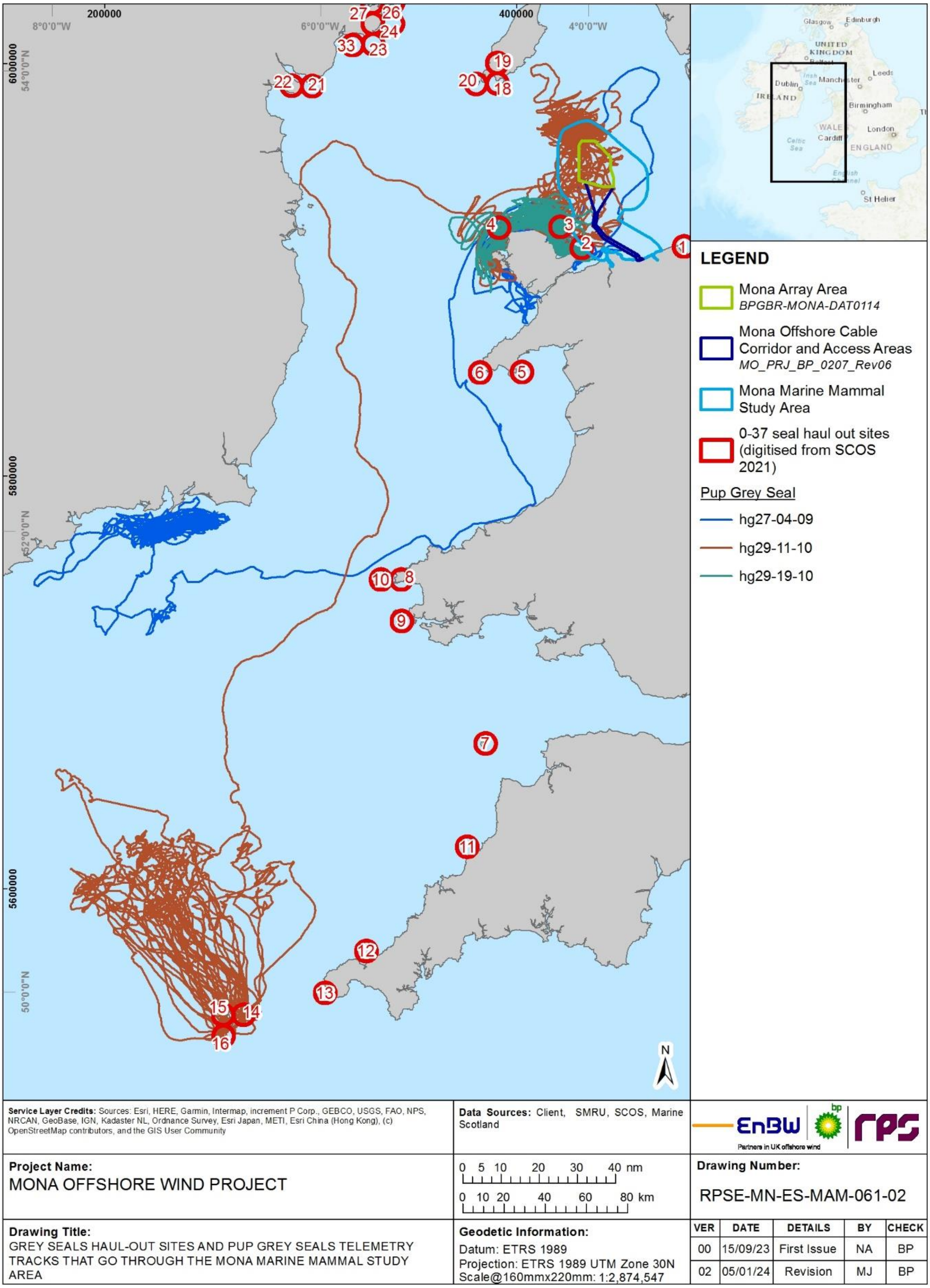


Figure 4.20: Pup Grey seal tracks from SMRU that transverse the Mona marine mammal study area and haul out sites (digitised from SCOS, 2021).

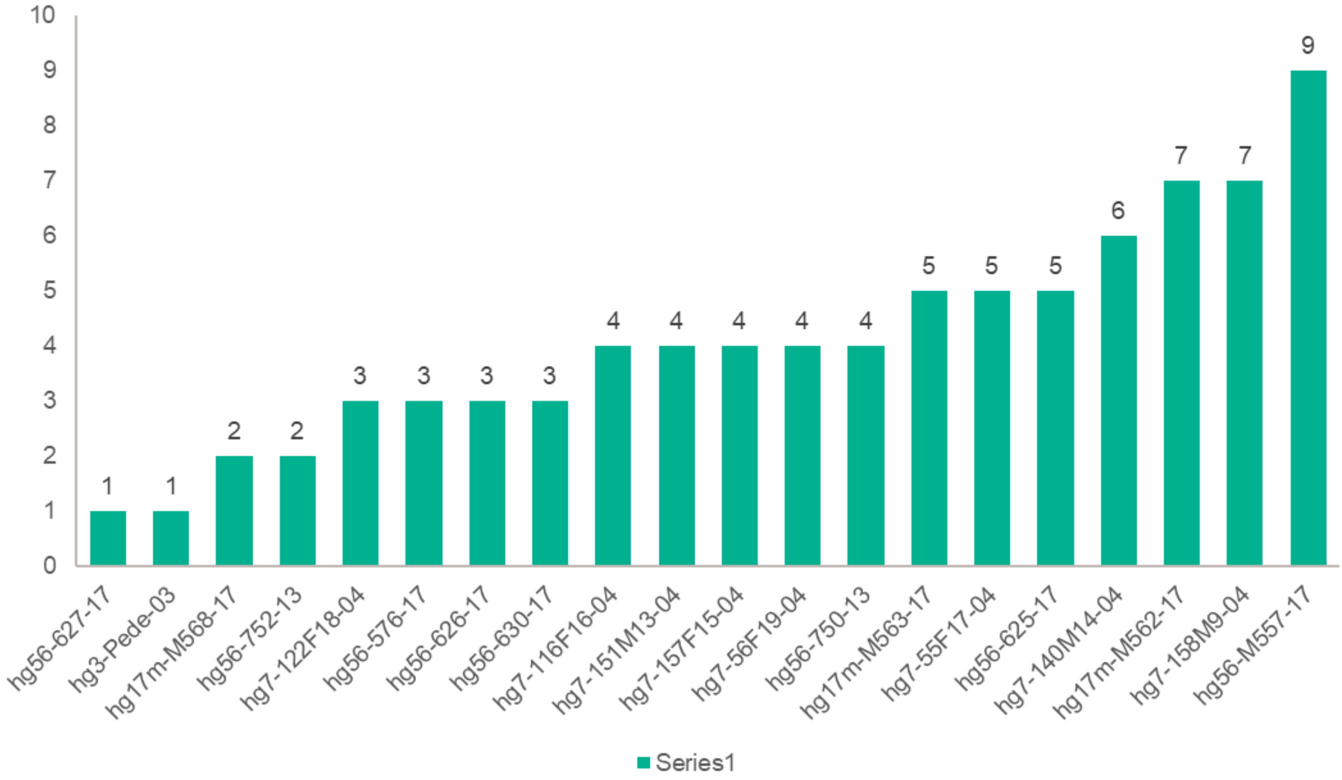


Figure 4.21: Number of haul out sites visited by each grey adult seal that entered the Mona marine mammal study area.

4.9.3.98 In terms of SACs, adult grey seal telemetry data showed a total of 36 animals (from 44 adult grey seals tagged between 2004 and 2018) recorded tracks within a 100 km buffer of the proposed Mona Offshore Wind Project (based on average foraging range of species), 19 of which showed connectivity to the surrounding SACs. Of these 17 grey seals showed connectivity with Pen Llŷn a'r Sarnau/Llŷn Peninsula and the Sarnau SAC (47.2%), eight showed connectivity with Pembrokeshire Marine/Sir Benfro Forol SAC (22.2%), eight showed connectivity with Cardigan Bay SAC (22.2%), three showed connectivity with Saltee Islands SAC (8.3%) and one seal showed connectivity with The Maidens SAC (2.8%). These totals are derived from the SMRU data presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

4.9.3.99 Therefore, it can be concluded that there is a high level of connectivity the Mona Offshore Wind Project and three SACs in the Wales MU (Pen Llŷn a'r Sarnau/Llŷn Peninsula and the Sarnau SAC and the Pembrokeshire Marine/Sir Benfro Forol SAC and the Cardigan Bay SAC) and comparatively lower levels of connectivity with SACs at further distances from the Mona Offshore Wind Project (Saltee Islands SAC and Isle of Scilly Complex SAC).

4.9.3.100 For grey seal pups, 13 pups (from a 17 total of grey seal pups tagged between 2009 and 2010) recorded telemetry tracks within a 100 km buffer of the Mona Offshore Wind Project, 11 of which showed connectivity to surrounding SACs. Of these, 10 seals showed connectivity with Pen Llŷn a'r Sarnau/Llŷn Peninsula and the Sarnau SAC (76.9%), six with Pembrokeshire Marine/Sir Benfro Forol SAC (46.2%), three with Cardigan Bay SAC (23.1%), three with Saltee Islands SAC (Ireland) (23.1%) and two with Isle of Scilly Complex SAC (15.4%). As in paragraph 4.9.3.99, there is a high level of connectivity between the Mona marine mammal study area and SACs within the Wales MU and further afield.

4.9.3.101 Grey seal typically live between 20 to 30 years with gestation lasting between ten to 11 months (SCOS, 2015; SCOS, 2018), thus the duration of piling (albeit intermittent) could potentially overlap with up to two breeding cycles. Considering the above, the duration of the effect in the context of the life cycle of grey seal is classified as medium term.

4.9.3.102 Population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the impact assessment. Results of the iPCoD modelling for grey seal showed that the median ratio of the impacted population to the unimpacted population (when using both the GSRP and OSPAR region III) at six and 25 years was 1.0000 for both the maximum temporal and maximum spatial scenarios (Appendix A). Moreover, simulated grey seal population sizes for both baseline (unimpacted) and impacted populations showed no difference (Figure 4.22). Therefore, it was considered that there is no potential for long-term effects on this species.

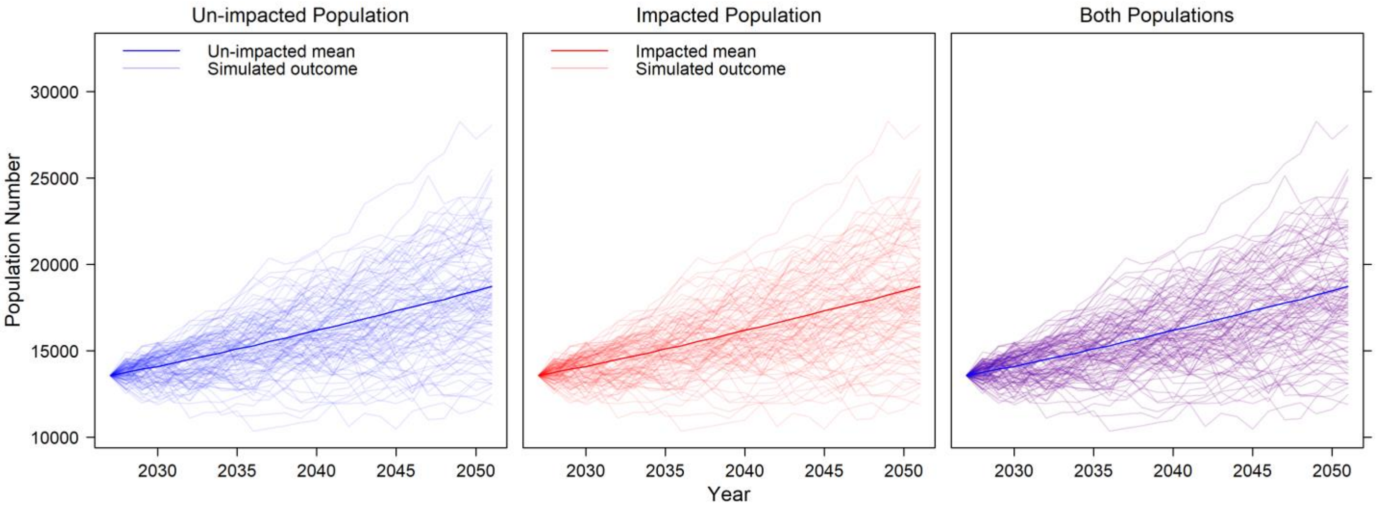


Figure 4.22: Simulated grey seal population sizes for both the baseline (unimpacted) and the impacted populations under the maximum temporal scenario, using the GSRP.

4.9.3.103 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium-term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. A small proportion (up to 0.32% of the GSRP, or 0.07% of OSPAR Region III) would be affected during piling and the results of the iPCoD modelling suggest that over the duration of the impact and up to 25 years after the start of piling there would be no long-term effects on the grey seal population. Whilst the impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding) there would be no population-level consequences of disturbance. The magnitude is therefore considered to be **low**.

Harbour seal

4.9.3.104 For harbour seal, the most conservative estimate of disturbance (using dose-response) led to up to one animal (Carter *et al.*, 2022 densities) predicted to experience potential disturbance from concurrent piling of pin piles at a maximum hammer energy of 3,000 kJ. This equates to 0.01% of the HSRP (Wales, NW England, Northern Ireland SMUs) (Table 4.12). Telemetry studies (presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement) demonstrate that harbour seal traverse all three SMUs and therefore population estimates for three SMUs have been summed to give one reference population for which to assess potential disturbance against.

4.9.3.105 The unweighted threshold of 143 dB re 1µPa^{2}s single strike sound exposure level (SELss) (at the North modelled location, Figure 4.10) (see paragraph 4.9.2.25) led up to three animals disturbed (using the higher inshore density of 0.001 animals per km^2), equating to 0.2% of the HSRP.

4.9.3.106 As identified in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, seven sites are designated for protection of harbour seal are located within the regional marine mammal study area (Langness MNR, Ramsey Bay MNR, West Coast MNR, Strangford Lough SAC, Murlough SAC, Lambay Island SAC and Slaney River Valley SAC). There is potential overlap of sound contours with Langness MNR, Ramsey Bay MNR, Strangford Lough SAC, Murlough SAC and Lambay Island SAC. Telemetry tracks presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement demonstrated some connectivity both between designated sites, and between the Mona Offshore Wind Project and designated sites, therefore there is potential that some of the harbour seal within the impacted area may be associated with other wider SACs. It must be noted that harbour seal have a smaller maximum foraging range (273 km) and therefore levels of connectivity between SACs are less than for grey seal which forage further distances.

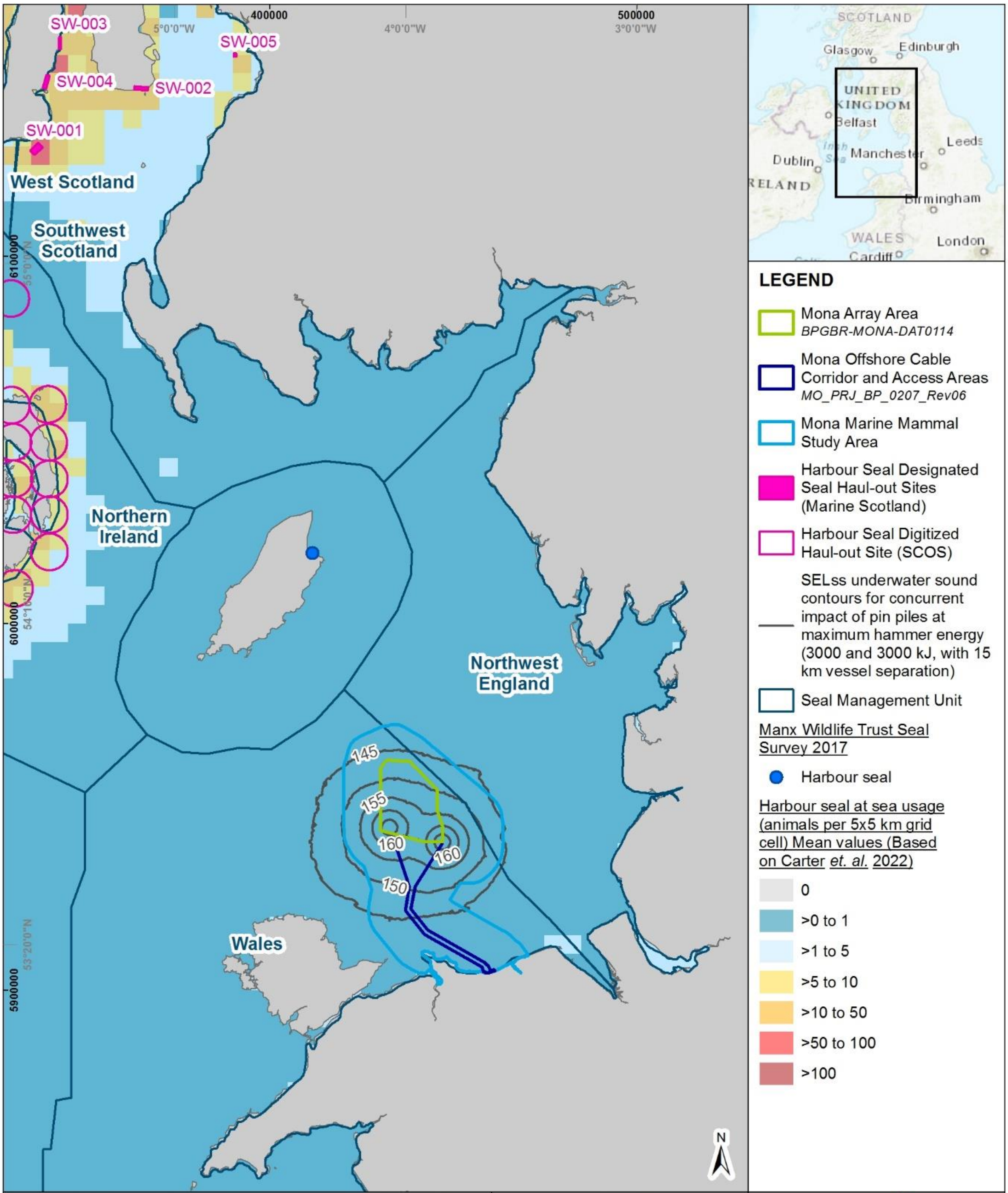
4.9.3.107 Similarly, applying the area-based unweighted sound threshold of 160 dB re 1 µPa SPL_{rms} (strong disturbance) predicted no overlap with any SAC or MNR designated for harbour seal in the marine mammal study area. There was, however, an overlap with two of the IoM MNRs with harbour seal as features (Langness and Ramsey Bay) for the larger contour predicted for the 140 dB re 1µPa SPL_{rms} (mild disturbance) threshold although noting that this would be unlikely to displace animals from the area as received sound levels would elicit mild disruptions in behaviour (Figure 4.13). Therefore, there would not be anticipated to be strong disturbance of individuals within protected sites although individuals originating from these sites could range as far as the ensonified areas. Further assessment of the potential effects on SACs is provided in the ISAA (Document Reference E1.3).

Barrier effect

4.9.3.108 The potential for barrier effects (i.e. the ability to move between key areas such as haul-out sites and foraging areas offshore) is considered for both concurrent and single piling scenarios. The level at which a measurable response is predicted to occur in seal species is at a maximum received sound level of 145 dB re 1 µPa^{2}s (SEL_{ss}) (Whyte *et al.*, 2020) and the outer contours show levels of 130 dB re 1 µPa^{2}s. The 143 dB re 1 µPa^{2}s (SEL_{ss}) threshold from Tougaard (2021) (based on VHF harbour porpoise) is below this measurable response for seal species, and these contours do not overlap high density areas of harbour seal.

4.9.3.109 Animals exposed to lower sound levels in the outer disturbance contours are likely to experience mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement, are unlikely to occur (Southall *et al*., 2021).

4.9.3.110 It is considered that very small numbers of harbour seal (i.e. no more than one animal at any one time) close to the coast could experience mild disturbance but that this is unlikely to lead to barrier effects, (i.e. preventing animals from using the foraging grounds in waters along the coast) as animals are unlikely to be excluded from the coastal areas. Furthermore, as mentioned in paragraph 4.9.3.59, animals can travel to other areas to feed during piling, although harbour seal tend to forage within 50 km of the coast and therefore may be restricted in the area of available habitat. Note also that animals would be likely to avoid offshore areas where received levels during piling exceed thresholds for strong disturbance and there may be an energetic cost associated with longer foraging trips and alternative habitat may be sub-optimal in terms of abundance of key prey species.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community	**Data Sources:** Client, JNCC, St Andrews University	
Project Name: MONA OFFSHORE WIND PROJECT	0 5 10 20 nm / 0 10 20 40 km	**Drawing Number:** RPSE-MN-ES-MAM-E003-01
Drawing Title: HARBOUR SEAL AT-SEA USAGE (CARTER ET AL., 2022) OVERLAID WITH UNWEIGHTED SELSS (DB) CONTOURS FROM MONA OFFSHORE WIND PROJECT DUE TO CONCURRENT IMPACT PILING OF WIND TURBINE PIN PILES AT MAXIMUM HAMMER ENERGY (3000 AND 3,000 KJ) AT SE LOCATION	**Geodetic Information:** Datum: ETRS 1989 Projection: ETRS 1989 UTM Zone 30N Scale@160mmx220mm: 1:1,750,000	

VER	DATE	DETAILS	BY	CHECK
00	21/09/23	First Issue	NA	BP
01	30/10/23	Revision	MJ	BP

Figure 4.23: Harbour seal at-sea usage (Carter *et al.*, 2022) overlaid with unweighted SEL_{ss} (dB) contours from Mona Offshore Wind Project due to concurrent impact piling of foundations for wind turbine pin piles at maximum hammer energy (3,000 and 3,000 kJ) at southeast modelling location.

4.9.3.111 Harbour seal typically live between 20 to 30 years with gestation lasting between ten to 11 months (SCOS, 2015; SCOS, 2018), thus the duration of piling (albeit intermittent) could potentially overlap with up to two breeding cycles. Considering the above, the duration of the effect in the context of life cycle of harbour seal is classified as medium term. The magnitude of the potential impact could also result in a very small effect on the distribution of harbour seal during piling only and may affect the fecundity of very small numbers in the context of the reference population (up to 0.01% of the combined total of MU population at any one time) over the medium term. Due to the very small numbers and small proportion of the population affected the magnitude of the impact is unlikely to lead to a population-level effect and this species was not carried forward for further assessment within the iPCoD model framework.

4.9.3.112 The impact (elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium-term duration, intermittent and high reversibility (the impact itself occurs only during piling). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. Whilst the impact could result in some measurable changes to a very small number of individuals that are disturbed (i.e. interruption of feeding or breeding) there would be no population-level consequences of disturbance. The magnitude is therefore considered to be **negligible**.

Sensitivity of the receptor

Auditory injury

Harbour porpoise

4.9.3.113 Kastelein *et al*. (2013) reported that hearing impairment as a result of exposure to piling sound is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum. An experiment undertaken as a part of this study demonstrated that for simulated piling sound (broadband spectrum), harbour porpoise hearing around 125 kHz (the key frequency for echolocation) was not affected. Instead, a measurable threshold shift in hearing was induced at frequencies of 4 kHz to 8 kHz, although the magnitude of the hearing shift was relatively small (2.3 dB to 3.6 dB at 4 kHz to 8 kHz) due to the lower received SELs at these frequencies. This was due to most of the energy from the simulated piling occurring in lower frequencies (Kastelein *et al*., 2013). Subsequent study confirmed sensitivity declined sharply above 125 kHz (Kastelein *et al*., 2017).

4.9.3.114 The duty cycle of fatiguing sounds is also likely to affect the magnitude of a hearing shift, e.g. hearing may recover to some extent during inter-pulse intervals (Kastelein *et al*., 2014). Other studies reported that whilst a threshold shift can accumulate across multiple exposures, the resulting shift will be less than the shift from a single, continuous exposure with the same total SEL (Finneran, 2015).

4.9.3.115 In order to minimise exposure to sound, cetaceans are able to undertake some self-mitigation measures, e.g. the animal can change the orientation of its head so that sound levels reaching the ears are reduced, or it can suppress hearing sensitivity by one or more neurophysiological auditory response control mechanisms in the middle ear, inner ear, and/or central nervous system. Kastelein *et al*. (2020) highlighted the lack of reproducibility of TTS in a harbour porpoise after exposure to repeated airgun sounds, and suggested the discrepancies may be due to self-mitigation.

4.9.3.116 It is important to note that extrapolating the results from captive bred studies to how animals may respond in the natural environment should be treated with caution as there are discrepancies between experimental and natural environmental conditions. In addition, the small number of test subjects would not account for intraspecific differences (i.e. differences between individuals) or interspecific differences (i.e. extrapolating to other species) in response. However, based on current scientific evidence, PTS is a permanent and irreversible hearing impairment. It is therefore anticipated that harbour porpoise is sensitive to this effect as the loss of hearing would affect key life functions (e.g. mating and maternal fitness, communication, foraging, predator detection) and could lead to a change in an animal's health (chronic) or vital rates (acute) (Erbe *et al*., 2018). In addition to studies conducted in controlled environments, there is also evidence on sound-induced hearing loss, based on inner ear analysis in a free-ranging harbour porpoise (Morell *et al*., 2021). Considering the above, a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals (Costa, 2012).

4.9.3.117 The assessment of sensitivity provided below takes into account the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication in all cetaceans.

4.9.3.118 Although a threshold shift may occur outside of the most sensitive hearing range, the occurrence of PTS in harbour porpoise, due to the species reliance on hearing, could be detrimental to an individual's capacity for survival and reproduction. Harbour porpoise is therefore deemed to have limited resilience, low recoverability and is of international value. The sensitivity of the receptor to PTS is therefore considered to be **high.**

Bottlenose dolphin, short-beaked common dolphin, Risso's dolphin

4.9.3.119 Individuals experiencing PTS would suffer a biological effect that could impact the animal's health and vital rates (Erbe *et al*., 2018). Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin are all classed as high-frequency cetaceans (Southall *et al*., 2019). As described for harbour porpoise in section 4.9.3.113 there are frequency-specific differences in the onset and growth of a sound-induced threshold shift in relation to the characteristics of the sound source and hearing sensitivity of the receiving species. For example, exposure of two captive bottlenose dolphin to an impulsive sound source between 3 kHz and 80 kHz found that there was increased susceptibility to auditory fatigue between frequencies of 10 to 30 kHz (Finneran and Schlundt, 2013). The SEL_{cum} threshold incorporates hearing sensitivities of marine mammals and the magnitude of effects for high-frequency cetaceans are considerably smaller compared to the very high-frequency (e.g. harbour porpoise) and low-frequency (e.g. minke whale) species, highlighting that species such as bottlenose dolphin, short-beaked common dolphin and Risso's dolphin are less sensitive to the frequency components of the piling sound signal. The assessment considered the irreversibility of the effects (i.e. as noted for harbour porpoise) and importance of sound for echolocation, foraging and communication in small, toothed cetaceans.

4.9.3.120 The assessment of sensitivity provided below takes into account the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication in all cetaceans.

4.9.3.121 Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin are deemed to have limited resilience to PTS, low recoverability and international value. The sensitivity of the receptors to PTS is therefore, considered to be **high.**

Minke whale

4.9.3.122 Empirical evidence of hearing sensitivities for minke whale is limited, although studies suggest that their vocalisation frequencies are likely to overlap with anthropogenic sounds. Minke whale do not echolocate but likely use sound for communication and, like other mysticete whales, are able to detect sound via a skull vibration enabled bone conduction mechanism (Cranford and Krysl, 2015). Baleen whales have an estimated functional hearing range between 17 Hz and 35 kHz and it is likely that they rely on low frequency hearing (Ketten and Mountain, 2009). A strong reaction to a 15 kHz ADD has been recorded in controlled exposure study on free-ranging minke whale in Iceland, suggesting that this frequency is at the likely upper limit of their hearing sensitivity (Boisseau *et al*., 2021). As described for harbour porpoise in paragraph 4.9.3.113, there are likely to be frequency-specific differences in the onset and growth of a sound-induced threshold shift in relation to the characteristics of the sound source and hearing sensitivity of the receiving species.

4.9.3.123 The assessment of sensitivity provided below takes into account the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication in all cetaceans.

4.9.3.124 Minke whale is deemed to have limited resilience to PTS, low recoverability and international value. The sensitivity of the receptor to PTS is therefore, considered to be **high.**

Harbour seal and grey seal

4.9.3.125 Seals rely on sound for communication and predator avoidance (Deecke *et al*., 2002), rather than for foraging. They detect swimming fish with their vibrissae (Schulte-Pelkum *et al*., 2007), however, in certain conditions, they may also listen to sounds produced by vocalising fish in order to hunt for prey. Thus, likely ecological consequences of a sound induced threshold shift in seals are a reduction in fitness, reproductive output and longevity (Kastelein *et al*., 2018). Hastie *et al*., (2015) reported that, based on calculations of SEL of tagged harbour seal during the construction of the Lincs Offshore Wind Farm (Greater Wash, UK), at least half of the tagged animals would have received sound levels from pile driving that exceeded auditory injury thresholds for pinnipeds (PTS). However, population estimates indicated that the relevant population trend is increasing and therefore, although there are many other ecological factors that will influence the population health, this indicated that predicted levels of PTS did not affect a sufficient number of individuals to cause a decrease in the population trajectory (Hastie *et al*., 2015). However, it has been noted that due to paucity of data on effects of sound on seal hearing, the exposure criteria used are intentionally conservative and therefore predicted numbers of individuals likely to be affected by PTS presented in the study were also highly conservative.

4.9.3.126 Reichmuth *et al*. (2019) reported the first confirmed case of PTS following a known acoustic exposure event in a seal. The study included evaluation of the underwater hearing sensitivity of a trained harbour seal before and immediately following exposure to 4.1 kHz tonal fatiguing stimulus (SPL_{rms} was increased from 117 to 182 dB re 1 μPa), and rather than the expected pattern of TTS onset and growth, an abrupt threshold shift of >47 dB (i.e. the difference between the pre-exposure and post-exposure hearing thresholds in dB) was observed half an octave above the exposure frequency. Hearing at 4.1 kHz recovered within 48 hours, however, there was a PTS of at least 8 dB at 5.8 kHz, and hearing loss was evident for more than ten years.

4.9.3.127 Seals rely on hearing much less than cetaceans and therefore it is anticipated that they would exhibit some resilience or behavioural adaptation to the effects of underwater sound, (i.e. is it unlikely to cause a change in either reproduction or survival rates). In addition, in order to minimise exposure to sound, it has been proposed that seals are able to undertake some self-mitigation measures, e.g. reduce their hearing sensitivity in the presence of loud sounds in order to reduce their perceived SPL (Kastelein *et al*., 2018).

4.9.3.128 The telemetry data confirmed that there is a high level of connectivity between the marine mammal study area and the Pen Llŷn a'r Sarnau/Llŷn Peninsula and the Sarnau SAC, the Pembrokeshire Marine/Sir Benfro Forol SAC and the Cardigan Bay/Bae Ceredigion SAC and lower levels of connectivity with grey seal SACs at further distances from the Mona Offshore Wind Project. Therefore, individuals from these designated sites have a potential to be present within the injury range during piling at the Mona Offshore Wind Project. The same applies to harbour seal from the Strangford Lough SAC and Murlough SAC, as five harbour seal tagged in the Northern Ireland MU showed the connectivity with these designated sites and north of the Mona marine mammal study area.

4.9.3.129 Harbour seal and grey seal are deemed to have limited resilience to PTS, low recoverability and international value. The sensitivity of the receptor to PTS is therefore, considered to be **high.**

Behavioural disturbance

Harbour porpoise

4.9.3.130 Given that harbour porpoise is vulnerable to heat loss through radiation and conduction and has a high metabolic requirement, it needs to forage frequently to lay down sufficient fat reserves for insulation. Kastelein *et al*. (1997) conducted a study on six non-lactating harbour porpoise and found that they require between 4 % and 9.5 % of their body weight in fish per day. It has been reported that in the wild, porpoise forage almost continuously day and night to achieve their required calorific intake (Wisniewska *et al*., 2016) and therefore they are vulnerable to starvation if their foraging is interrupted. Although, based on the aerial data, modelled densities of harbour porpoise within Mona marine mammal study area were higher during winter, other studies consider harbour porpoise to be present year around in the Irish Sea (for more details see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement). Therefore, harbour porpoise could be vulnerable to piling at any time of year.

4.9.3.131 The responsiveness as a result of behavioural disturbance due to increased underwater sound is context-specific. Ellison *et al*. (2012) reported that factors important in determining the likelihood of a behavioural response and therefore their sensitivity include the activity state of the receiving animal, the nature and novelty of the sound (i.e. previous exposure history), as well as the spatial relation between sound source and receiving animal.

4.9.3.132 In recent study, Kastelein *et al.* (2022) studied the effects of six piling sounds (average in the pool of up to 135 dB re 1 µPa^{2}s) on one harbour porpoise in experimental conditions. The study found that after each test period (exposing animal to piling sounds for 15 minutes) in which the harbour porpoise responded to the sound by behavioural reaction (e.g. changing her respiration rate, moving away from the sound source), behaviour was observed to return to normal immediately. At-sea measurements reported by Brandt *et al.* (2012) observed reduced porpoise acoustic activity within a 2.6 km range from a piling site 24 hours to 72 hours after sounds stopped, although shorter return times were recorded after application of sound abatement methods such as air bubble screens (approximately six hours). The discrepancy between times required for harbour porpoise to return to the affected area in the pool versus at sea are likely to relate to the SEL experienced by the animal, which at sea depends on their distance from the piling location (Kastelein *et al.,* 2022). The study also reported that the frequency content of sounds is an important factor determining the response of harbour porpoise and that the high-frequency part of the spectrum of impulsive pile driving has a relatively large effect on their behaviour.

4.9.3.133 Empirical evidence from monitoring at offshore wind farms during construction (Brandt *et al*., 2011) suggests that during pile driving there will be a proportional decrease in avoidance at greater distances from the pile driving source and therefore it is unlikely to lead to 100% avoidance of all individuals exposed. Measurements at Horns Rev Offshore Wind Farm demonstrated 100 % avoidance in harbour porpoise at up to 4.8 km from the piles, whilst at greater distances (10 km plus) the proportion of animals displaced reduced to <50% (Brandt *et al*., 2011). Subsequently, Graham *et al*. (2019) used data from piling at the Beatrice Offshore Wind Farm and suggested that harbour porpoise may adapt to increased sound disturbance over the course of the piling phase, thereby showing a degree of tolerance and behavioural adaptation. This study also demonstrated that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the sound source. Similarly, Brandt *et al*. (2018) reported that detections of harbour porpoise declined several hours before the start of piling within the vicinity (up to 2 km) of the construction site and were reduced for about one to two hours post-piling, whilst at the maximum effect distances (from 17 km out to approximately 33 km) avoidance only occurred during the hours of piling. Porpoise detections during piling were found at sound levels exceeding 143 dB re 1 μPa^2s and at lower received levels – at greater distances from the source – there was little evident decline in porpoise detections (Brandt *et al*., 2018). Studies described above corroborate the dose-response relationship between received sound levels and declines in porpoise detections although noting that the extent to which responses could occur will be context-specific such that, particularly at lower received levels (i.e. 130 dB -140 dB re 1 μPa^2s), detectable responses may not be evident from region to region.

4.9.3.134 Building on earlier work presented in Southall *et al*. (2007) and the expanding literature in this area, Southall *et al*. (2021) introduced a concept of behavioural response severity spectrum with progressive severity of possible responses within three response categories: survival (e.g. resting, navigation, defence), feeding (e.g. search, consumption, energetics), and reproduction (e.g. mating, parenting). For example, at the point of the spectrum rated seven to nine, where sensitivity is highest, displacement is likely to occur resulting in movement of animals to areas with an increased risk of predation and/or with sub-optimal feeding grounds. A failure of vocal mechanisms to compensate for sound can result in interruption of key reproductive behaviour including mating and socialising, causing a reduction in an individual's fitness leading to potential breeding failure and impact on survival rates.

4.9.3.135 There are limitations of the single step-threshold approach for strong disturbance and mild disturbance as it does not account for inter-, or intra-specific variance or context-based variance. However, according to Southall *et al*. (2021), harbour porpoise within the area modelled as 'strong disturbance' would be most sensitive to behavioural effects and therefore may have a response score of seven or above. Mild disturbance (score four to six) could lead to effects such as changes in swimming speed and direction, minor disruptions in communication, interruptions in foraging, or disruption of parental attendance/nursing behaviour (Southall *et al*., 2021). Therefore, at the lower end of the behavioural response spectrum, the potential severity of effects is reduced and whilst there may be some detectable responses that could result in effects on the short-term health of animals, these are less likely to impact on an animal's survival rate.

4.9.3.136 Although harbour porpoise may be able to avoid the disturbed area and forage elsewhere, there may be a potential effect on reproductive success of some individuals. As mentioned previously, it is anticipated that there would be some adaptability to the elevated sound levels from piling and therefore survival rates are not likely to be affected. Due to uncertainties associated with the effects of behavioural disturbance on vital rates of harbour porpoise, the assessment is highly conservative as it assumes the same level of sensitivity for both strong and mild disturbance, noting that for the latter the sensitivity is likely to be lower.

4.9.3.137 Harbour porpoise is deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor to behavioural disturbance is therefore, considered to be **medium.**

Bottlenose dolphin, short-beaked dolphin, Risso's dolphin

4.9.3.138 Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin are not thought to be as vulnerable to disturbance as harbour porpoise; with larger body sizes and lower metabolic rates, the necessity to forage frequently is lower.

4.9.3.139 There is limited information regarding the specific sensitivities of high frequency cetaceans to disturbance from piling sound as most studies have focussed on harbour porpoise. A study of the response of bottlenose dolphin to piling sound during harbour construction works at the Nigg Energy Park in the Cromarty Firth (northeast Scotland) found that there was a weak but measurable response to impact and vibration piling with animals reducing the amount of time they spent in the vicinity of the construction works (Graham *et al*., 2017). Fernadez-Betelu *et al*. (2021) investigated dolphin detections in the Moray Firth during impact piling at the Beatrice and Moray Offshore Wind Farms and found surprising results at small temporal scales with an increase in dolphin detections on the southern Moray coast on days with impulsive sound compared to days without with predicted maximum received levels in coastal areas of 128 dB re. 1µPa^{2}s and 141 dB re. 1µPa^{2}s respectively. The authors of this study warn that caution must be exercised in interpreting these results as increased click changes do not necessarily equate to larger group sizes but may be due to a modification in behaviour (e.g. an increase in vocalisations during piling) (Fernadez-Betelu *et al*., 2021). It is important to note that the results of this study suggest that impulsive sound generated during piling at the offshore wind farms did not cause any displacement of bottlenose dolphin from their population range.

4.9.3.140 The severity spectrum presented by Southall *et al*. (2021) applies across all marine mammals considered in this chapter and therefore it is expected that, as described for harbour porpoise, strong disturbance in the near field could result in displacement whilst mild disturbance over greater ranges would result in other, less severe behavioural responses.

4.9.3.141 Short-beaked dolphin exhibit seasonal shifts around the UK. Individuals move onto continental waters in the summer (coinciding with the mating/calving period) and come back to inshore waters during winter. As they tend to move towards the Celtic Shelf and into the western English Channel and St. George's Channel, probability of presence within Mona marine mammal study area is low. The Mona digital aerial surveys did not record any short-beaked common dolphin across the duration of aerial surveys.

4.9.3.142 Bottlenose dolphin is largely coastally distributed in relation to the Mona marine mammal study area and are more abundant during summer and autumn compared to late winter and early spring months (Baines and Evans, 2012). This was corroborated by site-specific aerial surveys with bottlenose dolphin records in June 2021 and January 2022.

4.9.3.143 Risso's dolphin are common in Manx territorial waters and there is a potential for these species to be present in the vicinity of the Mona marine mammal study area in summer months (for more details see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement). Therefore, due to their distribution and seasonality these species are unlikely to be disturbed equally as a result of piling for all months of the year, they may be more likely to be disturbed in summer than winter months. Additionally, these is no indication that waters within the Mona marine mammal study area are important for foraging or breeding for these species, though the waters to the south and east of the Isle of Man may still be important for this species.

4.9.3.144 Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin may be able to avoid the disturbed area and whilst there may some impacts on reproduction in closer proximity to the source (i.e. within the area of 'strong disturbance'), these are unlikely to impact on survival rates as some resilience is expected to build up over the course of the piling. It is anticipated that animals would return to previous activities once the impact had ceased.

4.9.3.145 The bottlenose dolphin, short-beaked common dolphin and Risso's dolphin are deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor to behavioural disturbance is therefore, considered to be **medium.**

Minke whale

4.9.3.146 Minke whale occurs seasonally within the Mona marine mammal study area. Although sandeel is thought to be the key food resource for minke whale within the North Sea, the distribution of minke whale seems to mirror the distribution of herring in Manx and Irish waters (Howe, 2018). Given its reliance on herring, the disturbance from areas that are important for herring could have implications on the health and survival of disturbed individuals. Herring habitat in the vicinity of the Mona Offshore Wind Project is described in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. The majority of the Mona fish and shellfish ecology study area was considered as unsuitable sediment for herring spawning, although significant spawning areas were identified to the northwest of the Mona fish and shellfish ecology study area, and to the north, east and northeast of the Isle of Man. The displacement of minke whale could lead to reduced foraging for disturbed individuals particularly since minke whale maximise their energy storage whilst on feeding grounds (Christiansen *et al*., 2013a).

4.9.3.147 It is expected that for minke whale, as described by the Southall *et al*. (2021), strong disturbances in the nearfield could result in displacement whilst mild disturbance over larger ranges would result in other, less severe behavioural responses. In terms of context the Mona Offshore Wind Project is situated in region of relatively high levels of existing sound disturbance. Therefore, minke whale that occur within the Mona marine mammal study area are subject to underwater sound from existing activities and may to some extent be desensitised to increased sound levels, particularly in the far field where mild disturbance could occur.

4.9.3.148 The minke whale is deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor to behavioural disturbance is therefore, considered to be **medium**.

Harbour seal and grey seal

4.9.3.149 Mild disturbance has the potential to disturb seals, however this constitutes only slight changes in behaviour, such as changes in swimming speed or direction, and is unlikely to result in population-level effects. Although there are likely to be alternative foraging sites for both harbour seal and grey seal, barrier effects as a result of installation of pin piles could either prevent seals from travelling to forage from haul-out sites or force seals to travel greater distances than is usual during periods of piling. Strong disturbance could result in displacement of seals from an area.

4.9.3.150 Hastie *et al*. (2021) measured the relative influence of perceived risk of a sound (silence, pile driving, and a tidal turbine) and prey patch quality (low density versus high density), in grey seal in an experimental pool environment. Foraging success was highest under silence, but under tidal turbine and pile driving treatments success was similar at the high-density prey patch but significantly reduced under the low-density prey patch. Therefore, avoidance rates were dependent on the quality of the prey patch as well as the perceived risk from the anthropogenic sound and therefore it can be anticipated such decisions are consistent with a risk/profit balancing approach.

4.9.3.151 Seal behaviour during offshore wind farm installation has been studied based on empirical data. Russell *et al*. (2016) studied movements of tagged harbour seal during piling at the Lincs Offshore Wind Farm in the Greater Wash and reported significant avoidance of the offshore wind farm by harbour seal. Within this study, seal abundance significantly reduced over a distance of up to 25 km from the piling activity and there was a 19% to 23% decrease in usage within this range. However, the displacement was limited to pile driving activity only, with harbour seal returning rapidly to baseline levels of activity within two hours of cessation of the piling (Russell *et al*., 2016). Aarts *et al*. (2018) reported reactions of tracked grey seal to pile driving during construction of the Luchterduinen and Gemini wind farms as diverse, ranging from altered surfacing and diving behaviour, changes in swimming direction, or coming to a halt. In some cases, however, no apparent changes in diving behaviour or movement were observed (Aarts *et al*., 2018). Similar to the conclusions drawn by Hastie *et al*., (2021) the study at the Luchterduinen and Gemini wind farms suggested animals were balancing risk with profit. Whilst approximately half of the tracked grey seal were absent from the pile-driving area altogether, this may be because animals were drawn to other more profitable areas as opposed to active avoidance of the sound, although a small sample size (n = 36 animals) means that no firm conclusions could be reached. It was notable that, in some cases, grey seal exposed to pile-driving at distances shorter than 30 km returned to the same area on subsequent trips. This suggests that the incentive to go to the area was stronger than potential deterrence effect of underwater sound from pile driving in some seals.

4.9.3.152 Changes in behaviour and subsequent barrier effects have a potential to affect the ability of phocid seals to accumulate the energy reserves prior to both reproduction and lactation (Sparling *et al*., 2006). As a strategy to maximise energy allocation to reproduction, female seals increase their foraging effort (including increased diving behaviour) before the breeding season. Especially during the third trimester of pregnancy, grey seal accumulate reserves of subcutaneous blubber which they use to synthesize milk during lactation (Hall *et al*., 2001). Therefore, during this period, grey seal forging at sea may be most vulnerable, as maternal energy storage is extremely important to offspring survival and female fitness (Mellish *et al*., 1999; Hall *et al*., 2001). As a result, potential exclusion from foraging grounds during this time could affect reproduction rates and probability of survival.

4.9.3.153 Depending on the breeding strategy of particular species, phocid seals may also be vulnerable to disturbance during the lactation period. Altered behaviour could have a particular impact on harbour seal during lactating periods between June and August, when female harbour seal spend much of their time in the water with their pups, and foraging is more restricted than during other periods (Thompson and Härkönen, 2008). Consequences of disturbance may include reduced fecundity, reduced fitness, and reduced reproductive success. Although harbour seal may be able to avoid the disturbed area and forage elsewhere, there may be an energetic cost to having to move greater distances to find food, and therefore there may be a potential effect on reproductive success of some individuals. The lactation period for grey seal is shorter (lasting around 17 days; Sparling *et al*., 2006) with females remaining mostly on shore, fasting. Additionally, as grey seal females do not forage often during lactation, it is expected that they may exhibit some tolerance to disturbance as they would not spend as much time in sea, where they can be affected by underwater sound. Note, however, that following lactation female grey seal return to the water and must forage extensively to build up lost energy reserves.

4.9.3.154 Harbour seal and grey seal are deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor to behavioural disturbance is therefore, considered to be **medium**.

Significance of the effect

Auditory injury

4.9.3.155 A summary of the significance of effect for injury (PTS) from elevated underwater sound from piling during the construction phase is presented in Table 4.29.

Harbour porpoise, bottlenose dolphin short-beaked common dolphin and Risso’s dolphin

4.9.3.156 Overall, with primary and tertiary mitigation applied, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. There would be no change to the international value of these species. The effect on bottlenose dolphin, short-beaked common dolphin and Risso’s dolphin will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Minke whale

4.9.3.157 Overall, with primary and tertiary mitigation applied, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **high**. Whilst there may be some residual effect with a small number of animals potentially exposed to sound levels that could elicit PTS this is unlikely to affect the international value of the species as there is no long-term decline in the regional population predicted as demonstrated with the iPCoD modelling assessment. The effect on minke whale will be of **minor adverse** significance, which is not significant in EIA terms.

Grey seal and harbour seal

4.9.3.158 Overall, with primary and tertiary mitigation applied, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. There would be no change to the international value of these species. The effect on grey seal and harbour seal will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Table 4.29: Summary of the significance of effect of PTS from elevated underwater sound from piling during the construction phase.

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Harbour porpoise	Negligible	High	Minor adverse
Bottlenose dolphin	Negligible	High	Minor adverse
Short-beaked common dolphin	Negligible	High	Minor adverse
Risso's dolphin	Negligible	High	Minor adverse
Minke whale	Low	High	Minor adverse
Grey seal	Negligible	High	Minor adverse
Harbour seal	Negligible	High	Minor adverse

Behavioural disturbance

4.9.3.159 A summary of the significance of effect for disturbance from elevated underwater sound from piling during the construction phase is presented in Table 4.30.

Harbour porpoise

4.9.3.160 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. The effects are unlikely to affect the international value of the species in the context of the CIS MU as there is no long-term decline in the regional population predicted as demonstrated with the iPCoD modelling assessment. The effect on harbour porpoise will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.3.161 There is, however, predicted to be a spatial overlap with the North Anglesey Marine/Gogledd Môn Forol SAC and consequently this will be considered as part of the Habitats Regulations Assessment.

Bottlenose dolphin

4.9.3.162 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. The effects are unlikely to affect the international value of the species in the context of the Irish Sea MU as there is no long-term decline in the regional population predicted, as demonstrated with the iPCoD modelling assessment. The effect on bottlenose dolphin will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Short-beaked common dolphin and Risso's dolphin

4.9.3.163 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. The effects are unlikely to affect the international value of short-beaked common dolphin or Risso's dolphin in the context of the CGNS MU. The effect on short-beaked common dolphin and Risso's dolphin will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Minke whale

4.9.3.164 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. The effects are unlikely to affect the international value of the species in the context of the CGNS MU as there is no long-term decline in the regional population predicted, as demonstrated with the iPCoD modelling assessment. The effect on minke whale will, therefore be of **minor adverse** significance, which is not significant in EIA terms.

Grey seal

4.9.3.165 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. The effects are unlikely to affect the international value of the species in the context of the GSRP or OSPAR Region III MU as there is no long-term decline in the regional population predicted for either reference population, as demonstrated with the iPCoD modelling assessment. The effect on grey seal will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Harbour seal

4.9.3.166 Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **medium**. The effects are unlikely to affect the international value of the species in the context of the Irish Sea Mus. The effect on harbour seal will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Table 4.30: Summary of the significance of effect of disturbance from elevated underwater sound from piling during the construction phase.

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Harbour porpoise	Low	Medium	Minor adverse
Bottlenose dolphin	Low	Medium	Minor adverse
Short-beaked common dolphin	Low	Medium	Minor adverse
Risso's dolphin	Low	Medium	Minor adverse
Minke whale	Low	Medium	Minor adverse
Grey seal	Low	Medium	Minor adverse
Harbour seal	Negligible	Medium	Minor adverse

Further mitigation measures

4.9.3.167 The project alone assessment of injury and disturbance from elevated underwater sound during piling has no significant effect in EIA terms. However, recognising the potential contribution to elevated underwater sound in the regional marine mammal study area (see section 4.11.2), the project has committed to the development of an Underwater sound management strategy which is secured in the deemed marine licence (with an Outline underwater sound management strategy included with the application for consent, Document Reference J16) to reduce the magnitude of impact such that any residual significant effects from the project are reduced to a non-significant level (on the basis of a refined project envelope and programme).

4.9.3.168 The Outline underwater sound management strategy (Document Reference J16) will set out the process for investigating options to manage underwater sound levels (such as NAS, temporal and spatial piling restrictions, piling methods, soft start) in order to reduce the magnitude for the Mona Offshore Wind Project. The Underwater sound management strategy (Document Reference J16) will be developed in consultation with the licensing authority and SNCBs.

4.9.4 Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance

4.9.4.1 The clearance of UXO prior to commencement of construction may result in detonation (high order) of a UXO. This activity has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater sound sources (von Benda-Beckman *et al*., 2015), and are considered a high energy, impulsive sound source. The potential effects of this activity will depend on sound source characteristics, the receptor species, distance from the sound source and sound attenuation within the environment.

4.9.4.2 Further detail on sound modelling of UXO clearance is provided in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement. For high order detonation, acoustic modelling was undertaken following the methodology described in Soloway and Dahl (2014). Estimates were conservative as the charge is assumed to be freely standing in mid-water, unlike a UXO which would be resting on or partially buried in the seabed and could potentially be buried, degraded or subject to other significant attenuation. In addition, the explosive material is likely to have deteriorated over time, so maximum sound levels are likely to be over-estimates of true sound levels. Frequency-dependent weighting functions were applied to allow comparison with marine mammal hearing weighted thresholds.

4.9.4.3 For low order techniques, according to Robinson *et al.* (2020), low order deflagration results in a much lower amplitude of peak sound pressure than high order detonations, and therefore acoustic modelling has been based on the methodology described in paragraph 4.9.4.2 but using a smaller donor charge size.

<u>Construction phase</u>

Magnitude of impact

4.9.4.4 Potential effects of underwater sound from high order UXO clearance on marine mammals include mortality, physical injury or auditory injury. The duration of impact (elevated sound) for each UXO detonation is very short (seconds) therefore behavioural effects are considered to be negligible in this context. TTS is presented as a temporary auditory injury but also represents a threshold for disturbance (for the onset of a moving away response) (see paragraph 4.9.4.19 for detailed discussion). Specific sound modelling for the Mona Offshore Wind Project was carried out using published and peer-reviewed criteria to determine PTS and TTS ranges for marine mammal receptors (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). A project-specific MMMP (Document Reference J16) will be developed in order to reduce the potential to experience injury.

4.9.4.5 It is anticipated that up to 22 UXOs within the Mona Array Area and Offshore Cable Corridor and Access Areas are to be cleared. The absolute maximum UXO size is assumed to be 907 kg (representing the MDS), the most likely (common) size is 130 kg and the smallest UXO size is 25 kg (Table 4.16), thus all sizes have been assessed. A low order clearance donor charge of 0.08 kg is assumed whilst low-yield donor charges are multiples of 0.75 kg (up to four required for the largest UXO). For donor charges for high-order clearance activities, charge weights of 1.2 kg (the most common) and 3.5 kg (single barracuda blast charge) have been included.

4.9.4.6 The clearance activities will be tide and weather-dependent. The aim is to enable clearance of at least one UXO per tide, during the hours of daylight and good visibility. There is an assumption of up to 0.5 kg net explosive quantity (NEQ) clearance shot for neutralisation of residual explosive material at each location.

Permanent threshold shift (PTS)

4.9.4.7 PTS ranges for low order and low yield UXO clearance activities are presented in Table 4.31, donor charges used in high order UXO clearance presented in Table 4.32 and high order clearance of UXO presented in Table 4.33. The number of animals predicted to experience PTS due to low order disposal is presented in Table 4.34, donor charges used in high order UXO in Table 4.35 and high order clearance in Table 4.36.

4.9.4.8 It is considered that there is a small risk that a low order clearance could result in high order detonation of UXO, and therefore the assessment considered both high order and low order techniques. With regard to UXO detonation (low order techniques as well as high order events), due to a combination of physical properties of high frequency energy, the sound is unlikely to still be impulsive in character once it has propagated more than a few kilometres (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). The NMFS (2018) guidance suggested an estimate of 3 km for transition from impulsive to continuous (although this was not subsequently presented in the later guidance, Southall *et al*., 2019). Hastie *et al*. (2019) suggest that some measures of impulsiveness (for seismic airguns and pile-driving) change markedly within approximately 10 km of the source. Therefore, caution should be used when interpreting any results with predicted injury ranges in the order of tens of kilometres as the PTS ranges are likely to be significantly lower than those predicted.

4.9.4.9 An explosive mass of 907 kg (absolute maximum high order explosion) yielded the largest PTS ranges for all species, with the greatest injury range (15,370 m) seen for harbour porpoise (using the SPL_{pk} metric) (Table 4.31). However, the most likely (common) 130 kg charge sees this injury range reduce to 8,045 m for harbour porpoise (SPL_{pk}). Conservatively, the number of harbour porpoise that could be potentially injured, based on the Welsh Marine Mammal Atlas density of 0.2773 animals per km^2 (Table 4.12), was estimated as 206 animals for the absolute maximum 907 kg UXO high order explosion (using the SPL_{pk} metric) equating to 0.329% of the CIS MU. Predicted numbers were much smaller for the most likely (common) 130 kg and 25 kg UXOs with up to 57 animals and 19 animals potentially experiencing PTS respectively (using the SPL_{pk} metric). For low order techniques, the largest range of 2,290 m was predicted from the 4 x 0.75 kg low-yield charges, which could injure up to three harbour porpoise within this range.

4.9.4.10 The underwater sound assessment found that the maximum injury (PTS) range estimated for bottlenose dolphin, short-beaked common dolphin and Risso's dolphin using the SPL_{pk} metric is 890 m for the absolute maximum detonation of charge size of 907 kg, but this is reduced to 464 m for 130 kg (most likely (common) maximum) and 268 m for 25 kg. Therefore conservatively, during high order detonation of any size of UXO up to the maximum number of individuals that could be potentially injured for any of these species (based on densities presented in Table 4.12) was estimated as no more than one. With reference to the wider populations of these species, this equated to very small proportions of the relevant Mus (0.001% for bottlenose dolphin, 0.000001% for short-beaked common dolphin and 0.001% for Risso's dolphin). For low order techniques, the injury ranges were considerably lower with a maximum of 133 m from the 4 x 0.75 kg low-yield charges estimated with no more than one animal of any species likely to be present within this range.

4.9.4.11 The underwater sound assessment found that the maximum injury (PTS) range estimated for minke whale using the SEL_{cum} metric is 4,215 m for the detonation of a charge size of 907 kg (absolute maximum), but this is reduced to 1,705 m for the most likely (common) maximum 130 kg and 775 m for 25 kg. Therefore conservatively, the number of individuals that could be potentially injured was estimated as less than one animal for the absolute maximum 907 kg UXO high order explosion, which equates to 0.005% of the MU, and less than one animal for 130 kg UXO (most likely (common) maximum) and 25 kg UXO. For low order techniques, the maximum range predicted was up to 406 m and there would be no more than one animal potentially injured within this range.

4.9.4.12 The underwater sound assessment found that the maximum injury (PTS) range estimated for grey seal using the SPL_{pk} metric was 3,015 m for the detonation of charge size of 907 kg (absolute maximum), but this was reduced to 1,580 m for 130 kg and 910 m for 25 kg. Therefore conservatively, the number of individuals that could be potentially injured, based on the inshore densities, was estimated as less than six animals for 907 kg UXO high order explosion (absolute maximum), which equates to 0.04% of the Grey Seal Reference Population or 0.008% of the OSPAR III population, and less than two animals for 130 kg UXO (most likely (common) maximum) and less than one animal for 25 kg UXO. For low order techniques, the maximum range predicted was up to 449 m and there would be no more than one animal potentially within this range.

4.9.4.13 The underwater sound assessment found that the maximum injury (PTS) range estimated for harbour seal using the SPL_{pk} metric was 3,015 m for the detonation of a charge size of 907 kg (absolute maximum), but this was reduced to 1,580 m for 130 kg and 910 m for 25 kg. Therefore conservatively, the number of individuals that could be potentially injured, was estimated as less than one animal for 907 kg UXO high order explosion (absolute maximum), 130 kg UXO (most likely (common) maximum) and 25 kg UXO, which equates to up to 0.002% of the reference population (Wales, NW England and Northern Ireland SMUs). For low order techniques, the maximum range predicted was up to 449 m and there would be no more than one animal potentially within this range.

Table 4.31: Potential PTS ranges for Low Order and Low Yield UXO clearance activities.

Charge Size	PTS ranges (m)				
	Threshold	VHF	HF	LF	PCW
0.08 kg low-order donor charge	SPL_{pk}	685	40	122	135
	SEL_{cum}	190	2	47	9
0.5 kg clearing shot	SPL_{pk}	1,265	73	223	247
	SEL_{cum}	421	4	115	22
2 x 0.75 kg low-yield charge	SPL_{pk}	1,820	105	322	357
	SEL_{cum}	650	7	196	38
4 x 0.75 kg low-yield charge	SPL_{pk}	2,290	133	406	449
	SEL_{cum}	840	10	275	53

Table 4.32: Potential PTS ranges for donor charges used in High Order UXO clearance activities.

Charge Size	PTS range (m)				
	Threshold	VHF	HF	LF	PCW
1.2 kg	SPL_{pk}	1,690	98	299	331
	SEL_{cum}	596	6	176	34
3.5 kg	SPL_{pk}	2,415	140	427	473
	SEL_{cum}	885	10	297	57

Table 4.33: Potential PTS ranges for High Order clearance of UXOs.

Charge Size	PTS range (m)				
	Threshold	VHF	HF	LF	PCW
25 kg UXO – high order explosion	SPL_{pk}	4,645	268	825	910
	SEL_{cum}	1,645	27	775	147
130 kg UXO – high order explosion	SPL_{pk}	8,045	464	1,425	1,580
	SEL_{cum}	2,520	61	1,705	323
907 kg UXO – high order explosion	SPL_{pk}	15,370	890	2,720	3,015
	SEL_{cum}	3,820	151	4,215	800

Table 4.34: Number of animals with the potential to experience PTS due to Low Order and Low Yield UXO clearance activities.

Threshold	Estimated maximum number of animals with the potential to be injured						
	Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
0.08 kg low-order donor charge							
SPL_{pk}	<1	<1	<1	<1	<1	<1	<1
SEL_{cum}	<1	<1	<1	<1	<1	<1	<1
0.5 kg clearing shot							
SPL_{pk}	2	<1	<1	<1	<1	<1	<1
SEL_{cum}	<1	<1	<1	<1	<1	<1	<1
2 x 0.75 kg low-yield charge							
SPL_{pk}	3	<1	<1	<1	<1	<1	<1
SEL_{cum}	<1	<1	<1	<1	<1	<1	<1
4 x 0.75 kg low-yield charge							
SPL_{pk}	5	<1	<1	<1	<1	<1	<1
SEL_{cum}	<1	<1	<1	<1	<1	<1	<1

Table 4.35: Number of animals with the potential to experience PTS due to donor charges used in High Order UXO clearance activities.

Threshold	Estimated maximum number of animals with the potential to be injured						
	Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
1.2 kg donor charge for high-order UXO disposal							
SPL_{pk}	3	<1	<1	<1	<1	<1	<1
SEL_{cum}	<1	<1	<1	<1	<1	<1	<1
3.5 kg donor blast-fragmentation charge for high-order UXO disposal							
SPL_{pk}	6	<1	<1	<1	<1	<1	<1
SEL_{cum}	<1	<1	<1	<1	<1	<1	<1

Table 4.36: Number of animals with the potential to experience PTS due to High Order clearance of UXOs

Threshold	Estimated maximum number of animals with the potential to be injured						
	Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
25 kg UXO – high order explosion							
SPL_{pk}	19	<1	<1	<1	<1	<1	<1
SEL_{cum}	3	<1	<1	<1	<1	<1	<1

Threshold	Estimated maximum number of animals with the potential to be injured						
	Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
130 kg UXO – high order explosion							
SPL_{pk}	57	<1	<1	<1	<1	2	<1
SEL_{cum}	6	<1	<1	<1	<1	<1	<1
907 kg UXO – high order explosion							
SPL_{pk}	206	<1	<1	<1	<1	6	<1
SEL_{cum}	12	<1	<1	<1	1	<1	<1

4.9.4.14 For the purposes of this assessment, it has been assumed that the MDS will be clearance of UXO with a NEQ of 907 kg as an absolute maximum, cleared by either low order or high order techniques although clearance of UXO with an NEQ of 130 kg is considered the more likely (common) scenario. Primary mitigation can be employed to reduce the likelihood of injury by using low order techniques to clear UXOs where possible, noting however, that low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO, therefore low order is included in the assessment.

4.9.4.15 With primary measures (i.e. using low order techniques) in place (see section 4.8) the assessment found (based upon the absolute maximum 907 kg UXO) that there would be a risk of injury over a range of 2,290 m (for harbour porpoise using the SPL_{pk} metric) that would require further mitigation (Table 4.31). Where low order/low yield measures are not possible there is a maximum risk of injury (predicted for harbour porpoise) out to 15 km for a 907 kg UXO (absolute maximum) and 8 km for a 130 kg UXO (most likely (common) maximum). Therefore, adopting standard industry practice (JNCC, 2010b), tertiary mitigation will be applied as part of a MMMP (Document Reference J21), as an annex of the Underwater sound management strategy (with an Outline underwater sound management strategy submitted as part of the application, Document Reference J16) (Table 4.17).

4.9.4.16 The injury ranges (for both low order and high order clearance) are considerably larger than the standard 1,000 m mitigation zone recommended for UXO clearance (JNCC, 2010b) and there are often difficulties in detecting marine mammals (particularly harbour porpoise) over such large ranges (McGarry *et al*., 2017). Visual surveys note that there is often a significant decline in detection rate with increasing sea state (Embling *et al*., 2010; Leaper *et al*., 2015). Tertiary mitigation will therefore also include the use of ADDs and potentially scare charges to deter animals from the injury zone (Table 4.17). The efficacy of such deterrence will depend upon the device selected and reported ranges of effective deterrence vary. One of the loudest devices available, the Lofitech ADD, operates at a range of frequencies and may be suitable as a multi-species deterrent. Brandt *et al.* (2012) reported effective deterrence of harbour porpoise out to 7.5 km whilst Dähne *et al.* (2017) suggest detectable deterrence to 12 km. Olesiuk *et al.* (2002) report a displacement range of 3.5 km for the Airmar dB plus II ADD whilst Kyhn *et al.* (2015) report effective deterrence to 2.5 km for harbour porpoise. A full review of available devices is provided in McGarry *et al.* (2020). In addition to the ADD, deterrence can also be achieved through the use of soft start charges, the application of which will be discussed and agreed with consultees post-submission, once more information on the size and type of UXOs are known. Details of appropriate tertiary mitigation as set out in the draft MMMP (Document Reference

J21) (as an annex of the Underwater sound management strategy, Document Reference J16) will be discussed and agreed with consultees post-consent when further details of the size and type of potential UXOs are understood. To illustrate what this may entail for high order clearance of the most likely scenario (130 kg NEQ), based on a swim speed of 1.5 m/s for harbour porpoise, a total of 89 minutes of deterrence activities would be required for animals to clear the risk zone.

4.9.4.17 Adopting a precautionary approach, and assuming application of tertiary measures as part of the Mona Offshore Wind Project (section 4.8), the assessment considered the magnitude for a high order detonation (the absolute maximum 907 kg UXO). The magnitude of impact is predicted to be of local to regional spatial extent (depending on species), very short-term duration, intermittent and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during the detonation event), the effect of injury on sensitive receptors is permanent. It is predicted that the impact will affect the receptor directly. With tertiary mitigation applied it is anticipated that, for most species, animals would be deterred from the injury zone and therefore the likelihood of PTS would be reduced. The magnitude is therefore considered to be **negligible** (for bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal).

4.9.4.18 For harbour porpoise the ranges of effect are large for high order clearance, and there is considered to be a residual risk of PTS to a number of individuals, therefore conservatively (based upon the absolute maximum 907 kg UXO), the magnitude is considered to be **medium** for harbour porpoise. Whilst it is difficult to quantify this residual risk (due to uncertainties over the predicted ranges of effect and the potential ranges over which deterrence measures are effective, alongside assessing on the MDS of high order clearance which may be refined following site-investigation surveys), it is anticipated that there would be some measurable changes at an individual level but that this would not manifest to population-level effects due to the small proportion of the CIS MU potentially affected.

Behavioural displacement (TTS as a proxy)

4.9.4.19 A second threshold assessed was the onset of TTS where the resulting effect would be a potential temporary loss in hearing. Whilst similar ecological functions would be inhibited in the short term due to TTS, these are reversible on recovery of the animal's hearing and therefore not considered likely to lead to any long-term effects on the individual. However, the onset of TTS also corresponds to a moving away or 'fleeing response' as this is the threshold at which animals experience disturbance and are likely to move away from the ensonified area. Thus, the onset of TTS also reflects the threshold at which strong disturbance could occur (it represents the boundary between the most severe disturbance levels and the start of physical auditory impacts on animals) TTS thresholds are less conservative than those for PTS thresholds and can aid in counterbalancing the precautionary nature of the underwater sounds models.

4.9.4.20 As previously described in paragraph 4.9.2.5, the sound is unlikely to be impulsive in character once it has propagated more than a few kilometres (detailed discussion in paragraphs 1.5.5.26 to 1.5.5.29 of Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). It is particularly important when interpreting results for disturbance with ranges of up to 34.37 km as these are likely to be significantly lower than predicted.

4.9.4.21 As before, the assessment of strong disturbance considered low order and low yield UXO clearance activities (Table 4.37), donor charges for high order UXO disposal (Table 4.38) and high order explosions (Table 4.39). The largest ranges using SPL_{pk}

were predicted for clearance of the 907 kg UXO (absolute maximum) with potential strong disturbance/moving away response over a distance of up to ~28 km for harbour porpoise for example (Table 4.39). Ranges predicted for other species using SPL_{pk} were smaller for all other species, however, for minke whale a larger strong disturbance range of ~34 km was predicted using the SEL_{cum} threshold.

Table 4.37: Potential strong disturbance (TTS used as a proxy) ranges for Low Order and Low Yield UXO clearance activities.

Charge Size	Strong disturbance ranges (m)				
	Threshold	VHF	HF	LF	PCW
0.08 kg low-order donor charge	SPL_{pk}	1,265	73	224	247
	SEL_{cum}	1,500	23	655	124
0.5 kg clearing shot	SPL_{pk}	2,325	134	411	455
	SEL	2,465	56	1,585	301
2 x 0.75 kg low-yield charge	SPL_{pk}	3,350	194	593	660
	SEL_{cum}	3,120	95	2,665	504
4 x 0.75 kg low-yield charge	SPL_{pk}	4,220	244	750	830
	SEL_{cum}	3,600	131	3,670	695

Table 4.38: Potential strong disturbance (TTS used as a proxy) ranges for donor charges high order UXO.

Charge Size	Strong disturbance range (m)				
	Threshold	VHF	HF	LF	PCW
1.2 kg	SPL_{pk}	3,110	180	551	610
	SEL_{cum}	2,795	85	2,400	454
3.5 kg	SPL_{pk}	4,445	257	790	875
	SEL_{cum}	3,715	141	3,940	745

Table 4.39: Potential strong disturbance (TTS used as a proxy) ranges for High Order clearance of UXOs.

Charge Size	Strong disturbance range (m)				
	Threshold	VHF	HF	LF	PCW
25 kg UXO – high order explosion	SPL_{pk}	8,555	494	1,515	1,680
	SEL_{cum}	5,290	343	9,325	1,760
130 kg UXO – high order explosion	SPL_{pk}	14,825	855	2,625	2,905
	SEL_{cum}	6,830	680	17,755	3,360
907 kg UXO – high order explosion	SPL_{pk}	28,320	1,635	5,015	5,550
	SEL_{cum}	8,925	1,380	34,365	6,470

4.9.4.22 The number of animals that would potentially experience disturbance due to low order and low yield UXO clearance activities is presented in Table 4.40, donor charges for high order UXO disposal in Table 4.41 and high order explosions in Table 4.42. As seen for PTS the highest number of animals affected, based on high order detonation of a 907 kg UXO (absolute maximum), was found for harbour porpoise where up to 699 animals could experience TTS within the 28.3 km range equating to 1.12% of the MU population (based on SPL_{pk}). Based on SEL_{cum}, the number of grey seal within a predicted 6.47 km disturbance range was estimated as 24 animals (0.18% of the Grey Seal Reference Population or 0.04% of the OSPAR region III population) and for minke whale up to 65 animals may occur within the 34.3 km disturbance range (0.319% of the MU population). For all other species the number of animals predicted to be disturbed was very small with no more than one animal within the predicted effect zones.

4.9.4.23 Behavioural effects are reversible and therefore animals are anticipated to fully recover following cessation of the activity. It is, however, recognised that where tertiary mitigation is applied to reduce the risk of PTS, deterrence measures (i.e. ADD and soft start charges) by their nature would contribute to, rather than reduce, the moving away response.

Table 4.40: Number of animals with the potential to experience strong disturbance (TTS used as a proxy) due to low order UXO detonations.

Threshold	Estimated number of animals with the potential to be disturbed						
	Harbour Porpoise	Bottlenose Dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
0.08kg low-order donor charge							
SPL_{pk}	2	<1	<1	<1	<1	<1	<1
SEL_{cum}	2	<1	<1	<1	<1	<1	<1
0.5kg clearing shot							
SPL_{pk}	5	<1	<1	<1	<1	<1	<1
SEL_{cum}	6	<1	<1	<1	<1	<1	<1
2 x 0.75kg low-yield charge							
SPL_{pk}	10	<1	<1	<1	<1	<1	<1
SEL_{cum}	9	<1	<1	<1	<1	<1	<1
4 x 0.75kg low-yield charge							
SPL_{pk}	16	<1	<1	<1	<1	<1	<1
SEL_{cum}	12	<1	<1	<1	<1	<1	<1

Table 4.41: Number of animals with the potential to experience strong disturbance (TTS used as a proxy) due to donor charges high order UXO.

Threshold	Estimated Number of Animals with the Potential to be Disturbed					
	Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
1.2 kg donor charge for high-order UXO disposal							
SPL_{pk}	9	<1	<1	<1	<1	<1	<1
SEL_{cum}	7	<1	<1	<1	<1	<1	<1
3.5 kg donor blast-fragmentation charge for high-order UXO disposal							
SPL_{pk}	18	<1	<1	<1	<1	<1	<1
SEL_{cum}	13	<1	<1	<1	<1	<1	<1

Table 4.42: Number of animals with the potential to experience strong disturbance (TTS used as a proxy) due to High Order clearance of UXOs.

Threshold	Estimated Number of Animals with the Potential to be Disturbed						
	Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
25 kg UXO – high order explosion							
SPL_{pk}	64	<1	<1	<1	<1	2	<1
SEL_{cum}	25	<1	<1	<1	5	2	<1
130 kg UXO – high order explosion							
SPL_{pk}	192	<1	<1	<1	<1	5	<1
SEL_{cum}	41	<1	<1	<1	18	7	<1
907 kg UXO – high order explosion							
SPL_{pk}	699	<1	<1	<1	2	18	<1
SEL_{cum}	70	<1	<1	<1	65	24	<1

4.9.4.24 Adopting a precautionary approach, and with tertiary measures adopted, the assessment considered the magnitude of a high order detonation. The magnitude of disturbance resulting from a high order detonation is predicted to be of regional spatial extent, very short-term duration, intermittent and both the impact itself (i.e. the elevation in underwater sound during detonation event) and effect of disturbance is reversible (TTS represents a non-trivial disturbance but not permanent injury). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low** for all species.

Sensitivity of receptor

Permanent Threshold Shift

4.9.4.25 The main feature of the acoustical properties of explosives is a short shock wave, comprising a sharp rise in pressure followed by an exponential decay with a time constant of a few hundred microseconds (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). The interactions of the shock and acoustic waves create a complex pattern in shallow water, and this was investigated further by Von Benda-Beckmann *et al*. (2015). Harbour porpoise were most often studied in the scientific literature due to their high sensitivity to sound. The effects of explosives on harbour porpoise in the southern North Sea was studied by Von Benda-Beckmann *et al*. (2015). The study measured SEL and peak overpressure (in kPa) at distances up to 2 km from the explosions of seven aerial bombs (charge mass of 263 kg and 121 kg) detonated at approximately 26 m to 28 m depth, on a sandy substrate. The results suggested that the largest distance at which a risk of ear trauma could occur was at 500 m and that sound-induced PTS was likely to occur greater than the 2 km range that was measured during the study since the SEL recorded at this distance was 191 dB re. 1 µPa^{2}s (i.e. 1 dB above the 'very likely to occur' threshold). Von Benda-Beckmann *et al*. (2015) also modelled possible ranges for 210 explosions that had been logged by the Royal Netherland Navy (RNLN) and the Royal Netherlands Meteorological Institute (RNMI) over a two-year period (2010 and 2011). Using the empirical measurements of SEL out to 2 km, the authors found that the effect distances ranged between hundreds of metres to just over 10 km (for charges ranging from 10 kg up to 1,000 kg). Near the surface, where porpoises are known to spend a large proportion of time (e.g. 55% based on Teilmann *et al*., 2007) the SELs were predicted to be lower with effect distances for the onset of PTS just below 5 km. However, whilst the model could provide a reasonable estimate of the SEL within 2 km (since the empirical measurements were made out to this point), estimates above this distance required further validation since the uncorrected model systematically overestimated SEL.

4.9.4.26 Estimating how individuals are exposed to sound over time depends on an animals' mobility. Aarts *et al.* (2016) demonstrated that harbour porpoise movement strategy affects the cumulative number of animals acoustically exposed to underwater explosions. The study estimated the number of animals receiving temporary or permanent hearing loss due to underwater detonations of recovered explosives (mostly WWII aerial bombs) and found when porpoises remained in a local area, fewer animals would receive PTS and TTS than those free roaming but more individuals would be subjected to repeated exposures.

4.9.4.27 Salomons *et al*. (2021) analysed the sound measurements performed near two detonations of UXO (charge masses of 140 kg and 325 kg) and derived a PTS effect distance in the range 2.5 km to 4 km (using weighted SEL values and threshold levels from Southall *et al*. (2019)). When comparing the experimental data and model predictions, the same study concluded thar harbour porpoise are at risk of permanent hearing loss at distances of several kilometres, i.e. distance between 2 km and 6 km based on 140 kg and 325 kg charge masses, respectively.

4.9.4.28 Due to paucity of studies on these species, less is known about the sensitivity of bottlenose dolphin, short-beaked dolphin, Risso's dolphin and minke whale to blasting. During a clearance of relatively small explosives (35 kg charge) at an important feeding area for a resident community of bottlenose dolphin in Portugal, acoustic pressure levels in excess of 170 dB re 1 µPa (SPL_{rms}) were measured and despite pressure levels being 60 dB higher than ambient sound, no adverse effects were recorded in the behaviour or appearance of the resident community (Santos *et al*., 2010). Nonetheless, other studies reported that although dolphins experienced external injuries consistent with inner ear damage due to explosives, they expressed little change in surface behaviour near blast areas (Ketten, 1993).

4.9.4.29 Robinson *et al*. (2020) found that using low order UXO disposal methods offers a substantial reduction in acoustic output over traditional high-order detonations, with the peak SPL_{pk} and SEL_{cum} observed being typically > 20 dB lower for the deflagration of the same sized munition (a reduction factor of just over ten in SPL_{pk} and 100 in acoustic energy). The study reported that the acoustic output depends on the size of the shaped charge, rather than the size of the UXO itself. Considering the above, compared to high-order methods, Robinson *et al*. (2020) provided evidence that low order techniques offer the potential for greatly reduced acoustic sound exposure of marine mammals.

4.9.4.30 All marine mammals are deemed to have limited resilience to PTS, low recoverability and international value. The sensitivity of the receptors to PTS is therefore, considered to be **high.**

Behavioural Disturbance (TTS as a proxy)

4.9.4.31 Although underwater sound as a result of UXO clearance has the potential to produce behavioural disturbance, there are no agreed thresholds for the onset of a behavioural response generated as a result of a single explosion. Thresholds for the onset of behavioural disturbance from detonation of explosives exist (Finneran and Jenkins, 2012) following the proposed approach by Southall *et al.* (2007), but these are intended for repeated detonations over a 24 hour period and therefore not suitable for single destinations of a UXO. Finneran and Jenkins (2012) states for these single detonations, behavioural disturbance is likely to be limited to ‘a short-lived startle reaction’ and therefore does not use any unique behavioural disturbance thresholds for marine mammals exposed to single explosive events.

4.9.4.32 Southall *et al*. (2007) recommended that the use of TTS onset as an auditory effect may be most appropriate for single pulses (such as UXO detonation) and therefore it has been applied to inform the assessment.

4.9.4.33 Given that TTS is a temporary and reversible hearing impairment, it is anticipated that any animals experiencing this shift in hearing would recover after they have moved beyond the injury zone are no longer exposed to elevated sound levels. The implication of animals experiencing TTS, leading to potential displacement, is not fully understood, but it is likely that aversive responses to anthropogenic sound could temporarily affect life functions as described for PTS. Therefore, in this respect animals exposed to sound levels that could induce TTS have similar susceptibility as those exposed to sound levels that could induce PTS. There is an important distinction, however, given that TTS is only temporary hearing impairment, it is less likely to lead to acute effects and will largely depend on recoverability. The degree and speed of hearing recovery will depend on the characteristics of the sound the animal is exposed to, and on the degree of shift in hearing experienced.

Harbour porpoise

4.9.4.34 SEAMARCO (2011) measured recovery rates of harbour porpoise following exposure to a piling playback sound source of 175 dB re 1 $\mu Pa^2 s$ (SEL) over 120 minutes and found that recovery to the pre-exposure threshold was estimated to be complete within 48 minutes following exposure (the higher the hearing threshold shift, the longer the recovery).

4.9.4.35 Kastelein *et al*. (2021) found that the susceptibility to TTS depends on the frequency of the fatiguing sound causing the shift and the greatest TTS depends on the SPL (and related SEL). In a series of studies measuring TTS occurrence in harbour porpoise at a range of frequencies typical of high amplitude anthropogenic sounds, the greatest shift in mean TTS occurred at 0.5 kHz with hearing recovery within 60 minutes after the fatiguing sound stopped. Scientific understanding of the biological effects of TTS is limited to the results of controlled exposure studies on small numbers of captive animals (reviewed in Finneran, 2015). Extrapolating these results to how animals may respond in the natural environment should be treated with caution as it is not possible to exactly replicate natural environmental conditions, and the small number of test subjects would not account for intraspecific differences (i.e. differences between individuals) or interspecific differences (i.e. extrapolating to other species) in response.

Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin

4.9.4.36 Finneran *et al*. (2000) investigated the behavioural and auditory responses of two captive bottlenose dolphin to sounds that simulated distant underwater explosions. The animals were exposed to an intense sound once per day and no auditory shift (i.e. TTS) greater than 6 dB in response to levels up to 221 dB re 1 µPa peak-to-peak (p-p) was observed. Behavioural shifts, such as delaying approach to the test station and avoiding the 'start' station, were recorded at 196 dB and 209 dB re 1 µPa p-p for the two bottlenose dolphin and continued at higher levels. There are several caveats to this study (discussed in Nowacek *et al*. (2007)), (i.e. the signals used in this study were distant and the study measured masked-hearing signals). The animals used in the experiment were also trained and rewarded for tolerating high levels of sound and subsequently, it can be anticipated that behavioural disruption would likely be observed at lower levels in other contexts.

4.9.4.37 Whilst there are no available species-specific recovery rates for mid-frequency cetaceans to TTS, there is no evidence to suggest that recovery will be significantly different to harbour porpoise recovery rates therefore animals can recover their hearing after they are no longer exposed to elevated sound levels. It can be anticipated that both all three species would be able to tolerate the effect without any impact on reproduction or survival rates with the ability to return to previous behavioural states or activities once the impacts had ceased.

Minke whale

4.9.4.38 There are no species-specific recovery rates for minke whale to TTS. However, there is no evidence to suggest that recovery will be significantly different to harbour porpoise recovery rates as studies reported that minke whale avoid a 15 kHz ADD and clearly react to signals at the likely upper limit of their hearing sensitivity (Boisseau *et al*., 2021). It is anticipated that minke whale would be able to tolerate the effect without any impact on reproduction or survival rates and is expected to return to previous behavioural states or activities once the impacts had ceased.

Harbour seal and grey seal

4.9.4.39 Kastelein *et al*. (2018) measured recovery rates of harbour seal following exposure to a sound source of 193 dB re 1 µPa2s (SEL_{cum}) over 360 minutes and found that recovery from TTS to the pre-exposure baseline was estimated to be complete within 72 minutes following exposure. These results are in line with findings reported in SEAMARCO (2011), which showed that for small TTS values, recovery in seal species was very fast (around 30 minutes) and the higher the hearing threshold shift, the longer the recovery. Kastelein *et al*. (2019) also reported relatively fast recover, with full hearing recovery within two hours following exposure.

4.9.4.40 Considering the above, in most cases, impaired hearing for a short time is anticipated to have little effect on the total foraging period of a seal. If hearing is impaired for longer periods (hours or days) the impact has the potential to be ecologically significant (SEAMARCO, 2011). Nevertheless, the findings of studies presented in this section indicate that seal species are less vulnerable to TTS than harbour porpoise for the sound bands tested. It is also expected that animals would move beyond the injury range prior to the onset of TTS. The assessment considered that both grey seal and harbour seal are likely to be able to tolerate the effect without any impact on either reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased.

4.9.4.41 All marine mammals are deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor to TTS is therefore, considered to be **low.**

Significance of effect

4.9.4.42 In the case that a low order technique is not possible, or results in a high order detonation (as per paragraph 4.9.4.8) conclusions presented in 4.9.4.43 onwards are based on the assessment for high order clearance.

Auditory injury

4.9.4.43 Overall, with primary and tertiary mitigation applied, for bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptors is considered to be **high**. There is not anticipated to be any effect on the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.4.44 Overall, with primary and tertiary mitigation applied, for harbour porpoise, the magnitude of the impact is deemed to be **medium,** and the sensitivity of the receptor is considered to be **high**. On the basis of the absolute maximum high order detonation, there may be some residual effect with a small number of animals potentially exposed to sound levels that could elicit PTS. The effect will, therefore, be of **moderate adverse** significance, which is significant in EIA terms.

4.9.4.45 Mitigation measures via the MMMP (secured in the deemed marine licence), will be developed in accordance with the Outline MMMP (Document Reference J21, included as part of the application) to reduce the residual risk of injury to harbour porpoise. The details of which will be agreed post-consent when further information is available regarding the type/size of UXO to be cleared. There is a general hierarchy of preferred mitigation with regard to UXO (as detailed in Table 4.17), with a preference to avoid UXO, and then clear with low order techniques if possible. Where detonation of UXO using low order techniques occurs this is considered to be primary mitigation (noting, however, that it is not possible to fully commit to this measure at this stage) and would reduce the risk to negligible, therefore not significant. However, if low order/low yield clearance is not possible, and measures adopted as part of the Mona Offshore Wind Project do not fully mitigate (as detailed in the Outline MMMP (Document Reference J21)), further measures are considered in the Underwater sound management strategy (Document Reference J16) discussed below. A more detailed assessment of mitigation will be undertaken post-consent as further information on the number, condition, and type of UXOs becomes available to inform the MMMP (Document

Reference J21) and will be developed in consultation with the licensing authority and SNCBs.

Further mitigation measures

4.9.4.46 The project alone assessment of injury from elevated underwater sound during UXO clearance concludes a significant effect in EIA terms, for harbour porpoise only. The project alone assessment of disturbance from elevated underwater sound during UXO clearance concludes no significant effect in EIA terms, for all marine mammal receptors. The project has committed to the development of an Underwater sound management strategy (Document Reference J16) to manage underwater sound levels associated with significant impacts from the project, to reduce the magnitude of impacts such that there will be no residual significant effect.

4.9.4.47 The Underwater sound management strategy will present relevant further mitigation options (such as NAS, temporal and spatial restrictions, low order clearance methods, soft start) in order to manage underwater sound levels so as to reduce the magnitude of impacts for the project alone. The project has prepared an Outline underwater sound management strategy (Document Reference J16) which is secured in the deemed marine licence in Schedule 14 of the draft DCO, which establishes a process of investigating options to manage underwater sound levels, in consultation with the licensing authority and SNCBs and agreeing prior to construction, mitigation measures that will be implemented to reduce the magnitude of impacts such that there will be no residual significant effect from the project (in this case, on harbour porpoise). These further measures would also reduce impacts associated with underwater sound for other marine mammal receptors.

Behavioural disturbance (TTS used as a proxy)

4.9.4.48 Overall, with tertiary mitigation applied, the magnitude of the impact for all species is deemed to be **low** and the sensitivity of the receptors is considered to be **low**. There is not anticipated to be any effect on the international value of any marine mammal species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.5 Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities

4.9.5.1 Increased vessel movements during the construction, operations and maintenance, and decommissioning phases have the potential to result in a range of effects to marine mammals such as avoidance behaviour or displacement and masking of vocalisations or changes in vocalisation rate.

4.9.5.2 The assessment of potential impacts from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is based on a vessel and/or activity basis, considering the maximum injury/disturbance range as assessed in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement. However, several activities could be potentially occurring at the same time and therefore ranges of effects may extend from several vessels/locations where the activity is carried out and potentially overlap.

Construction phase

Magnitude of impact

Auditory injury

4.9.5.3 During the construction phase of the Mona Offshore Wind Project, the increased levels of vessel activity will contribute to total underwater sound levels. Vessels are used for construction activities for the Mona Offshore Cable Corridor and Access Areas (paragraph 4.9.5.4), the Mona Array Area (paragraph 4.9.5.5) and the landfall cable installation (paragraph 4.9.5.6).

4.9.5.4 The MDS for construction activities associated with the Mona Offshore Cable Corridor and Access Areas is up to a total of 17 construction vessels on site at any one time . This includes six cable lay installation and support vessels will carry out up to 40 return trips. A maximum of one guard vessel will carry out 18 return trips. Two survey vessels will carry out up to four return trips. A maximum of four seabed preparation vessels for boulder removal, grapnel, pre-sweep and levelling will carry out 24 return trips. Two crew transfer vessels will carry out 20 return trips. Two cable protection vessels will carry out 20 return trips.

4.9.5.5 The MDS for construction activities associated with the Mona Array Area, is up to a total of 69 vessels on site at any one time. This includes maximum of 22 main installation and support vessels, carrying out 521 trips. Eight tug/anchor handlers will carry out 74 return trips. Seven cable lay installation and support vessels will carry out 56 return trips across the total construction period. One guard vessel will carry out 50 return trips. Six survey vessels will carry out 31 return trips. Maximum of eight seabed preparation vessels for boulder removal, grapnel, pre-sweep and levelling will carry out 19 return trips. Twelve crew transfer vessels will carry out 1,135 return trips. Three scour protection installation vessels will carry out 41 return trips, and two cable protection vessels will carry out two return trips.

4.9.5.6 The MDS for construction activities associated with the landfall cable installation, is up to a total of ten vessels on site at any one time. This includes a maximum of one cable barge grounding vessel carrying out 16 return trips, one jackup operations vessel carrying out 16 return trips, two installation and support vessels carrying out 32 return trips, two tug/anchor handlers carrying out 32 return trips, one cable installation & support vessel carrying out 16 return trips, one guard vessel carrying out 16 return trips, one survey vessel carrying out 16 return trips, one CTV carrying out 16 return trips.

4.9.5.7 Whilst this will lead to an uplift in vessel activity, the movements will be limited to within the Mona Array Area and Mona Offshore Cable Corridor and Access Areas and are likely to follow existing shipping routes to and from the ports. Approximately 3,166 vessels in total pass through the Mona Array Area per year (Volume 6, Annex 7.1: Navigational Risk Assessment (NRA) of the Environmental Statement). Vessel traffic activity shows a seasonal trend that peaks over the summer months (May-Aug) and decreases in the winter months (Nov-Feb) (Figure 4.24). This is primarily due to an increase in ferry service operations and recreational activity. The NRA demonstrated much of the marine mammal study area experienced over 640 vessel trips per year (Figure 4.25). The majority of vessels crossing the Mona Offshore Cable Corridor and Access Areas are commercial cargo, tanker and passenger vessels and commercial traffic is largely concentrated where the route crosses the approaches to Liverpool and the associated ferry routes. The vessel movements will be contained within the Mona

Array Area and Mona Offshore Cable Corridor and Access Areas and are likely to follow existing shipping routes to and from the ports.

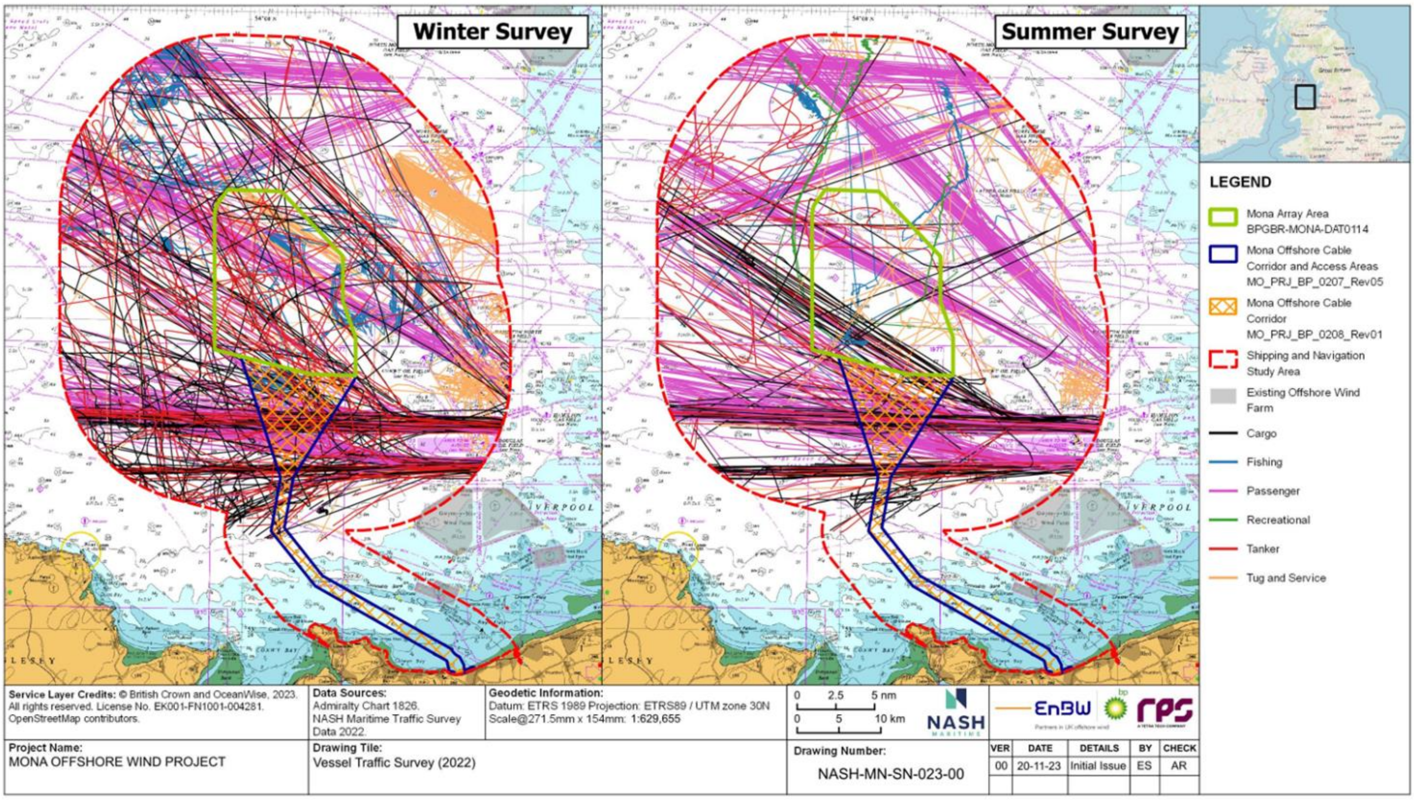


Figure 4.24: Vessel traffic survey data within the shipping and navigation study area (source: vessel traffic surveys).

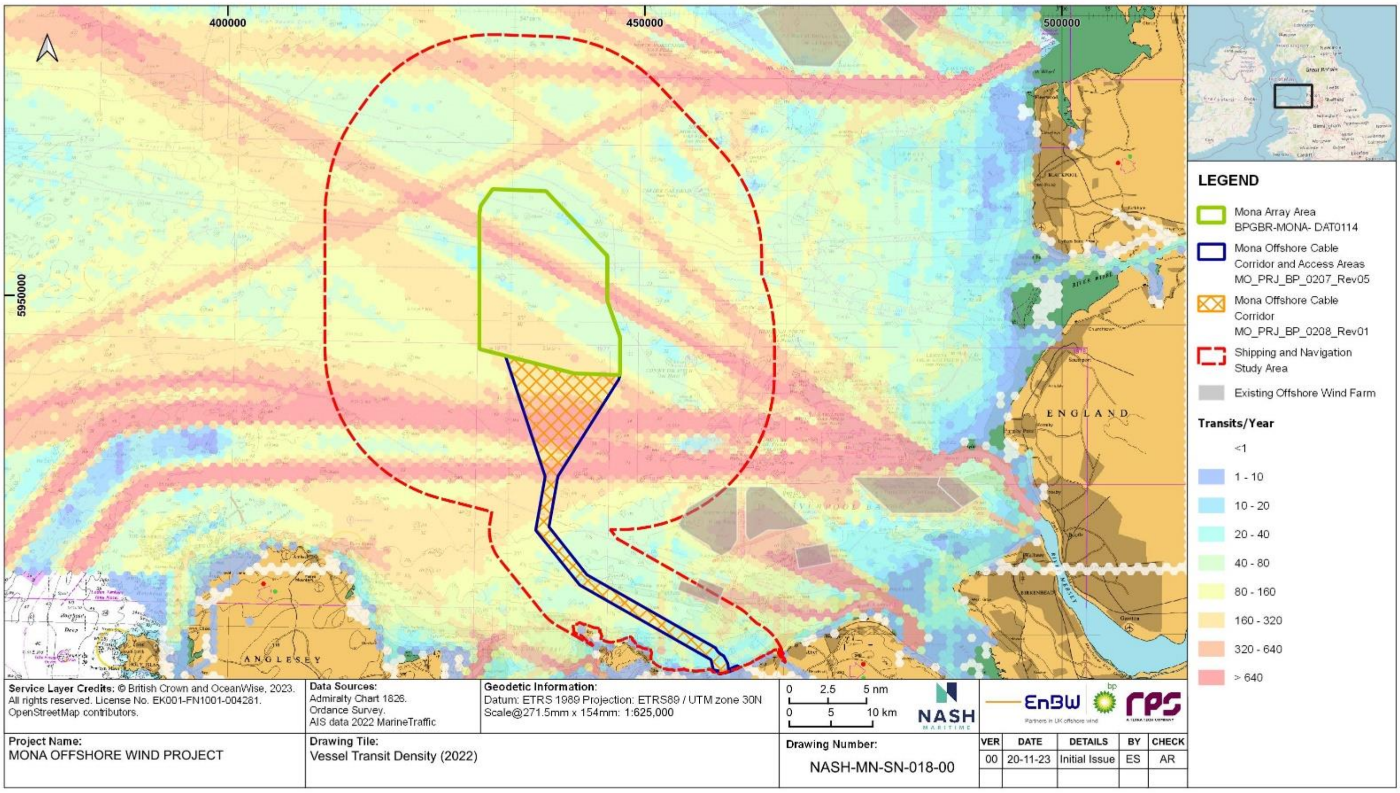


Figure 4.25: Annualised vessel traffic density within the shipping and navigation study area (source: MarineTraffic, 2019).

4.9.5.8 The main drivers influencing the magnitude of the impact are vessel type, speed and ambient sound levels (Wilson *et al*., 2007). Baseline levels of vessel traffic in the Mona marine mammal study area are at a high level, largely due to ferry routes. For example, commercial ferry routes based on annual data from 2022 (see Volume 2 Chapter 7: Shipping and Navigation of the Environmental Statement) between the UK mainland (Liverpool, Heysham) and the IoM (Douglas) total approximately 2,044 annual crossings, between the UK mainland (Liverpool and Heysham) to Belfast with a total of 2,582 annual crossings, between UK mainland (Heysham) to Warrenpoint with 1,099 crossings and UK Mainland (Heysham, Liverpool) to Dublin with 3,858 crossings, highlighting there is a high ferry vessel baseline alone in the area.

4.9.5.9 As described in the NRA (Volume 6, Annex 7.1: Navigational Risk Assessment of the Environmental Statement), occasional vessel traffic movements associated with jack-ups and other platforms also occur in the region.

4.9.5.10 Other sound-generating activities for the Mona Offshore Wind Project will include drilled piling and cable burial (Table 4.16). Up to 100% of overall piles are anticipated to require drilling (64 four-legged turbine jacket foundations with a diameter of 3.8 m, plus four four-legged OSP jacket foundations with a diameter of 3.5 m) with up to two concurrent drilling vessels. Burial of inter-array cables (325 km) will also occur, with 50 km of interconnector cables and 360 km of export cable via seabed preparation activities (including boulder clearance, sandwave clearance), ploughing, trenching and jetting; cable burial and rock dumping. See Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement for more information about SELs associated with the above construction activities.

4.9.5.11 A detailed underwater sound modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals resulting from elevated underwater sound (non-impulsive sound), using the latest criteria (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). A conservative assumption has been made that all individual marine mammals will respond aversively to increases in vessel sound (i.e. that there is no intra or inter-specific variation or context-dependent differences). The distance over which effects may occur will, however, vary according to the species, the ambient sound levels, hearing ability, vertical space use and behavioural response differences. Furthermore, vessels and construction sound will be temporary and transitory, as opposed to permanent and fixed.

4.9.5.12 SELs have been estimated for each vessel type based on 24 hours continuous operation, although it is important to note that it is highly unlikely that any marine mammal would stay at a stationary location or within a fixed radius of a vessel for 24 hours. Therefore, the acoustic modelling has been undertaken based on an animal swimming away from the source (or the source moving away from an animal).

4.9.5.13 The sound modelling results indicate that the threshold for PTS was not exceeded for any species for all vessels, drilled piling and all cable burial activities. Therefore, there is a negligible risk of PTS occurring to marine mammals as a result of elevated underwater sound due to vessel use, drilled piling or cable burial activities. Acoustic modelling was also conducted for TTS for completeness (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement), however ranges indicated are likely to be overestimates as for continuous sources such as vessel sound the thresholds do not take into account any ambient sound levels in the region (which is already has high levels of shipping activity, see paragraph 4.9.5.7).

4.9.5.14 Ranges for TTS were between <10 m and 162 m for vessels (based on harbour porpoise), and between <10 m and 162 m for drilled piling and cable burial activities.

Whist the likelihood of auditory injury is extremely low, the maximum duration of the construction phase is up to four years (48 months).

4.9.5.15 The impact is predicted to be of limited spatial extent, medium term duration, intermittent and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during the activities), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Since the PTS threshold was not predicted to be exceeded for any activities or species, the magnitude is considered to be **negligible**.

Behavioural disturbance

4.9.5.16 Disturbance from vessel sound is likely to occur only where vessel sound associated with the construction of the Mona Offshore Wind Project exceeds the background ambient sound level. As discussed in paragraphs 4.9.5.7 to 4.9.5.9, the Mona Offshore Wind Project is located in a relatively busy shipping area and therefore background sound levels are likely to be relatively high. For impulsive sound sources there is an understanding of the difference between strong and mild disturbance, whereas for non-impulsive (continuous) sound sources such as from vessels, there is only a single available threshold (120 dB re 1 μPa (rms), the Level B harassment threshold[3]) (NMFS, 2005), which is proposed as the basis for the onset of a strong behavioural reaction. JNCC *et al.* (2010) state that "it is most unlikely that a passing vessel would cause more than trivial disturbance. It is the repeated or chronic exposure to vessel noise that could cause disturbance". Therefore it is important to bear in mind when viewing these potential disturbance radii that the 120 dB re 1 μPa (rms) criterion is very precautionary and does not consider background sound levels, and that ambient sound levels in the area could well exceed this value (Xodus, 2014). As such, an understanding of background underwater sound level is valuable when assessing potential effects from elevated underwater sound due to vessel use.

4.9.5.17 Furthermore, NMFS (2005) highlights that it is possible that sound pressure levels in the local environment will already be as high as the continuous behavioural disturbance threshold of 120 dB re 1 μPa (SPL_{rms}) for marine mammals much of the time, and therefore represents an over-precautionary assessment and therefore may not necessarily result in strong displacement of animals. In their maps of shipping sound of the North-east Atlantic, Farcas *et al.* (2020) showed areas of high shipping densities often exceeded 120 dB re 1 μPa, with total underwater sound exceeding 121 dB re 1 μPa in areas of the east Irish Sea and annual median ship sound surpassing 20 dB excess (sound above modelled natural background sound) in the Irish Sea. This combined with worst case assumptions made in the modelling can mean ranges are highly over-precautionary.

4.9.5.18 A detailed underwater sound modelling assessment has been carried out to investigate the potential for behavioural effects on marine mammals resulting from increased vessel sound and other activities. The estimated ranges within which there is a potential for disturbance to marine mammals are presented in Table 4.43.

4.9.5.19 Survey vessel and support vessels, crew transfer vessel, scour/cable protection and seabed preparation/installation vessels resulted in the greatest modelled disturbance out to 4.082 km for all marine mammal species (Table 4.43). The greatest disturbance range for other non-vessel continuous sound behavioural effects was predicted to be

[3] This level B exposure is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioural patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioural patterns are abandoned or significantly altered" NMFS (2005).

3.412 km due to underwater sound from cable trenching activities. In comparison, installation vessels and construction vessels, rock placement vessels, and cable installation vessels all resulted in a predicted disturbance range of 2.195 km; vessels for boulder clearance had a disturbance range of 191 m (0.191 km); tug/anchor handlers had a disturbance range of 1.169 km; and jack up rigs had a disturbance range of 10 m (0.01 km).

Table 4.43: Estimated disturbance ranges (m) for marine mammals as a result of vessels and other activities.

Threshold	Disturbance Range (m)
Vessels	
Sandwave clearance, installation vessel, construction vessel (using Dynamic Positioning), rock placement vessel and cable installation vessels	2,195
Boulder Clearance	191
Jack-up Rig	<10
Tug/anchor handlers, guard vessels	1,169
Survey vessel and support vessels, crew transfer vessels, scour/cable protection/seabed preparation/installation vessels	4,082
Other activities	
Cable trenching	3,412
Cable laying	2,195
Jack-up rig	<10
Drilled piling	251

4.9.5.20 Ranges for disturbance for vessels are presented up to the 120 dB re 1 µPa (rms) threshold, and as there is no differentiation between mild and strong disturbance for continuous underwater sound (just one single fixed threshold for Level B harassment), this assumes 100% of animals above this threshold are disturbed (single step-function criterion used in the NMFS thresholds assume a “all-or-none” threshold).In reality, for those animals disturbed there is likely to be a proportional response (i.e. not all animals will be disturbed to the same extent), but there is no dose-response curve available to apply in the context of non-impulsive sound sources for key species in the Irish Sea. Dose-response curves for vessels have been created for killer whales (Joy *et al*., 2019), thus indicating there is evidence of proportional response to vessel sound.

4.9.5.21 It must be noted that thresholds that relate single exposure parameters (e.g. received sound level) to behavioural responses across species and sound types may lead to over-simplification in prediction effects. Ideally differences between species, situational context, spatial scales and interacting effects of multiple stressors would be quantified to predict effects, but Southall (2021) highlights few studies report this critical data in a systematic structured way. Tyrack and Thomas (2019) demonstrated using the RLp50 step function can lead to underestimates of animals impacted (e.g. number affected was underestimated by a factor of 280), but highlighted their approach was far more complex to apply than the single threshold approach preferred by regulators (it requires combining dose response function with animal and stressor distribution). Furthermore, the dose-response function used was derived from experiments performed on free-swimming killer whales exposed to a steadily increasing level of sonar sounds (Miller *et al*., 2014) and therefore a dose-response specifically for continuous sound (such as those in Joy *et al.* 2019) would be more appropriate.

4.9.5.22 Furthermore animals in areas of high shipping are frequently exposed to vessel sound, and it has been suggested vessel type and speed rather than presence are relevant factors (e.g. 75% of all negative reactions of harbour porpoise in South West Wales were in response to high-speed planing-hulled vessels, with the remainder being neutral responses (Oakley *et al.*, 2017)) and reactions are different dependent on vessel type, distance and speed (Wisniewska *et al.* 2018) (see 4.9.5.30. for further discussion). It is important to note that the life history of an individual and the context will also influence the likelihood of an individual to exhibit an aversive response to sound, and it must be highlighted that these potential impacts will not be continuous over the construction phase, instead carried out over a shorter number of days within the period. Therefore, given the limited quantitative information available, as described above, any simplified calculation would likely lead to an unrealistic overestimation of the number of animals likely to be disturbed. Multiplying the area of ensonification by each species-specific density would lead to unrealistic estimates, as serious disturbance would not occur over ranges such as 23 km. As such, this value has not been quantified.

4.9.5.23 Whilst it is difficult to quantify the response ranges based on a simple threshold approach (e.g. because it does not take into account context), empirical evidence suggests that for similar areas with existing vessel traffic, acoustic activity (and therefore presence of some marine species) may be reduced. As discussed in paragraph 4.9.5.32, Benhemma-Le Gall *et al.* (2021) suggested increased vessel activity (and other construction activities) led to a decrease in porpoise acoustic detections and activity at distances of up to 4 km. Porpoise responses decreased as the mean vessel distance increased (−24% at 3 km) until no apparent response was observed at 4 km. Similarly, McQueen *et al.* (2020) used a distance threshold of 5 km as a point of comparison for screening potential marine mammal habitat displacement (behavioural avoidance), based upon the relative size of the dredging area and habitat range of receptors. Verboom *et al.* (2014) also suggested a porpoise never approaches the study dredging ship in full operation at less than 5 km. Wisniewska *et al.* (2018) used sound and movement recording tags to detect fine-scale responses in harbour porpoise to sound from vessels, and determined that foraging may be temporarily disrupted up to 7 km. Graham *et al.* (2019) indicated higher vessel activity within 1 km was significantly associated with an increased probability of response in harbour porpoise.

4.9.5.24 Therefore, to give quantitative indication of impact, a range of distances from empirical studies (1 to 7 km) have been used as an effective impact range and the numbers of animals predicted to be disturbed is presented in Table 4.44 (noting this distance is based upon VHF species and does not account for different hearing groups, but is likely to be precautionary). The numbers disturbed presented are more likely to be the case for fast moving vessels such as a CTV (of which there are a maximum of 15 on site at one time) and not for slow-moving vessels such as boulder clearance or jack up rigs that show much smaller modelled disturbance ranges (Table 4.43).

4.9.5.25 It is important to highlight that multiplying these animals by the numbers of vessels in the array area would lead to unrealistic estimates as it does not allow for any overlap between vessels (and therefore would double count), nor does it account for periods when vessels are stationary.

Table 4.44: Potential number of animals predicted to be disturbed per vessel for a range between 1 (minimum) and 7 km (maximum).

Species	Number of animals disturbed (1 km)	% MU	Number of animals disturbed (7 km)	%MU
Harbour porpoise	<1	0.001%	43	0.07%
Bottlenose dolphin	<1	0.002%	<1	0.09%
Short-beaked dolphin	<1	0.000002%	<1	0.0001%
Risso's dolphin	<1	0.001%	5	0.04%
Minke whale	<1	0.0003%	3	0.01%
Grey seal	<1	0.004%	28	0.21%
Harbour seal	<1	0.000%	<1	0.01%

4.9.5.26 The impact is predicted to be of local spatial extent, medium-term duration, intermittent and reversible (i.e. the elevation in underwater sound only occurs during the activities). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

4.9.5.27 Increased vessel movements during all phases of the Mona Offshore Wind Project have the potential to result in a range of effects on marine mammals including injury as a result of elevated underwater sound; avoidance behaviour or displacement; and masking of vocalisations or changes in vocalisation rate.

Auditory injury

4.9.5.28 The sensitivity of marine mammal receptors to auditory injury has been assessed in piling (Section 4.9.2) and is not reiterated here.

4.9.5.29 All marine mammals are deemed to have limited tolerance to auditory injury, low recoverability and international value. The sensitivity of the receptor to auditory injury is therefore, considered to be **high.**

Behavioural disturbance

4.9.5.30 Disturbance levels for marine mammal receptors will be dependent on individual hearing ranges and background sound levels within the vicinity. Sensitivity to vessel sound is most likely related to the marine mammal activity at the time of disturbance (IWC, 2006; Senior *et al*., 2008), and the level of response dependent on upon vessel type and behaviour (e.g., heading, speed) (Oakley *et al.,* 2017; Hermannsen *et al*., 2019).

4.9.5.31 Cetaceans can both be attracted to and disturbed by vessels. For example, resting dolphins are likely to avoid vessels, foraging dolphins will ignore them, and socialising dolphins may approach vessels (Richardson *et al*., 1995). Anderwald *et al.* (2013) showed within their study that bottlenose dolphin were positively correlated with total number of boats and number of utility vessels, but minke whale and grey seal were displaced by high levels of vessel traffic.

4.9.5.32 Harbour porpoise is particularly sensitive to high frequency sound and likely to avoid vessels. Wisniewska *et al*. (2018) studied the temporary change in foraging rates of harbour porpoise in response to vessel sound in coastal waters with high traffic rates. The results show that occasional high sound levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 µPa SPL_{rms} (16 kHz third-octave). Heinänen and Skov (2015) found that the occurrence of harbour porpoise declines significantly when the number of vessels in a 5 km^2 area exceeds 20,000 ships per year (approximately 80 ships per day or 18 ships per km^2). A recent study by Benhemma-Le Gall *et al*. (2021) suggested increased vessel activity (and other construction activities) led to a decrease in porpoise acoustic detections and activity at distances of up to 4 km, when comparing occurrence and foraging activity between two offshore windfarms in the Moray Firth.

4.9.5.33 Other species of dolphin (e.g. common dolphin) are regularly sighted near vessels and may also approach vessels (e.g. bow-riding). However, dolphins are also known to show aversive behaviours to vessel presence, including increased swimming speed, greater time travelling, less time resting or socialising, avoidance, increased group cohesion and longer dive duration (Toro *et al*., 2020; Marley *et al.*, 2017; Miller *et al*., 2008). Meza *et al.* (2020) found increased foraging in bottlenose and common dolphin behavioural budgets, but a decrease in time spent foraging by harbour porpoise when exposed to purse seine vessels in the Istanbul Strait, which has high levels of human pressure with many vessels in a narrow space.

4.9.5.34 A study on concurrent ambient sound levels on social whistle calls produced by bottlenose dolphins in the western North Atlantic (Fouda *et al.*, 2018), demonstrated increases in ship sounds (both within and below the dolphin call bandwidth) resulted in simplified vocal calls, with higher dolphin whistle frequencies and a reduction in whistle contour complexity. This sound-induced simplification of whistles may reduce the information content in these acoustic signals and decrease effective communication, parent–offspring proximity or group cohesion. This upward shift in whistle frequency has also been observed in bottlenose dolphin related to vessel presence in Walvis Bay, Namibia (Heiler, 2016).

4.9.5.35 Reactions of marine mammals to vessel sound are often linked to changes in the engine and propeller speed (Richardson *et al*., 1995). Watkins (1986) reported avoidance behaviour in baleen whales from loud or rapidly changing sound sources, particularly where a boat approached an animal. Disturbance in dolphins and porpoises is likely to be associated with the presence of small, fast-moving vessels as they are more sensitive to high frequency sound, whilst baleen whales, such as minke whale, are likely to be more sensitive to slower moving vessels emitting lower frequency sound. Pirotta *et al*. (2015) found that transit of vessels (moving motorised boats) in the Moray Firth resulted in a reduction (by almost half) of the likelihood of recording bottlenose dolphin prey capture buzzes. They also suggest that vessel presence, not just vessel sound, resulted in disturbance.

4.9.5.36 However, Anderwald *et al*. (2013) suggested that in the study of displacement responses to construction-related vessel traffic, minke whale and grey seal were avoiding the area due to sound rather than vessel presence. In the same study, the presence of bottlenose dolphin was positively correlated with overall vessel numbers, as well as the number of construction vessels. It was, however, unclear whether the bottlenose dolphin were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time. Richardson (2012) investigated the effect of disturbance on bottlenose dolphin community structure in Cardigan Bay and found that group size was significantly smaller in areas of high vessel traffic.

4.9.5.37 Common reactions of pinnipeds to approaching vessels includes increased alertness (Henry and Hammill, 2001), head raising (Niemi, *et al*., 2013) and flushing off haul-out sites into the sea (Jansen *et al.,* 2015; Andersen *et al.,* 2012; Blundell and Pendleton, 2015; Johnson and Acevedo-Gutiérrez, 2007), but studies focused on presence of vessel rather than vessel sound. In a recent study on behaviour of grey and harbour seal to ship sound, a tagged grey seal changed its diving behaviour, switching rapidly from a dive ascent to descent (Mikkelsen *et al*., 2019). Pérez Tadeo *et al*. (2021) assessed the responses of grey seal to ecotourism during breeding and pupping seasons at White Strand Beach in southwest Ireland and found vessels approaching within 500 m of the beach showed strong influence on the proportion of grey seal entering the water and increase in vigilance and decrease in resting behaviour. This is similar to a previous study on harbour seal which showed avoidance behaviour or alert reactions in harbour seal when vessels approach within 100 m of a haul-out (Paterson *et al*., 2005). This disturbance to seal haul-outs could have negative consequences during the pupping season, due to trade-offs between feeding and nursing (see 4.9.5.37). Harbour seal have been shown to be alerted and move away when a boat approaches (Andersen *et al.*, 2012; Blundell and Pendleton, 2015), but this response varies by season. For example, they exhibit weaker and shorter lasting responses during the breeding season, appearing more reluctant to flee and return to the haul-out site after being disturbed (Andersen *et al.*, 2012), likely attributed to a trade-off between moving away and nursing, rather than habituation. In a study of harbour seal in Alaska, haul out probability was negatively affected by vessels, with cruise ships having the strongest effect (Blundell and Pendleton, 2015).

4.9.5.38 The presence of vessels in foraging grounds could also result in reduced foraging success. Christiansen *et al*. (2013b) found that the presence of whale-watching boats within an important feeding ground for minke whale led to a reduction in foraging activity and as a capital breeder such a reduction could lead to reduced reproductive success since female body condition is known to affect foetal growth (Christiansen *et al*., 2014). However, it is worth noting that the study was conducted in Faxafloi Bay in Iceland where baseline sound levels (compared to the Irish Sea) are very low (McGarry *et al*., 2017). In addition, a subsequent study conducted by Christiansen and Lusseau (2015) in the same study area found no significant long-term effects of disturbance from whale-watching on vital rates since whales moved into disturbed areas when sandeel numbers were lower across their wider foraging area. However, a study on grey seal by Hastie *et al*. (2021) demonstrated how foraging context is important when interpreting avoidance behaviour and should be considered when predicting the effects of anthropogenic activities, with avoidance rates depending on the perceived risk (e.g. silence, pile driving sound, operational sound from tidal turbines) versus the quality of the prey patch. It highlights that sound exposure in different prey patch qualities may result in markedly different avoidance behaviour and should be considered when predicting impacts in EIAs. Given the existing levels of vessel activity in the Mona shipping and navigation study area it is expected that marine mammals could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

4.9.5.39 There is evidence of tolerance to boat traffic, and anthropogenic sounds and activities in general (Vella *et al*., 2001), and therefore a slight increase from the existing levels of traffic in the vicinity of the Mona Offshore Wind Project may not necessarily result in high levels of disturbance. The Liverpool Bay area already has a high level of anthropogenic activities as a baseline (see paragraphs 4.9.5.7 and 4.9.5.7). Whilst it cannot be assumed that tolerance to a stressor is evidence of absence of detrimental consequences for targeted animals (e.g. physiological responses are not readily detectable in free-ranging animals), there is multi-species evidence of animals remaining in areas of high vessel traffic. Seal bulls have been known to approach fishing vessels in Liverpool Bay (Dobson, 2002, pers comm). High co-occurrence between grey seal/harbour seal and shipping traffic within 50 km of the coastline near to haul out sites were shown in a national scale assessment of seals and shipping in the UK (Jones *et al*, 2017).

4.9.5.40 Regarding cetaceans, Thompson *et al*. (2011) (Scottish Natural Heritage (SNH) commissioned report) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth would not have a negative effect on the local population of bottlenose dolphin, although it did note that foraging may be disrupted by disturbance from vessels which was also suggested by Benhemma-Le Gall *et al.* (2021) (see paragraph 4.9.5.32). Potlock *et al.* (2023) used C-POD detections of sonar activity as a proxy for vessel disturbance during construction of wind turbines foundations off Blyth, Northumberland. The vessel sonar variable was significant in both the dolphin (potentially bottlenose dolphin and/or white-beaked dolphin) and harbour porpoise models. The effect size was substantial in both species, with around 8 min of sonar occurrence per hour leading to a 50% decline in harbour porpoise occurrence and around 13 min of sonar occurrence per hour leading to a 50% decline in dolphin occurrence. Despite this, dolphin occurrence during and after construction were not significantly different to the occurrence before the construction phase. Similarly, the increase in harbour porpoise occurrence across this study suggests that construction and after-construction vessel activity did not result in any overall decline in area usage (Potlock *et al.,* 2023).

4.9.5.41 Bottlenose dolphins have been found to both increase and decrease whistle frequencies in noisy environments, avoiding acoustic masking and improving signal transmission (Heiler *et al.,* 2016, May-Collado and Wartzok, 2008, La Manna *et al.,* 2013, Rako Gospić and Picciulin, 2016, Peters, 2018). These findings suggest that if marine mammals depend on specific areas to maintain their activities and the benefits exceed the cost of disturbance, animals show tolerance instead of site avoidance (Antichi *et al.,* 2022). As such, marine mammals could continue to regularly visit the areas where they may be affected by the vessel presence (Rako Gospić and Picciulin, 2016, Antichi *et al.,* 2022). For example, Wisniewska *et al.* (2018) found tagged porpoises did not appear to avoid highly trafficked areas (where large ship traffic concentrates in deeper channels that allow access to ports or open water) perhaps because these overlapped with important foraging habitats (deep waters which may aggregate important prey items).

4.9.5.42 Furthermore, Joy *et al.* (2019) conducted a voluntary commercial vessel slowdown trial through 16 nm of shipping lanes which overlapped with critical habitat of at-risk southern resident killer whales. Disturbance metrics were simplified to a “lost foraging time” measure and demonstrated (when compared to baseline sound levels in the region) the slowdown trial achieved 22% reduction in ‘potential lost foraging time’ for killer whales (with 40% reductions when 100% of vessels were under the 11 knot speed limit). Vessels involved in the construction phase are likely to be travelling at a speed slower than 14 knots. With the exception of CTVs, most vessels involved in the construction phase are likely to be travelling considerably slower than this (Laist, 2001), and all vessels will be required to follow an Offshore EMP (which includes Measures to minimise disturbance to marine mammals and rafting birds from transiting vessels (Document reference J17) (Table 4.17). All marine mammals are deemed to have some tolerance to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Auditory injury

4.9.5.43 Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Behavioural disturbance

4.9.5.44 Overall, with measures adopted (in place via an EMP), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

4.9.5.45 Vessel use during the operations and maintenance phase of the Mona Offshore Wind Project may lead to injury and/or disturbance to marine mammals. Vessel types which will be required during the operations and maintenance phase include those used during routine inspections, geophysical surveys, repairs and replacements of navigational equipment, removal of marine growth, replacement of corrosion protection anodes, painting, replacement of access ladders and boat landings, modifications to/replacement of J-tubes, replacement of consumables, minor repairs and replacements to wind turbines or OSPs, major component replacement to wind turbines or OSPs, inter-array/interconnector cable repair or reburial, export cable repair or reburial (subtidal) (Table 4.16). This will involve crew transfer vessels/workboats, jack up vessels, cable repair vessels, service operation vessels (SOVs) or similar vessels, excavators/backhoe dredgers. Up to a maximum of 21 vessels will be on site at any one time, with 849 operations and maintenance vessel movements (return trips) will be carried out each year (730 CTVs/workboats, 25 jack-up vessels, 8 cable repair vessels, 78 SOV or similar and 8 excavators/backhoe dredgers).

4.9.5.46 The uplift in vessel activity during the operations and maintenance phase is considered to be relatively small in the context of the baseline levels of vessel traffic in the Mona marine mammal study area described in section 4.4.3. Presence of the operational wind farm may divert some of the shipping routes and therefore, current traffic within the Mona array area, which is not associated with Mona Offshore Wind Project, is likely to be reduced. It is likely that this reduction will be ultimately counterbalanced by presence of maintenance vessels. Vessel movements will be within the Mona Array Area and Mona Offshore Cable Corridor and Access Areas and will follow the measures to minimise disturbance to marine mammals within the Offshore EMP (which includes Measures to minimise disturbance to marine mammals and rafting birds from transiting vessels (Document reference J17). The Offshore EMP will be issued to all project vessel operators to minimise the potential for collision risk as described in Table 4.17.

4.9.5.47 The size and sound outputs from vessels during the operations and maintenance phase will be similar to those used in the construction phase and therefore will result in a similar maximum design spatial scenario (Table 4.16). However, the number of vessel round trips and their frequency is much lower for the operations and maintenance phase compared to the construction phase.

Auditory injury

4.9.5.48 An overview of potential impacts from elevated underwater sound due to vessel use and other (non-piling) sound producing activities as well as associated effects (auditory injury) are described in paragraph 4.9.5.3 for the construction phase and have not been reiterated here for the operations and maintenance phase. The impact is predicted to be of limited spatial extent, long term duration, intermittent and although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during the activities), the effect of PTS (if it were to occur) is permanent. It is predicted that the impact will affect the receptor directly. Since the PTS threshold was not predicted to be exceeded for any activities or species, the magnitude is considered to be **negligible**.

Behavioural disturbance

4.9.5.49 An overview of potential impacts from elevated underwater sound due to vessel use and other (non-piling) sound producing activities as well as associated effects (behavioural disturbance) are described in paragraph 4.9.5.16 for the construction phase with behavioural disturbance ranges presented in Table 4.43 and have not been reiterated here for the operations and maintenance phase. The impact is predicted to be of local spatial extent, long-term duration, intermittent and reversible (i.e. the elevation in underwater sound only occurs during the activities). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Auditory injury

4.9.5.50 The sensitivity of marine mammal receptors to auditory injury has been assessed in paragraph 4.9.5.28 and is not reiterated here. All marine mammals are deemed to have limited tolerance to auditory injury, low recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Behavioural disturbance

4.9.5.51 The sensitivity of the receptors during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase. The sensitivity of marine mammal receptors to elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described previously in 4.9.5.30. All marine mammals have some tolerance to behavioural disturbance, high recoverability, and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Auditory injury

4.9.5.52 Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Behavioural disturbance

4.9.5.53 Overall, with measures adopted where vessels will follow the EMP, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

4.9.5.54 Vessel use during the decommissioning phase of Mona Offshore Wind Project may lead to injury and/or disturbance to marine mammals. Vessel types which will be required during the decommissioning phase include those used during removal of foundations, cables and cable protection (Table 4.16).

4.9.5.55 Maximum levels of underwater sound during decommissioning would be from underwater cutting required to remove structures. This is likely to be much less than pile driving and therefore impacts would be less than as assessed during the construction phase (see paragraph 4.9.5.3 to 4.9.5.26). Piled solutions are assumed to be cut off at or below the seabed.

4.9.5.56 Since the numbers and types of vessel used to remove infrastructure (and hence their size and outputs) are expected to be similar to those used for installation, therefore potential impacts from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is expected to result in a similar maximum design spatial scenario as the construction phase. The magnitude of the impact of the decommissioning phase for both auditory injury and disturbance as a result of elevated underwater sound due to vessel use, for all marine mammal receptors, is therefore not expected to differ or be greater than that assessed for the construction phase.

Auditory injury

4.9.5.57 An overview of potential impacts from elevated underwater sound due to vessel use and other (non-piling) sound producing activities as well as associated effects (auditory injury) are described in paragraph 4.9.5.3 for the construction phase have not been reiterated here for the decommissioning phase. The impact is predicted to be of local spatial extent, medium term duration, intermittent and although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during the activities), the effect of PTS (if it were to occur) is permanent. It is predicted that the impact will affect the receptor directly. Since the PTS threshold was not predicted to be exceeded for any activities or species, the magnitude is considered to be **negligible**.

Behavioural disturbance

4.9.5.58 An overview of potential impacts from elevated underwater sound due to vessel use and other (non-piling) sound producing activities as well as associated effects (behavioural disturbance) are described in paragraph 4.9.5.16 for the construction phase with behavioural disturbance ranges presented in Table 4.43 and have not been reiterated here for the decommissioning phase. The impact is predicted to be of local spatial extent, medium term duration, intermittent and reversible (i.e. the elevation in underwater sound only occurs during the activities). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Auditory injury

4.9.5.59 The sensitivity of marine mammal receptors to auditory injury has been assessed in paragraph 4.9.5.28 and is not reiterated here. All marine mammals have limited tolerance to auditory injury, low recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Behavioural disturbance

4.9.5.60 The sensitivity of the receptors during the decommissioning phase is not expected to differ from the sensitivity of the receptors during the construction phase. The sensitivity of marine mammal receptors to elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described previously in paragraph 4.9.5.30. All marine mammals, are deemed to have some tolerance to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Auditory injury

4.9.5.61 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **high.** There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Behavioural disturbance

4.9.5.62 Overall, with measures adopted where vessels will follow the offshore EMP, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.6 Increased likelihood of injury of marine mammals due to collision with vessels

Construction phase

Magnitude of impact

4.9.6.1 Vessel traffic associated with the Mona Offshore Wind Project has the potential to lead to an increase in vessel movements within the Mona marine mammal study area. This increase in vessel movement could lead to an increase in interactions between marine mammals and vessels during offshore construction. Whilst a broad range of vessel types are involved in collisions with marine mammals (Laist *et al.*, 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger impact (Schoeman *et al*., 2020). The severity of lesions seems also to be a function of speed. Laist *et al.* (2001) reported among collisions with lethal or severe injuries, 89% of the 28 vessels investigated were moving at 14 kn or faster.

4.9.6.2 Collisions of vessels with marine mammals have the potential to result in both fatal and non-fatal injuries (Laist *et al*., 2001; Vanderlaan and Taggart, 2007; Cates *et al*., 2017). Evidence for fatal collisions has been gathered from carcasses washing up on beaches (Laist *et al*., 2001; Peltier *et al*., 2019), carcasses caught on vessel bows (Laist *et al*., 2001; Peltier *et al*., 2019) and floating carcasses. Injuries including propeller cuts, significant bruising, oedema, internal bleeding radiating from a specific site, fractures and ship paint marks have strongly suggested ship strike as cause of death (Jensen and Silber, 2004; Jensen and Silber, 2003; Douglas *et al*., 2008). Fatalities from ship strikes, however, often go unreported (Authier *et al*., 2014). For non-fatal injuries there is evidence of animals which have survived ship strikes with no discernible injury; animals which survive with non-fatal injuries from propellers have been widely documented (Wells *et al*., 2008; Luksenburg, 2014).

4.9.6.3 Guidance provided by National Oceanic and Atmospheric Administration (NOAA) has defined serious injury to marine mammals as ”*any injury that will likely result in mortality*” (NMFS, 2005). NMFS clarified its definition of ‘serious injury’ (SI) in 2012 and stated their interpretation of the regulatory definition of serious injury as any injury that is ”*more likely than not*” to result in mortality, or any injury that presents a greater than 50% chance of death to the marine mammal (NMFS, 2012; Helker *et al*., 2017). Non-serious injury is likely to result in short-term impacts which may have long-term effects on health and lifespan.

4.9.6.4 Vessel traffic associated with construction activities will result in an increase in vessel movements within the Mona marine mammal study area as up to 2,199 return trips (Table 4.16) by construction vessels may be made throughout the construction phase. This increase, described in more detail in paragraph 4.9.5.3, could lead to an increase in interactions between marine mammals and vessels. Vessels travelling at 7 m/s (or 14 knots) or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al*., 2001; Wilson *et al*., 2007). Vessels involved in the construction phase are likely to be travelling at a speed slower than 14 knots, which is appropriate for species found within the marine mammal study areas. For larger slow-moving species such as humpback whale *Megaptera novaeangliae* (which are rare sightings in the Irish Sea), studies have shown a slower speed may be favourable to reduce likelihood of ship strikes (Vanderlaan and Taggart, 2007), with 10 knots adopted for mandatory limits on the US East coast for the conservation of North Atlantic Right Whale for example (NOAA, 2020). With the exception of CTVs, most vessels involved in the construction phase are likely to be travelling considerably slower than this (Laist, 2001), and all vessels will be required to follow an Offshore EMP (which includes Measures to minimise disturbance to marine mammals and rafting birds from transiting vessels (Document reference J17). The offshore EMP outlines instructions for vessel behaviour and vessel operators, including advice to operators to not deliberately approach marine mammals and to avoid sudden changes in course or speed. (Table 4.17). Therefore, with measures adopted as part of the Mona Offshore Wind Project in place (Table 4.17), the likelihood of collision is anticipated to be reduced and would only be present for transiting vessels (as opposed to stationary). A reduction in vessel speed has been successful in reducing collision risk for whales and is the preferred measure from the International Whaling Commission to implement when vessels cannot be re-routed for smaller marine species (International Whaling Commission, 2014; International Maritime Organization, 2016).

4.9.6.5 A proportion of vessels involved in construction will be relatively small in size (e.g. tugs, vessels carrying ROVs, crew transfer vessels, dive boats, barges and RIBs) and due to good manoeuvrability would be able to move to avoid marine mammals, when detected (Schoeman *et al*., 2020). Larger vessels with lower manoeuvrability may need larger distances to avoid an animal, however they will also be travelling at slower speeds and have more time to react when a marine mammal is detected. In addition, the sound emissions from vessels involved in the construction phase are likely to deter animals from the potential zone of impact. The vessel movements will likely be contained within the Mona Array Area and Mona Offshore Cable Corridor and are likely to follow existing shipping routes to and from the ports.

4.9.6.6 With measures adopted as part of the Mona Offshore Wind Project in place to reduce the likelihood of collision (Table 4.17), the impact is predicted to be of limited spatial extent, medium term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of receptor

4.9.6.7 Marine mammals are able to detect and avoid vessels in advance, particularly when conducting activities such as seismic surveys (Koski *et al.,* 2009). However, it remains unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al*., 2020) with analysis of data showing various interacting factors (e.g. ambient underwater sound, can affect the ability of marine mammals to detect approaching ships (Gerstein *et al.* 2005). It has been suggested that behaviours such as resting, foraging, nursing, and socialising could distract animals from detecting the risk posed by vessels regardless of detection abilities (Dukas, 2002; Gerstein *et al.* 2005). There can be consequences to this lack of response to disturbance for all marine mammals; behavioural habituation can result in decreased wariness of vessel traffic, which has the potential to result in an increased collision risk (Cates *et al*., 2017). Vessel strikes are known to be a cause of mortality in marine mammals (Carrillo and Ritter, 2010), and it is possible that mortality from vessel strikes is under-recorded (Van Waerebeek *et al*., 2007), particularly for smaller marine mammals (Schoeman *et al*., 2020).

4.9.6.8 Collisions between vessels and large whales can often lead to death or serious injury (Kraus 1990), but as discussed in paragraph 4.9.6.2, collisions between cetaceans and vessels are not necessarily lethal on all occasions (Van Waerbeek *et al*., 2007). Although all types of vessels may hit whales, most lethal and serious injuries are caused by large ships (e.g. 80 m or longer) and vessels travelling at speeds faster than 14 knots (Laist *et al.* 2001).

4.9.6.9 Given that harbour porpoise (the most common cetacean in the Mona marine mammal study area) are small and highly mobile and considering their potential avoidance responses to vessel sound (see paragraph 4.9.5.32), it can be anticipated that they will largely avoid vessel collisions. UK Cetacean Stranding's Investigation Programme (CSIP) (CSIP, 2015) reported results of post-mortem analysis conducted on 53 harbour porpoise strandings in 2015. A cause of death was established in 51 examined individuals (approximately 96% of examined cases) and, of these, only four (8%) had died from physical trauma of unknown cause, which could have been vessel strikes (CSIP, 2015).

4.9.6.10 Vessel strikes can result in lethal or non-lethal injuries to dolphins (Schoeman *et al.,* 2020). Olson *et al.* (2022) reported that evidence from long-term photo-identification data shows that only one out of a group of 277 bottlenose dolphin present within the study region exhibit marks indicative of vessel interactions. Van Waerbeek *et al*. (2007) reported that bottlenose dolphin is one of the species that may receive a moderate impact from collisions, however these may be sustainable at species level because many strikes are nonlethal.

4.9.6.11 For seal species, trauma ascribed to collisions with vessels has been identified in <2% of both live stranded (Goldstein *et al*., 1999) and dead stranded seals in the USA (Swails, 2005). The Onoufriou *et al*. (2016) study in the Moray Firth, Scotland showed that seals utilise the same areas as vessels during trips between haul-outs and foraging sites but that seals tended to remain beyond 20 m from vessels with only three instances over 2,241 days of seal activity resulted in passes at <20 m.

4.9.6.12 Although the potential of actual collision from construction traffic is relatively low given marine mammals high hearing sensitivity to increased underwater sound, the consequences of collision risk could be fatal. All marine mammal receptors would be highly vulnerable to a collision, and the effect could cause changes in both the reproduction and survival of individuals if an injury is sustained, leading to potential population level effects if enough animals were impacted. However, there is a high likelihood that marine mammals will avoid vessels well in advance of collision risk, as they will be disturbed over a wide distance by underwater sound from vessels and move away, and therefore, collision risk is minimised.

4.9.6.13 Therefore, on the basis that not all collisions that do occur are lethal, there is considered to be a medium potential for recovery. Necropsies and observations of whales surviving a vessel strike have provided information about the relationship between the severity of injury (e.g. depth of laceration, anatomical site of injury) and vessel speed (Rommel *et al*., 2007; Vanderlaan and Taggart, 2007; Conn and Silber, 2013; Wiley *et al*., 2016; Combs, 2018) but this is highly species dependent and needs further investigation to support mitigation appropriate for each species. Furthermore factors such as interspecific differences in bone strength may result in different risks of incurring blunt force trauma (Clifton *et al*., 2008) and provide further complex variability in lethality of collisions.

4.9.6.14 All marine mammals are deemed to have some resilience/survivability (largely due to avoidance behaviour and the argument that not all collisions are fatal), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.9.6.15 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

4.9.6.16 Operations and maintenance vessel use during the operations and maintenance phase of the Mona Offshore Wind Project may lead to injury to marine mammals due to collision with vessels. Vessel types which will be required during the operations and maintenance phase include those used during routine inspections, geophysical surveys, repairs and replacements of navigational equipment, removal of marine growth, replacement of corrosion protection anodes, painting, replacement of access ladders and boat landings, modifications to/replacement of J-tubes, replacement of consumables, minor repairs and replacements to wind turbines or OSPs, major component replacement to wind turbines or OSPs, inter-array/interconnector cable repair or reburial, export cable repair or reburial (subtidal) (Table 4.16). The types of vessels are similar to those presented for the MDS for the construction phase. An overview of the potential impacts due to vessel presence and associated effects (collision) are described in paragraph 4.9.5.45 for the construction phase and have not been reiterated here for the operations and maintenance phase.

4.9.6.17 With measures adopted as part of the Mona Offshore Wind Project in place to reduce the likelihood of collision (Table 4.17), the impact is predicted to be of limited spatial extent, long term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

4.9.6.18 The sensitivity of the receptors during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase. Therefore, the sensitivity of marine mammal receptors to collision risk is as described previously in paragraph 4.9.6.7.

4.9.6.19 All marine mammals are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.9.6.20 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

4.9.6.21 An overview of the potential impacts due to vessel presence and associated effects (collision) are described in paragraph 4.9.5.45 for the construction phase and have not been reiterated here for the decommissioning phase.

4.9.6.22 Vessel use during the decommissioning phase of Mona Offshore Wind Project may lead to injury to marine mammals due to collision with vessels. Vessel types which will be required during the decommissioning phase include those used during removal of foundations (Table 4.16). The types of vessels used during decommissioning will result in a similar MDS as the construction phase.

4.9.6.23 With measures adopted as part of the Mona Offshore Wind Project in place to reduce the likelihood of collision (Table 4.17), the impact is predicted to be of limited spatial extent, medium term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

4.9.6.24 The sensitivity of the receptors during the decommissioning phase is not expected to differ from the sensitivity of the receptors during the construction phase. Therefore, the sensitivity of marine mammal receptors to collision risk is as described previously in paragraph 4.9.6.7.

4.9.6.25 All marine mammals are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of receptor

4.9.6.26 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.7 Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys

4.9.7.1 Site investigation surveys during the construction phase have the potential to cause direct or indirect effects (including injury or disturbance) on marine mammal IEFs (Table 4.12). A detailed underwater sound modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals as a result of geophysical and geotechnical surveys, using the latest criteria (Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement), which is drawn upon in the assessment below.

Summary of sound modelling

4.9.7.2 It is understood that several sonar-like sources will potentially be used for the geophysical surveys, including MBES, SSS, SBES, SBP and UHRS (0.05 – 4 kHz; 182 dB re 1µPa re 1m (rms). The equipment likely to be used can typically work at a range of signal frequencies, depending on the distance to the bottom and the required resolution. For sonar-like sources the signal is highly directional, acts like a beam and is emitted in pulses. Sonar-based sources are considered by the NMFS (2018) as continuous (non-impulsive) because they generally comprise a single (or multiple discrete) frequency as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement). Unlike the sonar-like survey sources, the UHRS is likely to utilise a sparker, which produces an impulsive, broadband source signal. A full description of the source sound levels for geophysical survey activities is provided in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement.

4.9.7.3 For geotechnical surveys, site activities include boreholes, Cone Penetration Tests (CPTs) and vibrocores. These site investigation surveys will involve the use of several geophysical/geotechnical survey vessels and take place over a period of up to 8 months.

4.9.7.4 As detailed in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement, for geophysical surveying the resulting injury and disturbance ranges for marine mammals are based on a comparison to the non-impulsive thresholds set out in Southall *et al*. (2019). CPT distances are based on a comparison to the Southall *et al*. (2019) thresholds for impulsive sound (with the distances presented in brackets for peak SPL thresholds) whereas borehole drilling and vibro-core results are compared against the non-impulsive thresholds. Borehole drilling source levels were reported as 142 dB to 145 dB re 1 µPa rms at 1 m, indicating little to no disturbance.

Construction phase

Magnitude of impact

Auditory injury

4.9.7.5 Potential impacts of site investigation surveys will depend on the characteristic of the source, survey design, frequency bands and water depth. Sonar like sources have very strong directivity which effectively means that there is only potential for injury when a marine mammal is directly underneath the sound source. Once the animal moves outside of the main beam, there is no potential for injury. This section provides estimated ranges for injury of marine mammals in the construction phase of the Mona Offshore Wind Project.

4.9.7.6 With respect to the ranges within which there is a potential of PTS occurring to marine mammals as a result of geophysical investigation activities, the maximum PTS is expected to occur out to 254 m for harbour porpoise due to SBP (chirp/pinger) (Table 4.47). For dolphin species the maximum PTS is expected to occur out to 41 m for MBES, for minke whale and pinniped species out to 40 m due to SBP.

4.9.7.7 With respect to the ranges within which there is a potential of PTS occurring to marine mammals as a result of geotechnical investigation activities, PTS threshold was not exceeded for most marine mammal species, except harbour porpoise and minke whale. PTS is expected to occur during cone penetration tests, out to a maximum of 55 m and 4 m for harbour porpoise and minke whale, respectively, and for vibro-coring to a maximum of 61 m for harbour porpoise.

4.9.7.8 The number of marine mammals potentially injured within the modelled ranges for PTS presented in Table 4.47 were estimated using species-specific density estimates (Table 4.12). Due to low injury ranges, for all marine species, there is the potential for no more than one animal to experience PTS (and no animals where the threshold is not exceeded) as a result of geophysical and geotechnical site investigation surveys. The site-investigation surveys are considered to be short term as they will take place over a period of several months. Mitigation for injury during geophysical surveys using a sub-surface sensor from a conventional vessel will involve the use of MMOs and PAM to ensure that the risk of injury over the defined mitigation zone is reduced in line with JNCC guidance (JNCC, 2017). The largest range was predicted as 254 m (for SBP) and it is considered that standard industry measures (Table 4.17) will be effective at reducing the risk of injury over this distance.

Table 4.45: Potential impact ranges (m) for marine mammals for geophysical site investigation surveys. Based on Comparison to Southall *et al*. (2019) SEL Thresholds.

[1]Non-impulsive threshold used from Southall *et al.* (2019)

[2]Impulsive threshold used from Southall *et al.* (2019)

Source	Potential impact range (m) for PTS			
	LF	HF	VHF	PCW
MBES[1]	12	41	68	25
SSS[1]	2	2	41	6
SBES[1]	12	12	68	25
SBP (chirp/pinger)[1]	40	40	254	40
UHRS (sparker)[2]	N/E	N/E	11	N/E

Table 4.46: Potential impact ranges (m) for marine mammals for geotechnical site investigation surveys. Comparison to Southall *et al*. (2019) SEL Thresholds (Comparison to Ranges for Peak SPL Where Threshold was Exceeded Shown in Brackets). N/E = Not exceeded.

[1]Non-impulsive threshold used from Southall *et al.* (2019)

[2]Impulsive threshold used from Southall *et al.* (2019)

Source	Potential impact range (m) for PTS			
	LF	HF	VHF	PCW
Borehole drilling[1]	N/E	N/E	N/E	N/E
Cone penetration testing[2]	4	N/E	55 (14)	N/E
Vibro-coring[1]	N/E	N/E	61	N/E

Table 4.47: Estimated number of animals with the potential to be injured from geophysical and geotechnical site investigation surveys.

Activity	Estimated Number of Animals with the Potential to be Disturbed						
	Harbour Porpoise	Bottlenose Dolphin	Short-beaked common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
Geophysical activities							
MBES	<1	<1	<1	<1	<1	<1	<1
SSS	<1	<1	<1	<1	<1	<1	<1
SBES	<1	<1	<1	<1	<1	<1	<1
SBP (chirp/pinger)	<1	<1	<1	<1	<1	<1	<1
UHRS (sparker)	<1	0	0	0	0	0	0
Geotechnical activities							
Borehole drilling	0	0	0	0	0	0	0
Cone penetration testing	<1	0	0	0	<1	0	0
Vibro-coring	<1	0	0	0	0	0	0

4.9.7.9 The site-investigation surveys are considered to be short term as they will take place over a period of up to several months. These will be carried out pre-construction but also may be carried out periodically over several years as part of seabed and cable protection surveys based on consenting requirements.

4.9.7.10 Pre-construction site investigation surveys will involve the use of several geophysical/geotechnical survey vessels and take place over a period of up to several months. The potential impacts of underwater sound associated with vessel movements are described in section 4.9.5.

4.9.7.11 Overall, with tertiary mitigation applied where required, the impact of site investigation surveys leading to PTS is predicted to be of very limited spatial extent, short-term duration, intermittent and whilst the impact itself will occur during the pre-construction phase only, the effect of PTS will be permanent. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be **negligible**.

Behavioural disturbance

4.9.7.12 The estimated maximum ranges for onset of disturbance are based on sound level being greater than the 120 dB re 1 µPa (rms) continuous sound threshold applicable for all marine mammals (see paragraph 4.9.2.25)

4.9.7.13 The disturbance ranges as a result of geophysical and geotechnical site-investigation surveys (Table 4.48) will be higher than those presented for PTS. Most of the predicted ranges are within 100s of meters, however the largest distance over which the disturbance could occur is out to approximately 14.3 km during vibro-coring. This is due to the higher source levels for this piece of equipment compared to other types of survey equipment.

Table 4.48: Disturbance for marine mammals (all species) during geophysical and geotechnical site investigation surveys.

Activity	Disturbance all species (m)
Geophysical	
MBES	830
SSS	310
SBES	830
SBP (chirp/pinger)	17,300
UHRS (sparker)	637 (mild)
	95 (strong)
Geotechnical	
Borehole drilling	1,320 (strong)
Cone penetration testing	1,350 (mild)
	158 (strong)
Vibro-coring	14,300

4.9.7.14 For geophysical surveys the maximum disturbance ranges were predicted for the SBP with mild disturbance potentially up to 17.3 km. For geotechnical surveys the maximum disturbance ranges were predicted for vibro-coring potentially up to 14.3 km (Table 4.48).

4.9.7.15 For impulsive sound sources (UHRS (sparker) and cone penetration testing) the number of marine mammals potentially disturbed within the modelled ranges for behavioural response are estimated using the most up to date species specific density estimates (Table 4.12). The largest distance over which mild disturbance could occur is out to 1,350 m, and the largest distance over which strong disturbance could occur is out to 158 m. Quantitatively, for cone penetration testing, this would lead to maximum disturbance of less than one harbour porpoise. For all other species, and for all species for UHRS (sparker) less than one animal has the potential to be disturbed.

4.9.7.16 As stated in section 4.9.5.20, for impulsive sound sources there is an understanding of the difference between strong and mild disturbance, whereas for non-impulsive (continuous) sound sources, there is only a single available threshold (120 dB re 1 µPa (rms)) for Level B disturbance (NMFS, 2005) which is a strong behavioural reaction. Ranges for disturbance for non-impulsive sound sources (MBES, SSS, SBES, SBP (chirp/pinger), borehole drilling and vibro-coring), are presented up to the 120 dB re 1µPa (rms) threshold (Table 4.48). However, for those animals disturbed, there is likely to be a proportional response (i.e. not all animals will be disturbed to the same extent), but there is no dose-response curve available to apply in the context of non-impulsive sound sources (except for killer whale, see 4.9.5.20). It is important to note that the life history of an individual and the context will also influence the likelihood of an individual to exhibit an aversive response to sound, and it must be highlighted that these potential impacts will not be continuous over the construction phase, instead carried out over a shorter number of days within the period. Furthermore, this threshold does not take into account ambient sound levels in the area which may be already above the 120 dB re 1 µPa (see Farcas *et al.* (2020)).

4.9.7.17 Therefore, given the limited quantitative information available, as described above, any simplified calculation would likely lead to an unrealistic overestimation of the number of animals likely to be disturbed. As such, this value has not been quantified. However, all geotechnical and geophysical surveys will be very short duration (up to several months), activities are likely to be intermittent, and animals are expected to recover quickly after cessation of the survey activities. The magnitude of the impact could result in a minor alteration to the distribution of marine mammals.

4.9.7.18 The impact of site investigation surveys leading to behavioural effects is predicted to be of local spatial extent, medium term duration, intermittent and the effect of behavioural disturbance is of high reversibility (with animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Auditory injury

4.9.7.19 For geotechnical surveys, injury to marine mammals is unlikely to occur beyond a few tens of metres and sound from vessels themselves is likely to deter marine mammals beyond this range. The maximum range for PTS from geophysical surveys (SBP) is 254 m. Sills *et al*. (2020) evaluated TTS onset levels for impulsive sound in seals following exposure to underwater sound from a seismic air gun and found transient shifts in hearing thresholds at 400 Hz were apparent following exposure to four to ten consecutive pulses (SEL_{cum} 191 dB – 195 dB re 1µPa^{2}s; 167 dB – 171 dB re 1µPa^{2}s with frequency weighting for phocid carnivores in water). Matthews *et al.* (2021) used a modelling approach to compare potential effects of a non-impulsive sound source (marine vibriosis (MV)) and impulsive seismic sources (air gun) on marine mammals, and found few marine mammals could be expected to be exposed to potentially injurious sound levels for either source type, but fewer were predicted for MV arrays than air gun arrays. They found the estimated number of animals exposed to sound levels was dependent on the selection of evaluation criteria, with more behavioural disturbance predicted for MV arrays compared to air gun arrays when using SPL but the opposite when using frequency-weighted sound fields and a multiple-step, probabilistic, threshold function. Matthews *et al.* (2021) therefore demonstrated the importance of using both SPL_{pk} and SEL threshold metrics, as they relate to different characteristics of both impulsive and continuous sound – e.g. SEL_{cum} looks at accumulative exposure over a set duration whilst SPL_{pk} measures acute exposure to high-amplitude sounds.

4.9.7.20 Ruppel *et al*., (2022) categorised marine acoustic sources into four tiers based on their potential to injure marine mammals using physical criteria about the sources (e.g. source level, transmission frequency, directionality, beamwidth, and pulse repetition rate). Those in Tier Four were considered unlikely to result in 'incidental take' (i.e. loss of individuals) of marine mammals and therefore termed *de minimis,* and included most high resolution geophysical sources (MBES, SSS, SBP, low powered sparkers). They also suggested that surveys that simultaneously deploy multiple, non-impulsive *de minimis* sources are unlikely to result in incidental take of marine mammals.

4.9.7.21 Marine mammals are deemed have limited resilience to PTS, low recoverability and international value. The sensitivity of the receptor to PTS from elevated underwater sound during site investigation surveys is therefore, considered to be **high**.

Behavioural disturbance

4.9.7.22 The transmission frequencies of many commercial sonar systems (approximately 12 kHz – 1800 kHz) overlap with the hearing and vocal ranges of many species (Richardson *et al*., 1995), and whilst many are high frequency sonar systems with peak frequencies well above marine mammal hearing ranges, it is possible that relatively high levels of sound are also produced as sidebands at lower frequencies (Hayes and Gough, 1992) so may elicit behavioural responses in marine mammals.

4.9.7.23 Hermannsen *et. al.* (2015) reported on the source characteristics and propagation of broadband pulses (10 Hz up to 120 kHz) from a small airgun, confirming that there are substantial medium-to-high frequency components in airgun pulses, indicating that small odontocetes and seals may be affected by even a single airgun. However, findings indicate that in the context of exposure to sonar-like sound sources (e.g. MBES, SBES) marine mammals may show subtle behavioural responses but factors such as species, behavioural context, location, and prey availability may be as important or even more important than the acoustic signals themselves (Ruppel *et. al.,* 2022). MacGillivray *et al*. (2014) compared sound level above hearing threshold as a function of horizontal distance, for seven acoustic sources including air guns, SBP, MBES and SSS. Weighting sounds according to hearing sensitivity allows assessment of relative risks associated with exposure and whilst this analysis did not directly relate to potential for behavioural responses, it allowed comparison of modelled acoustic sources. Modelling indicated that odontocetes were most likely to hear sounds from mid-frequency sources (fishery, communication, and hydrographic systems), mysticetes from low-frequency sources (SBP and airguns), and pinnipeds from both mid and low-frequency sources. For all species, modelled sensation levels were lowest for the high-frequency sources (e.g. SSS and MBES) which operate at the upper limits of the audible spectrum.

4.9.7.24 In a study on MBES surveys in 2020, Kates Varghese *et al.* (2020) showed that the only marine mammal metric that was identified as changing was vocalisation rate. Neither displacement nor changes in foraging were observed. Quick *et. al.* (2016) demonstrated that tagged short-finned pilot whale *Globicephala macrorhynchus* that were exposed to a SBES, did not change their foraging behaviour, but variance in directionality of movement was observed, suggesting increased vigilance while the SBES was active. However, the authors acknowledged that the range of behaviours exhibited could not be directly attributed to SBES operation, and that changes in behaviour were unlikely to be biologically significant. Cholewiak *et. al.* (2017) investigated the impact of SBES on toothed whales, recording fewer beaked whale vocalisations when the source was actively transmitting suggesting that animals either move away from the area or reduced foraging activity (although findings were not statistically significant).

4.9.7.25 Studies have largely focused on the effects of multi-array seismic surveys on marine mammals, and therefore evidence for behavioural responses to sonar-like sources (e.g. MBES, SSS, SBPs) is less widely available. Multi-array impulsive sound sources are broadband in character (i.e. produce sound across a wide range of frequencies), unlike sonar-like sources which typically produce more tonal sound either at a discrete frequency or a range of discrete frequencies. However, findings from studies of multi-array impulsive sources may be useful in supporting predictions of behavioural responses of marine mammals to geophysical survey sources in general, given the overlap of parameters that typically characterise sound sources (i.e. transmission frequency; source level; pulse duration) (see MacGillivray *et al.*, 2014; Ruppel *et al.,* 2022). Whilst evidence on the behavioural responses of melon-headed whales (or similar species) to MBES is limited, an Independent Scientific Review Panel (ISRP) deemed a 12 kHz MBES to be the most plausible trigger for an extreme behavioural response in melon-headed whale *Peponocephala electra*, which resulted in a mass group stranding in a shallow lagoon in Madagascar in 2008 (Southall *et al*., 2013) (an area where such open-ocean species would not usually frequent). Whilst an unequivocal cause and effect relationship between MBES and the strandings cannot be concluded, the paper states that intermittent, repeated sounds of this nature could present a salient and potential aversive stimulus and suggests potential for such behavioural responses (or indirect injury) from MBES should be considered in environmental assessments (Southall *et al*., 2013).

4.9.7.26 Fine-scale data from harbour porpoise equipped with high-resolution location and dive loggers when exposed to airgun pulses at ranges of 420 m to 690 m with sound level estimates of 135 dB–147 dB re 1µPa^{2}s (SEL) show different responses to sound exposure (van Beest *et al*., 2018). One individual displayed rapid and directed movements away from the exposure site whilst two individuals used shorter and shallower dives (compared to natural behaviour) immediately after exposure. This sound-induced movement typically lasted for eight hours or less, with an additional 24 hour recovery period until natural behaviour was resumed.

4.9.7.27 Results from 201 seismic surveys in the UK and adjacent waters demonstrated that cetaceans (including bottlenose dolphin, white-beaked dolphin and minke whale) can be disturbed by seismic exploration (Stone and Tasker, 2006), with small odontocetes showing strongest lateral spatial avoidance, moving out of the area, whilst mysticetes and killer whale showed more localised spatial avoidance, orienting away from the vessel and increasing distance from source but not leaving the area completely.

4.9.7.28 A study by Sarnocińska *et al*. (2020) indicated temporary displacement or change in harbour porpoise echolocation behaviour in response to a 3D seismic survey in the North Sea. No general displacement was detected from 15 km away from any seismic activity but decreases in echolocation signals were detected up to 8 km – 12 km from the active airguns. Taking into account findings of other studies (Dyndo *et al.,* 2015; Tougaard *et al.,* 2015) harbour porpoise disturbance ranges due to airgun sound are predicted to be smaller than to pile driving sound at the same energy. The reason for this is that the perceived loudness of the airgun pulses is predicted to be lower than for pile driving sound due to less energy at the higher frequencies where porpoise hearing is better (Sarnocinska *et al.,* 2020). Similarly, Thompson *et al*. (2013) used PAM and digital aerial surveys to study changes in the occurrence of harbour porpoise across a 2,000 km^2 study area during a commercial two-dimensional seismic survey in the North Sea and found acoustic detections decreased significantly during the survey period in the impact area compared with a control area, but this effect was small in relation to natural variation. Animals were typically detected again at affected sites within a few hours, and the level of response declined through the ten-day survey suggesting exposure led to some tolerance of the activity (Thompson *et al.,* 2013). This study suggested that prolonged seismic survey sound did not lead to broader-scale displacement into suboptimal or higher-risk habitat. Likewise, a ten-month study of overt responses to seismic exploration in humpback whale, sperm whale *Physeter macrocephalus* and Atlantic spotted dolphin *Stenella frontalis*, demonstrated no evidence of prolonged or large-scale displacement of each species from the region during the survey (Weir, 2008).

4.9.7.29 Hastie *et al*. (2014) carried out behavioural response tests to two sonar systems (200 kHz and 375 kHz systems) on grey seal at the SMRU seal holding facility. Results showed that both systems had significant effects on seal behaviour. Grey seal spent significantly more time hauled out during the 200 kHz sonar operation and although animals remained swimming during operation of the 375 kHz sonar, they were distributed further from the sonar.

4.9.7.30 Aside from displacement or avoidance, other behavioural responses have been demonstrated (Wright and Consentino, 2015). Responses to seismic surveys have included cessation of singing (Melcón *et al.,* 2012) and alteration of dive and respiration patterns which may lead to energetic burdens on the animals (Gordon *et al.*, 2004). In some cases, behavioural responses may lead to greater effects than expected, such as strandings (Cox *et al*., 2006; Tyack *et al*., 2006) or interruptions to migration (Heide-Jørgensen *et al*., 2013). However such responses are highly context-dependent and variable, depending on factors such as the activity of the animal at the time (Robertson *et al.,* 2013), prior experience to exposure (Andersen *et al.,* 2012), extent or type of disturbance (Melcón *et al*., 2012), environment in which they inhabit Heide-Jørgensen *et al*., 2013) and the type of survey (as discussed in section 4.9.7.20).

4.9.7.31 It is expected that, to some extent, marine mammals will be able to withstand temporary elevated levels of underwater sound during site investigation surveys and behavioural responses are highly species and context specific (evidenced by paragraphs 4.9.7.23 to 4.9.7.30) . Marine mammals are deemed to have some resilience, high recoverability and international value. The sensitivity of the receptor to disturbance from elevated underwater sound during site investigation surveys is therefore considered to be **medium.**

Significance of effect

4.9.7.32 Overall, the magnitude of the impact of PTS is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.7.33 Overall, the magnitude of the impact of disturbance is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.8 Underwater sound from wind turbine operation

Operations and maintenance phase

Magnitude of impact

4.9.8.1 Sound from wind turbines comes in two forms, namely the aerodynamic sound from the blades moving through the air leading to the characteristic ‘swish-swish’ sound and the mechanical sound associated with machinery housed in the nacelle of the wind turbine (Marmo *et al.,* 2013). As aerodynamic sound travels through the surrounding air to the interface between the air and water, due to the large impedance contrast it is almost entirely reflected and therefore little aerodynamic sound enters the marine environment.

4.9.8.2 Sound levels from operating windfarms are likely to be audible to marine mammals, particularly under scenarios where wind speeds increase as well as the size of the turbine. The Mona Offshore Wind project will consist of up to 64 of the largest wind turbines. Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement assumed an average wind speed of 10 m/s. The assessment is based upon the largest wind turbine size (as modelled in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement), as this would result in the greatest range of effect, thus for a larger number of smaller turbines (ie. up to 96 foundations) the effect ranges would be smaller, although the number of locations would increase.

Auditory injury

4.9.8.3 Potential injury ranges for marine mammals were calculated based on 24 hours exposure for a static animal. This conservative approach suggested that minke whale would need to remain within 5 m of an operational wind turbine for period of 24 hours to reach the PTS threshold. Unlike seals, which have been reported as foraging around operational wind turbine structures most likely due to the growth of benthic communities on the introduced hard substrate (Russell *et al.*, 2014) baleen whales are unlikely to move close to turbine foundations as there would be limited benefit in terms of foraging. Therefore, occurrence of minke whale within 5 m of operational wind turbines is considered highly unlikely to occur.

Table 4.49: Potential injury range for marine mammals due to operational wind turbine sound (static animals 24 hour exposure).

Species	PTS threshold (dB re 1µPa^{2}s)	PTS range (m)
Harbour porpoise	173	N/E
Bottlenose dolphin, short-beaked dolphin, Risso's dolphin	198	N/E
Minke whale	199	5
Grey seal, harbour seal	201	N/E

4.9.8.4 The impact is predicted to be of local spatial extent (5 m range), long term duration, intermittent and the effect will be of medium to low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Behavioural Disturbance

4.9.8.5 The underwater sound modelling (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement) predicted that potential behavioural disturbance to all species of marine mammal could occur within approximately 160 m of each wind turbine, based on the sound contour plot 120 dB re 1µPa (rms) contours.

4.9.8.6 The impact is predicted to be of local spatial extent, long term duration, intermittent and the effect will be of medium to low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

4.9.8.7 Thomsen *et al.* (2006) reported at 100 m distance from 1.5 MW turbines, underwater sound would be audible to both harbour porpoise and harbour seal. At a greater distance of 1,000 m the signal to ambient or background sound ratio is too low for detection in harbour porpoise, however, detection by harbour seal might be possible. However, the authors caveat these results as ambient sound values used in this study were extrapolated from measurements obtained in the Baltic, while the ambient sound in most parts of the North Sea is much higher and will decrease the radius of detection significantly.

4.9.8.8 The early measurements of underwater sound due to operational turbines were reviewed Madsen *et al.* (2006) who concluded that the underwater sound from operating wind turbines is limited to low frequencies (below 1 kHz) and of low intensity and would therefore be unlikely to affect marine mammals with main hearing sensitivities at higher frequencies (i.e. VHF and HF cetaceans and PCW) (see Figure 1.4 in Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

4.9.8.9 As discussed in Stöber and Thomsen (2021), studies using long term frequency data from wind farms with 5 MW turbines (Alpha Ventus, Germany) found that whilst operational sound can be identified, levels hardly exceed beyond ambient sound levels in areas near main shipping traffic routes thus marine mammals in high traffic areas may not be able to discern operational wind turbine sound from background levels. Analysis of individual frequencies predicted a correlation between SPLs and the operational status of the wind turbines as well as the wind speed, but the total impact of the operational sound was considered to be mostly negligible (Stöber and Thomsen, 2021).

4.9.8.10 Nedwell *et al.* (2007) analysed measurements of underwater sound inside and outside of four different offshore wind farms in British waters. Results showed that the operational sound levels were low and only exceeded background levels close to the wind turbines (<1 km). For example, the results for Kentish Flats (30 3 MW turbines) showed that for harbour seal the perceived sound levels were just a few decibels higher inside the wind farm than outside, and the report stated that as the perceived level of sound was low, there was predicted to be no effect on individuals. It must be noted that whilst this study is well-known, the sound level metrics used in the study have not been widely adopted for impact assessment, therefore the sound level values in the paper have not been presented here to avoid any confusion or comparisons with the metrics now commonly adopted for assessment purposes. However, qualitatively the study provides some indication of the low sensitivity of marine mammals to wind turbine operational sound.

4.9.8.11 Tougaard *et al*. (2009) studied recordings of underwater sound from three wind farms in Denmark (450 kW, 500 kW and 2 MW turbines) and found that turbine sound was only measurable above ambient sound at frequencies below 500 Hz. Total sound pressure level was in the range 109–127 dB re 1μPa rms, measured at distances between 14 and 20 m from the foundations. This study estimated the maximum distance where harbour seal could perceive the sound for different wind farms to be between 2.5 and 10 km. For porpoises, 63 m maximum distance of perception was found. The study concluded that the sound is unlikely to exceed injury thresholds at any distance from the turbines and the sound is considered incapable of masking acoustic communication by harbour seal and harbour porpoise.

4.9.8.12 Marmo *et al.* (2013) reported that rotational imbalances tend to occur at very low frequencies (<50 Hz), while gear meshing and electromagnetic interactions tend to occur at low to moderate frequencies (8 Hz to 2 kHz). Wind turbines produce vibration and related sound between 0.5 Hz to 2 kHz which overlaps frequency bands that are detectable by species living in UK waters (Marmo *et al.,* 2013), although noting that these frequencies only overlap the peak sensitivities for LF cetaceans. The same study modelled vibration produced by a generic 6 MW wind turbine across the 10 Hz to 2 kHz frequency band and predicted that modelled sound levels are likely to be audible to marine mammals particularly at wind speeds of approximately 15 m/s when the generic wind turbines are producing maximum power. Species with hearing specialised to low frequency, such as minke whale, may in certain circumstances detect the wind farm at least 18 km away and are the species most likely to be affected by sound from operational wind turbines. Harbour seal, grey seal and bottlenose dolphin are not considered to be at risk of displacement by the operational wind farm modelled.

4.9.8.13 Stöber and Thomsen (2021) collated 16 scientific publications about underwater sound levels related to the operation of offshore wind turbines and found that the broadband rms ranged from 129 to 166 dB re 1µPa @ 1m and showed a general increasing trend with increasing nominal power output (MW). Using the regression line for peak spectral levels, authors predicted an underwater source level of 177 dB re 1µPa @ 1m for a geared turbine with a nominal power of 10 MW. Whilst the 10 MW example was predicted to cause behavioural disturbance of up to 6.3 km (based on the 120 dB_{rms} threshold) this was below typical sound levels for main installation vessels (see section 4.9.5).

4.9.8.14 It is therefore considered likely that large amounts of shipping sound, present in the vicinity of the Mona Offshore Wind Project, would mask operational wind farm sound. This, however, is likely to be a function of distance and if animals are close to the Mona Offshore Wind Project then the operational sound may still be detected. Studies so far have been for smaller wind turbines than those in the MDS at the time of writing this assessment, and therefore it is important to highlight that conclusions presented in this section has been based on the latest available data.

4.9.8.15 Conservatively, it is considered that there is a potential that the ability of cetaceans to find their prey may be hindered to some extent within the Mona Offshore Wind Project due to the potential masking of acoustic cues from large operational wind turbines. However, man-made structures in the marine environment are known to act as artificial reefs, providing structure and habitat for many fish species and attracting small pelagic fish, thus increasing food availability for cetaceans and pinnipeds in the presence of offshore wind farms and attracting marine mammal species (further information is given in Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement and Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the Environmental Statement). Section 4.9.9 provides more details about changes in prey availability and indirect impacts on marine mammals. Evidence for positive effects have been reported where species such as harbour porpoise, minke whale, white-beaked dolphin, harbour seal and grey seal have been frequently recorded around offshore wind farms (Scheidat *et al*., 2011; Lindeboom *et al*., 2011; Russell *et al.,* 2014; Diederichs *et al*., 2008).

Auditory injury

4.9.8.16 All marine mammals are deemed to have limited resilience to PTS, low recoverability and international value. Due to the permanence of the effect, the sensitivity of the receptor to PTS is therefore, considered to be **high**.

Behavioural disturbance

4.9.8.17 All marine mammals are deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Auditory injury

4.9.8.18 Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Behavioural disturbance

4.9.8.19 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.9 Changes in fish and shellfish communities affecting prey availability

4.9.9.1 Potential effects on fish assemblages during the construction, operations and maintenance and decommissioning phases of the Mona Offshore Wind Project, as identified in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, may have indirect effects on marine mammals. The assessment includes temporary habitat loss/disturbance, long term habitat loss, increased SSC and associated sediment deposition, underwater sound impacting fish and shellfish receptors, EMF, disturbance/remobilisation of sediment-bound contaminants, as well as colonisation of hard structures.

4.9.9.2 The key prey species for marine mammals include small shoaling fish from demersal or pelagic habitats, particularly gadoids (e.g. cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus*), whiting, *Trispoterus* spp, clupeids (herring), European sprat *Sprattus sprattus,* sandeels, mackerel (*Scomber scombrus*), flatfish (plaice *Pleuronectes platessa*, sole *Solea solea*, flounder (suborder Pleuronectoidei), dab *Limanda limanda*) and cephalopods.

4.9.9.3 These prey species have been identified as being of regional importance within the Mona Offshore Wind Project fish and shellfish ecology study area (see Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). For example, there are important spawning and nursery grounds for plaice, dover sole, cod, whiting, sandeel, herring, mackerel and sprat. There are also nursery grounds for haddock, tope *Galeorhinus galeus* and spurdog *Squalus acanthias*. Consequently, negative effects on fish receptors may have indirect adverse effects on marine mammal receptors.

Construction phase

Magnitude of impact

4.9.9.4 Potential impacts on marine mammal prey species during the construction phase have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement using the appropriate MDSs for these receptors. Potential construction impacts includes temporary habitat loss/disturbance, long term habitat loss, increased suspended sediment concentration (SSC) and associated sediment deposition, underwater sound impacting fish and shellfish receptors and disturbance/remobilisation of sediment-bound contaminants. A summary of the impact assessment for fish and shellfish is given in sections 4.9.9.1, with the magnitude, sensitivity and significance of the changes in fish and shellfish presented afterwards.

4.9.9.5 The installation of infrastructure within the Mona Offshore Wind Project may lead to temporary habitat loss/disturbance as a result of a range of activities including use of jack-up vessels during foundation installation, installation of inter-array, interconnector and offshore export cables and associated seabed preparation, and anchor placements associated with these activities.

4.9.9.6 There is the potential for temporary habitat loss/disturbance to affect up to 60,512,833 m^2 of subtidal seabed during the construction phase although only a small proportion of this will be impacted at any one time. For long term habitat loss, up to 2,192,412 m^2 may be lost (see Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement).

4.9.9.7 Habitat loss/disturbance could potentially affect spawning, nursery or feeding grounds of fish and shellfish receptors, which will impact those feeding higher up the food chain. However, as suggested in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase and areas will start to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works.

4.9.9.8 There is also the potential for underwater sound and vibration during construction pile-driving to result in injury and/or disturbance to fish and shellfish communities. Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement determined the impact of underwater sound on most fish and shellfish receptors during the construction phase to predicted to be of regional spatial extent, relatively short term duration, intermittent and of high reversibility, with the soundscape returning to near-baseline conditions upon completion of construction activities, with a magnitude of low for most species. However, discrete high and low intensity mapped herring spawning grounds are located off the east coast of the IoM at Douglas Bank, with spawning occurring over an approximate six-week period in September and October, and therefore Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement conservatively assessed the magnitude as medium for herring. This, combined with high sensitivity herring, led to potential moderate adverse significance for this key prey species from underwater sound associated with piling.

4.9.9.9 Herring has been shown to be an important prey species for harbour porpoise (Santos *et al.* (2004), alongside many other prey species (e.g whiting, sandeel, haddock, saithe, pollock, Norway pout, poor-cod, cod, ling, blue whiting) (see further detail in Volume 6, Annex 4.1: Marine Mammal Technical Report of the Environmental Statement). Herring is a key prey species for bottlenose dolphin in the UK (Pesante *et al.* (2008); Nuuttila *et al.* (2017); Santos et al. (2001) however, they have an opportunistic diet with a wide range of prey species in the Irish Sea, such as mackerel, seabass, whiting, salmon, sandeel, saithe, pollock, haddock, poor-cod (Pesante *et al.* (2008); Nuuttila *et al.* (2017); Evans and Hintner (2013); Hernandez-Milian *et al*. (2011) and therefore it is highly likely can adapt to changes in prey availability. Hernandez-Milian *et al.* (2015) for example identified 37 prey taxa in stomach contents from 12 bottlenose dolphin. Short-beaked dolphins have a varied diet which often consists of small schooling fish including herring (see further detail in Volume 6, Annex 4.1: Marine Mammal Technical Report of the Environmental Statement). Risso's dolphins are almost exclusively teuthophagic, with herring not forming a key prey item for this species. Minke whale however appear to be tightly tied to herring stocks in the Irish Sea around the Isle of Man (detailed in Volume 6, Annex 4.1: Marine Mammal Technical Report of the Environmental Statement), however specific feeding information on animals in this area is lacking. Sandeel are the key food resource for minke whale throughout the North Sea, with sprat, shad and herring also preferred prey items (Robinson and Tetley, 2007). Samples taken from the stomach contents of specimens within the North Sea determined that in UK waters the dominant prey items were sandeels, followed by clupeids and to a lesser extent mackerel (Robinson *et al.,* 2007). Conservatively there may be an effect on minke whale prey availability given how tightly tied they are to herring stocks (discussed further in 4.9.9.2).

4.9.9.10 As discussed in Volume 6, Annex 4.1: Marine Mammal Technical Report of the Environmental Statement, grey seals are generalist feeders, and take a wide variety of prey including sandeels, gadoids (cod, whiting, haddock, ling), and flatfish (plaice, sole, flounder, dab). Similarly harbour seal are opportunistic, generalist feeders and their diet varies both seasonally and from region to region.

4.9.9.11 Therefore, whilst there may be certain prey species that comprise the main part of their diet, all marine mammals in this assessment are considered to be generalist opportunistic feeders and are thus not reliant on a single prey species (with the exception of Risso's dolphins which predominantly eat cephalopods). Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement concluded that most prey species would not be exposed to significant adverse effects as a result of Mona Offshore Wind Project. Given that marine mammals are wide-ranging in nature with the ability to exploit numerous food sources, there would be a variety of prey species available for marine mammal foraging. Furthermore, the Underwater sound management strategy (with an Outline underwater sound management strategy included as part of the application, Document Reference J16), secured in the deemed marine licence, will present a review of relevant additional mitigation options in order to reduce the magnitude of impacts leading to significant effects (for the project alone) on fish and shellfish (such herring spawning) to a non-significant effect, which would benefit marine mammal predators who may feed on these fish.

4.9.9.12 Other potential impacts included increased SSC and associated sediment deposition which may result in short-term avoidance of affected areas by fish and shellfish. Adult fish have high mobility and may show avoidance behaviour in areas of high sedimentation (EMU, 2004), however, there may be potential impacts on the hatching success of fish and shellfish larvae and consequential effects on the viability of spawning stocks due to limited mobility (Bisson and Bilby, 1982; Berli *et al*., 2014). However as described in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement most fish juveniles expected to occur in the Mona fish and shellfish ecology study area will be largely unaffected by the relatively low-level temporary increases in SSC and any impacts will be short in duration, returning to background levels relatively quickly, and the effect was of minor adverse significance which will not impact marine mammals.

4.9.9.13 A moderate adverse effect, which is significant in EIA terms was predicted for herring as a result of underwater noise during the construction phase of the Mona Offshore Wind Project (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). No other significant adverse effects were predicted to occur to fish and shellfish species (marine mammal prey) as a result of the construction of the Mona Offshore Wind Project (Volume 2, Chapter 3: Fish and shellfish ecology of the

Environmental Statement). Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, intermittent and high reversibility. The magnitude was therefore, considered to be **low**.

Sensitivity of receptor

4.9.9.14 Although there is interspecific variation in foraging strategies (e.g. income versus capital breeders as discussed in 4.9.2.34), marine mammals often exploit a range of different prey items switching prey sources depending on season and availability, and sometimes covering extensive distances to forage in areas of high productivity. Whilst species may show a degree of site-fidelity (e.g. bottlenose dolphin are semi-resident in Cardigan Bay and grey and harbour seal often return to the same haul-out locations), largely marine mammals are not confined to a particular location and can, and will, freely move to occupy available areas of suitable habitat within large home ranges. Given that the impacts of construction to prey resources will be localised and largely restricted to the boundaries of the Mona Offshore Wind Project, only a small area will be affected when compared to available foraging habitat in the Irish and Celtic Seas.

4.9.9.15 With respect to underwater sound, marine mammals occurring within the predicted impact areas for fish and shellfish also have the potential to be directly affected (injury and/or disturbance) and it is likely that the effects to prey resources (e.g. behavioural displacement) will occur over a similar, or lesser, extent and duration as those for marine mammals. There would, therefore, be no additional displacement of marine mammals as a result of any changes in prey resources during construction, as they would already be potentially disturbed as a result of underwater sound during piling. In addition, as prey resources are displaced from the areas of potential impact, marine mammals are likely to follow in order to exploit these resources.

4.9.9.16 The fish and shellfish communities found within the Mona fish and shellfish ecology study area (see Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement) are characteristic of the fish and shellfish assemblages in the wider Irish Sea and it is therefore reasonable to assume that, due to the highly mobile nature of marine mammals, there will be similar prey resources available in the wider area. There may be an energetic cost associated with increased travelling and two species, harbour porpoise and harbour seal, may be particularly vulnerable to this effect. Harbour porpoise has a high metabolic rate and only a limited energy storage capacity, which limits their ability to buffer against diminished food while harbour seal typically forage close to haul out sites, i.e. within nearest 50 km. Despite this, if animals do have to travel further to alternative foraging grounds, the impacts are expected to be short term in nature and reversible (i.e. elevated underwater sound would occur during piling only). For example, responses by harbour porpoise to pile-driving sounds documented at two offshore wind projects in Denmark indicated a return to activity levels normal for the construction period a few days after pile-driving ceased (Tougaard *et al*., 2005, 2003). Displacement may also vary between species, for example Russell *et al*. (2016) showed for harbour seal there was no significant displacement during construction, and displacement was limited to piling activity (within 2 hours of cessation of pile driving, seals were distributed as per non-piling scenario). It is likely that during construction marine mammals may temporarily shift their foraging efforts to other areas within or around the project area due to disturbances to benthic habitat and associated resources (Fiorentino and Wieting, 2014). Therefore, it is expected that all marine mammal receptors would be able to tolerate the effect without any impact on reproduction and survival rates and would be able to return to previous activities once the impact had ceased.

4.9.9.17 Minke whale has the potential to be particularly vulnerable to potential effects on herring. In the Irish Sea, two known herring stocks exist and minke whale seem to mirror these stocks in Manx Waters. The Manx herring stock are known to spawn on the east coast of the island, in September to October (Bowers, 1969), hence the presence of minke whale on the east coast during these months. During the summer months, the Manx stock and Mourne stock are found together off the west coast of the island (Bowers, 1980). Anderwald *et al*. (2012) studied flexibility of minke whale in their habitat use and found that although significantly higher sighting rates often occur in habitats associated with sandeel presence, an area of high occupancy by minke whale coincided with high densities of sprat during spring. Hence, the low energetic cost of swimming in minke whale and their ability to switch between different prey according to their seasonal availability indicates that these species would be able to respond to temporal changes in pelagic prey concentrations.

4.9.9.18 Most marine mammals, except for minke whale, are deemed to be resilient to changes in prey availability, have high recoverability and high international value. The sensitivity of the receptor is therefore, considered to be **low**.

4.9.9.19 For minke whale, due to their reliance on herring as a primary food source in the Irish Sea, they are deemed to have some resilience to changes in prey availability, have high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.9.9.20 Overall, the magnitude of the impact is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.9.9.21 Potential impacts on marine mammal prey species during the operations and maintenance phase have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, using the appropriate MDSs for these receptors. These include temporary habitat loss/disturbance, long term habitat loss, increased SSC and associated sediment deposition, injury and/or disturbance from underwater sound and vibration, EMF from subsea electrical cabling, disturbance/remobilisation of sediment-bound contaminants as well as colonisation of hard structures.

4.9.9.22 Impacts, with the exception of EMF from subsea electrical cabling, are the same or less than those described for the construction phase in paragraph 4.9.3.23. Operational sound was not assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement but potential impacts on marine mammal prey availability will be less than those in the construction phase due to lower underwater sound levels.

4.9.9.23 During operations and maintenance, there may be potential impacts of EMF from subsea cables. Fish and shellfish species (particularly elasmobranchs) are able to detect applied or modified magnetic fields, and may exploit magnetic fields to detect prey, predators or conspecifics in the local environment to assist with feeding, predator avoidance, navigation, orientation and social or reproductive behaviours. The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. However, the impact of EMF on fish and shellfish was predicted to be of local spatial extent, long term duration, continuous and high reversibility (when the cables are decommissioned) and of minor adverse significance.

4.9.9.24 Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement also considers long-term habitat loss in the operations phase, but highlights the reality is not a loss of habitat, but rather a change in a sedimentary habitat and replacement with hard artificial substrates. Given marine mammals are flexible predators that can switch prey if required, such changes are unlikely to affect prey availability in the long term. Potential colonisation of hard structures could occur within hours or days after construction by demersal and semi-pelagic fish species (Andersson, 2011), with more complex communities later likely attracted to the developing algal and suspension feeder communities as potential new sources of food (Karlsson *et al*., 2022). Feeding opportunities or the prospect of encountering other individuals in the newly introduced heterogenous environment (Langhamer, 2012) may attract fish aggregations from the surrounding areas, which may increase the carrying capacity of the area in the long-term, and thus lead to a change or increase in prey availability for marine mammals.

Magnitude of impact

4.9.9.25 The impact on marine mammals is predicted to be of local spatial extent, long-term duration, continuous and the effect on marine mammals is of high reversibility. Whilst most impacts are considered to be adverse there is the potential for some beneficial effects with respect to introduction of hard substrate which could increase prey availability for some species. The magnitude for both adverse and beneficial impacts is considered to be **low**.

Sensitivity of receptor

4.9.9.26 Following placement on the seabed, submerged parts of the wind turbines provide hard substrate for the colonisation by high diversity and biomass in the flora and fauna. Faecal deposits of dominant communities of suspension feeders are likely to alter the surrounding seafloor communities by locally increasing food availability (Degraer *et al*., 2020). Higher trophic levels, such as fish and marine mammals, are likely to benefit from locally increased food availability and/or shelter and therefore have the potential to be attracted to forage within offshore wind farm array areas. However, still relatively little is known about the distribution and diversity of marine mammals around offshore anthropogenic structures.

4.9.9.27 Species such as harbour porpoise, minke whale, white-beaked dolphin, harbour seal and grey seal were frequently recorded around offshore oil and gas structures (Todd *et al*., 2016; Delefosse *et al*., 2018; Lindeboom *et al*., 2011). Acoustic results from a T-POD measurement within a Dutch windfarm found that relatively more harbour porpoise are found in the wind farm area compared to the two reference areas (Scheidat *et al*., 2011; Lindeboom *et al*., 2011). Authors of this study concluded that this effect is directly linked to the presence of the wind farm due to increased food availability as well as the exclusion of fisheries and reduced vessel traffic in the wind farm (shelter effect). Similarly, during research on a Danish wind farm, no statistical differences were detected in the presence of harbour porpoise between inside and outside the wind farm (Diederichs *et al*., 2008). This study suggested that a small increase in detections during the night at hydrophones deployed in proximity to single wind turbines may indicate increased foraging behaviour near the monopiles.

4.9.9.28 Russell *et al.* (2014) monitored the movements of tagged harbour seal within two active wind farms in the North Sea and demonstrated that animals commonly showed grid-like movement patterns which strongly suggested that the structures were used for foraging.

4.9.9.29 Whilst there is some mounting evidence of potential benefits of man-made structures in the marine environment (Birchenough and Degrae, 2020), the statistical significance of such benefits and details about trophic interactions in the vicinity of artificial structures and their influence on ecological connectivity remain largely unknown (Petersen and Malm, 2007; Inger *et al*., 2009; Rouse *et al.,* 2020; McLean *et al.,* 2022; Elliott and Birchenough, 2022). Additional details about inter-related effects on marine organisms are provided in Section 4.14.

4.9.9.30 Overall, the sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase described in paragraph 4.9.9.14. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

4.9.9.31 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This is likely to be an over-estimation of the significance as there is some evidence (although with uncertainties) that marine mammal populations are likely to benefit from introduction of hard substrates and associated fauna during the operations phase. However, neither adverse, nor beneficial effects are likely to change the conservation value of the marine mammal receptors.

Decommissioning

4.9.9.32 Potential impacts on marine mammal prey species during the decommissioning phase have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement using the appropriate MDSs for these receptors. These include temporary habitat loss/disturbance, long term habitat loss, increased SSCs and associated sediment deposition, colonisation of hard structures and disturbance/remobilisation of sediment-bound contaminants.

4.9.9.33 Magnitude of impacts are as described for the construction phase in paragraph 4.9.3.23. The impact on marine mammals is predicted to be of local spatial extent, long-term duration, continuous and the effect on marine mammals is of high reversibility. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

4.9.9.34 The sensitivity of marine mammals during the decommissioning phase is not expected to differ from the sensitivity of the receptors during the construction phase described in paragraph 4.9.9.14. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

4.9.9.35 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **low**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.9.10 Future monitoring

4.9.10.1 No marine mammal monitoring to test the predictions made within the impact assessment is considered necessary.

4.10 Cumulative effects assessment methodology

4.10.1 Methodology

4.10.1.1 The cumulative effects assessment (CEA) takes into account the impact associated with the Mona Offshore Wind Project together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see Volume 5, Annex 5.1: CEA screening matrix of the Environmental Statement). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

4.10.1.2 The marine mammals CEA methodology has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental Statement. As part of the assessment, all projects and plans considered alongside the Mona Offshore Wind Project have been allocated into 'tiers' reflecting their current stage within the planning and development process, these are listed below

4.10.1.3 A tiered approach to the assessment has been adopted, as follows:

- Tier 1
  - Under construction
  - Permitted application
  - Submitted application
  - Those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact
- Tier 2
  - Scoping report has been submitted and is in the public domain
- Tier 3
  - Scoping report has not been submitted and is not in the public domain
  - Identified in the relevant Development Plan
  - Identified in other plans and programmes.

4.10.1.4 This tiered approach is adopted to provide a clear assessment of the Mona Offshore Wind Project alongside other projects, plans and activities. The specific projects, plans and activities scoped into the CEA, are outline in Table 4.50. A timeline of cumulative project timescales is presented in Table 4.51 to outline overlaps in different phases of projects, and spatial location is presented in Figure 4.26.

4.10.1.5 The CEA screening area initially focussed on projects within the extent of the harbour porpoise CIS MU, rather than the entire extent of the largest MU: the Celtic and Greater North Seas (CGNS) MU. This was to ensure a proportionate and pragmatic approach was taken, focussing on a region within which receptor-impact pathways are likely (since cumulative effects from the Mona Offshore Wind within the Irish Sea were considered unlikely to occur with projects in the North Sea, for example). However, in order to refine the assessment to a more species-specific approach, only projects within the Irish Sea MU will be used for CEA for bottlenose dolphin (see paragraph 4.11.2.16). For grey seal, following consultation feedback from NRW (see Table 4.5), an extended screening area was applied (OSPAR Region III) instead of the GSRP. Only offshore wind projects were included in this extended screening area to allow for a more proportionate approach to the CEA. For harbour seal, the HSRP is used as the relevant screening area.

Table 4.50: List of other projects, plans and activities considered within the CEA.

*These offshore wind projects are only included in the grey seal extended screening area (OSPAR region III) and lie outside of the CIS MU screening area.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Tier 1							
Awel y Môr	Consented	13.52	3.6	Offshore Wind Farm (over 350MW capacity)	2026 to 2029	2030 to 2055	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Awel y Môr Offshore Wind Farm.
West Anglesey Demonstration Zone tidal site	Permitted but not yet implemented	53.78	50.57	Tidal Demonstration Zone	2021 to 2023	2024 to 2061	Operational activities at the Mona Offshore Wind Project may overlap with operational activities of West Anglesey Tidal Demonstration Zone.
Mainstream, Renewable Power Ltd- Site Investigations off Co, Dublin	Submitted but not yet determined	106.56	110.3	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Mainstream Dublin Northeast Wind.
Statkraft North Irish Sea Array (NISA) Site Investigations	Operational	114.25	119.47	Offshore Wind Farm: site investigations	n/a	2021 to 2026	Construction activities at the Mona Offshore Wind Project may overlap with site investigation activities for the Statkraft NISA.
Site Investigations for the proposed Sunrise Offshore Wind Farm, off Counties Dublin and Wicklow	Submitted but not yet determined	115.61	118.56	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Sunrise Offshore Wind Farm.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
ESB Wind Development Limited Site Investigations at Sea Stacks Offshore Wind off Dublin and Wicklow	Submitted but not yet determined	117.42	119.82	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for ESB Sea Stacks Offshore Wind.
Site Investigations for proposed Offshore Wind Farm, off Counties Wicklow and Dublin	Submitted but not yet determined	124.69	125.24	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Banba Offshore Wind Farm.
RWE Renewables Ireland Site Investigations for Dublin Array Offshore Wind Farm	Submitted but not yet determined	126.12	129.03	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for RWE Renewables Dublin Array Offshore Wind Farm.
Site Investigations for the proposed Wicklow Project offshore wind farm, off County Wicklow	Submitted but not yet determined	129.91	125.75	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Wicklow Project Offshore Wind Farm.
Shelmalere Offshore Wind Farm - Site Investigations off Counties Wexford and Wicklow	Submitted but not yet determined	164.62	160.44	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Shelmalere Offshore Wind Farm.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
SSE Renewables Celtic Sea surveys	Submitted but not yet determined	239.08	231.44	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for SSE Renewables Celtic Sea Offshore Wind Farm.
Project Erebus	Under Construction	259.9	240.23	Floating Demonstration Projects	2024 to 2025	2026 to 2051	Construction activities at the Mona Offshore Wind Project may overlap with operational activities at Project Erebus.
ESB Wind Development Limited Site Investigations off Waterford and Cork Coasts - Helvick Head Offshore Wind	Submitted but not yet determined	267.83	260.12	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for ESB Helvick Head Offshore Wind.
White Cross	Submitted but not yet determined	287.7	264.1	Demonstration Floating Wind Farm	2025 to 2027	2027 to Unknown	Construction and operational activities at Mona Offshore Wind Project may overlap with construction and operational activities of White Cross.
ESB Celtic Offshore Wind - Site Investigations off Waterford and Cork	Submitted but not yet determined	305.21	298	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for ESB Celtic Offshore Wind.
Simply Blue Energy (Kinsale) Limited surveys	Submitted but not yet determined	338.83	331.26	Floating Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Simply Blue Energy (Kinsale) Limited surveys.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Site Investigations for the proposed Kinsale Project offshore wind farm, off County Cork	Submitted but not yet determined	363.92	356.95	Offshore Wind Farm: site investigations	n/a	Unknown	There is potential for construction activities at the Mona Offshore Wind Project to overlap with site investigation activities for Kinsale Project Offshore Wind Farm.
Twin Hub	Permitted but not yet implemented	377.1	350.9	Floating offshore wind platforms (32 MW)	2024-2026	2026 to Unknown	Construction and operational activities at Mona Offshore Wind Project may overlap with operational activities of Twin Hub.
Tier 2							
Morgan Offshore Wind Project Generation Assets	Pre-application	5.52	32.93	Offshore Wind Farm	2026 to 2029	2030 to 2065	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Morgan Generation Assets.
Morecambe Offshore Windfarm Generation Assets	Pre-application	8.9	21.5	Offshore Wind Farm	2026 to 2029	2030 to 2089	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Morecambe Generation Assets.
Morgan and Morecambe Offshore Windfarms Transmission Assets	Pre-application	8.92	21.53	Transmission Assets	2026 to 2029	2030 to 2065	Construction and operational activities for the Mona Offshore Wind Project may overlap with construction and operational activities of the Morgan and Morecambe Offshore Wind Farms: Transmission Assets.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Mooir Vannin	Pre-application	34.53	59.9	Offshore wind farm	2030 to 2032	Unknown	There is potential at the operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Mooir Vannin wind farm lease area.
North Irish Sea Array Offshore Wind Farm	Pre-application	112.7	118.6	Offshore Wind Farm	2025 to 2027	2027 to 2059	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at North Irish Sea Array.
Codling Wind Park Offshore Wind Farm	Pre-application	125.1	123.6	Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and/or operational activities at Codling Wind Park Offshore Wind Farm.
Dublin Array Offshore Wind Farm	Pre-application	126.1	129	Offshore Wind Farm	2026 to 2028	2029 to 2062	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Dublin Array.
North Channel Wind 2	Pre-application	128.5	151.52	Floating Offshore Wind Farm	2027-2030	unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at North Channel Wind 2.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Oriel Windfarm Offshore Wind Farm	Pre-application	130.4	138.1	Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and/or operational activities at Oriel Windfarm Offshore Wind Farm.
Arklow Bank Wind Park Phase 2	Pre-application	146.7	142.8	Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and/or operational activities at Arklow Bank Wind Park Phase 2.
North Channel Wind 1	Pre-application	157.25	180.93	Floating Offshore Wind Farm	2027-2030	unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at North Channel Wind 1.
Shelmalere Offshore Wind Farm	Pre-application	164.6	160.4	Offshore Wind Farm	2028 to 2029	2030 to 2055	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Shelmalere Offshore Wind Farm.
North Celtic Sea Offshore Wind Farm	Pre-application	256.4	248.84	Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and/or operational activities at North Celtic Sea Offshore Wind Farm.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Llŷr 2	Pre-application	263	240	Floating Demonstration Project	2025 to 2026	2026 to 2051	Construction and operational activities at the Mona Offshore Wind Project may overlap with operational activities at Llŷr 2.
Llŷr 1	Pre-application	267	245	Floating Demonstration Project	2025 to 2026	2026 to 2051	Construction and operational activities at the Mona Offshore Wind Project may overlap with operational activities at Llŷr 1.
Project Valorous	Pre-application	271.7	252.4	Early commercial Floating Offshore Wind Farm	2028 to 2029	2029 to 2054	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Project Valorous.
Inis Ealga Marine Energy Park	Pre-application	288.3	282.7	Floating Offshore Wind Farm	2028 to 2030	2030 to Unknown	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Inis Ealga Marine Energy Park.
Simply Blue Emerald	Pre-application	338.83	331.26	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with site investigation activities at Simply Blue Energy (Kinsale) Limited surveys.
Project Ilen	Pre-application	392.52	395.4	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Project Ilen.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Spiorad na Mara – Offshore Wind Project*	Pre-application	560.74	552.54	Offshore wind farm	2028 to unknown	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Spiorad na Mara – Offshore Wind Project.
Tier 3							
Eni Hynet CCS	Pre-application	12.07	9.52	Carbon Capture and Storage project in Liverpool Bay	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Eni Hynet CCS.
MaresConnect	Pre-application	16.39	0	Subsea and underground electricity interconnector cable between Republic of Ireland and North Wales	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at MaresConnect.
Lir Offshore Array	Pre-application	85.87	90.43	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Lir Offshore Array.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Braymore Point	Pre-application	114.15	119.31	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Braymore Point.
Realt na Mara	Pre-application	117.25	119.7	Offshore wind farm	2028 to 2029	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Realt na Mara.
Cooley Point Offshore Wind Farm	Pre-application	117.98	124.39	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Cooley Point Offshore Wind Farm.
Setanta Offshore Wind Park	Pre-application	120.67	125.07	Offshore wind farm	2027 to 2029	2030 to Unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Setanta Offshore Wind Park.
Clogher Head Offshore Wind Farm	Pre-application	122.99	129.34	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Clogher Head Offshore Wind Farm.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Codling Wind Park Extension Offshore Wind Farm	Pre-application	127.15	124.89	Offshore wind farm	Unknown	Unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Codling Wind Park Extension Offshore Wind Farm.
Mac Lir	Pre-application	135.08	133.2	Offshore wind farm	2028 to 2029	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Mac Lir.
Celtic Sea Array Offshore Wind Farm	Submitted but not yet determined	239.08	231.44	Offshore Wind Farm (1.2GW Capacity)	2027 to 2029	2030 to unknown	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Celtic Sea Array Offshore Wind Farm.
Blackwater Offshore Wind Farm	Pre-application	239.42	228.19	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Blackwater Offshore Wind Farm.
Malin Sea Wind*	Pre-application	246.77	262.37	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Malin Sea Wind.

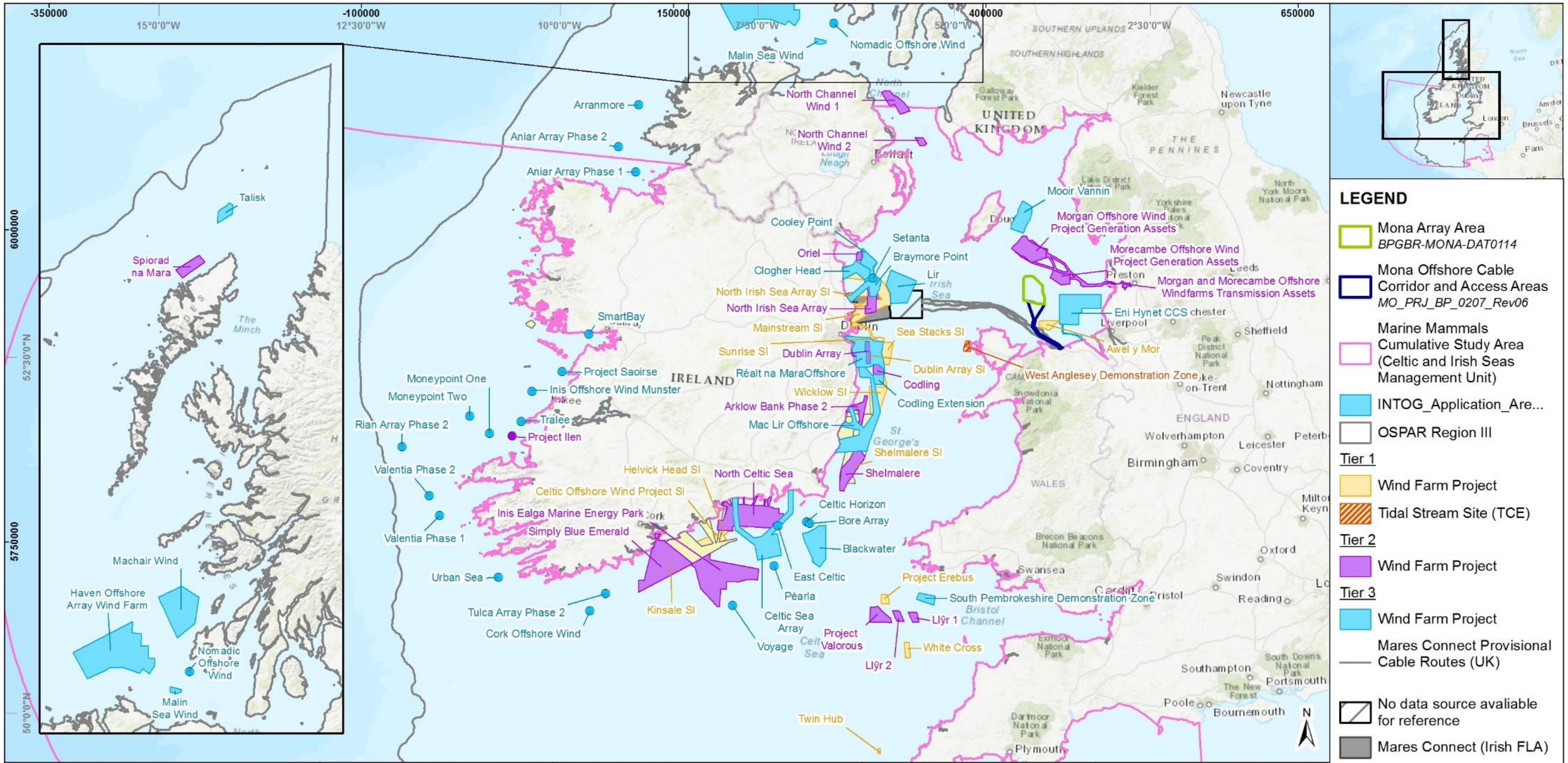
Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
South Pembrokeshire Demonstration Zone	Submitted but not yet determined	247.59	221.75	Wave energy demonstration project	Unknown	Unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at South Pembrokeshire Demonstration Zone.
Bore Array	Pre-application	247.65	237.23	Offshore wind farm	2027 to 2029	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Bore Array.
Celtic Horizon	Pre-application	248.63	238.53	Offshore wind farm	2027 to 2029	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Celtic Horizon.
Nomadic Offshore Wind*	Pre-application	253.95	270.98	Floating Offshore Wind Farm	Unknown	2030 to unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Nomadic Offshore Wind.
East Celtic	Pre-application	267.35	258.44	Offshore wind farm	Unknown	2030 to unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at East Celtic.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Haven Offshore Array Wind Farm*	Pre-application	268.9	290.5	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Haven Offshore Array Wind Farm.
Machair Wind – Hybrid Energy Project*	Pre-application	276.8	300.2	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Machair Wind – Hybrid Energy Project.
Péarla Offshore Wind Farm	Pre-application	292.21	281.22	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Péarla Offshore Wind Farm.
Aniar Offshore Array (Fixed)*	Pre-application	322.52	330.52	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Aniar Offshore Array (Fixed).
Voyage Offshore Array	Pre-application	337.89	326.93	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Voyage Offshore Array.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Arranmore*	Pre-application	338.27	348.66	Offshore wind farm	Unknown	Unknown	There is potential for construction and operational activities for the Mona Offshore Wind Project to overlap with construction and operational activities at Arranmore.
Aniar Offshore Array (Floating)*	Pre-application	341.64	350.36	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Aniar Offshore Array (Floating).
Inis Offshore Wind Munster	Pre-application	383.96	387.09	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities for Inis Offshore Wind Munster.
Project Saoirse	Pre-application	394.19	396.73	Wave energy demonstration project	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Project Saoirse.
Tulca Offshore Array Phase 2	Pre-application	409.48	403.12	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Tulca Offshore Array Phase 2.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Tralee	Pre-application	413.98	416.05	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Tralee.
Cork offshore wind project	Pre-application	427.4	420.7	Offshore Wind Farm (1 GW Capacity)	2028 to 2029	2030 to unknown	Construction and operational activities at the Mona Offshore Wind Project may overlap with construction and operational activities at Cork offshore wind project.
Cork Offshore Wind project	Pre-application	427.4	420.7	Offshore wind farm	2028 to 2029	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Cork Offshore Wind project.
Moneypoint Offshore One	Pre-application	441.18	443.03	Offshore wind farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities for Moneypoint Offshore One.
Urban Sea	Pre-application	475.79	472.15	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Urban Sea.

Project/Plan name	Status	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Valentia Phase 1	Pre-application	498.76	498.1	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Valentia Phase 1.
Valentia Phase 2	Pre-application	501.25	501.37	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Valentia Phase 2.
Rian Offshore Array Phase 2	Pre-application	511.5	513.58	Floating Offshore Wind Farm	Unknown	Unknown	There is potential for construction and/or operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Rian Offshore Array Phase 2.
Talisk*	Pre-application	560.74	580.73	Floating Offshore Wind Farm	2028 to 2029	2030 to unknown	There is potential for construction and operational activities at the Mona Offshore Wind Project to overlap with construction and operational activities at Talisk.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community	**Data Sources:** Client, TCE, EMODnet, gov.ie, JNCC	**Geodetic Information:** Datum: ETRS 1989. Projection: ETRS 1989 UTM Zone 30N. Scale@ 271.5mm x 154mm: 1:4,674,112	0 10 20 40 60 nm; 0 25 50 100 km
Project Name: MONA OFFSHORE WIND PROJECT	**Drawing Title:** OTHER PROJECTS, PLANS AND ACTIVITIES SCREENED INTO THE CEA WITH DIRECT IMPACTS ON MARINE MAMMALS	**Drawing Number:** RPSE-MN-ES-MAM-E001-02	

VER	DATE	DETAILS	BY	CHECK
00	11/10/23	First Issue	NA	BP
02	07/12/23	Revision	NA	BP

Figure 4.26: Other projects, plans and activities[1] screened into the CEA with direct impacts on marine mammals.

[1] Point data has been used for some projects where further details (such as an area of search) are not available.

Table 4.51: Temporal time scale for potential cumulative projects with direct impacts on marine mammals.

Cells shaded in blue refer to construction not started, green refer to construction, grey to operations and maintenance phase.

*These offshore wind projects are only included in the grey seal extended screening area (OSPAR region III) and lie outside of the CIS MU screening area.

Project	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	2024	2025	2026	2027	2028	2029	2030 onward	Operational end date
Tier 1										
Mona Offshore Wind Project	N/A	N/A				**Piling**	**Piling**			2064
Awel y Môr	13.52	3.6					**Piling**			2055
West Anglesey Demonstration Zone	53.78	50.57								2061
Project Erebus	259.9	240.23								2051
White Cross	287.6	264		**Piling**	**Piling**					Unknown
Twin Hub										Unknown
Tier 2										
Morgan Offshore Wind Project Generation Assets	5.52	32.93				**Piling**	**Piling**			2064
Morecambe Offshore Windfarm Generation Assets	8.9	21.5				**Piling**	**Piling**			2089
Morgan and Morecambe Offshore Windfarms Transmission Assets	8.92	21.53				**Piling**	**Piling**			2064

Project	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	2024	2025	2026	2027	2028	2029	2030 onward	Operational end date
Mooir Vannin	34.53	59.9								Unknown
North Irish Sea Array Offshore Wind Farm	112.7	118.6								Unknown
Codling Wind Park Offshore Wind Farm	125.1	123.6	Unknown							
Dublin Array Offshore Wind Farm	126.1	129								Unknown
North Channel Wind 2	128.5	151.52								Unknown
Oriel Windfarm Offshore Wind Farm	130.4	138.1	Unknown							
Arklow Bank Wind Park Phase 2	146.7	142.8	Unknown							
North Channel Wind 1	157.25	180.93								Unknown
Shelmalere Offshore Wind Farm	164.6	160.4								2055
North Celtic Sea Offshore Wind Farm	256.35	248.84	Unknown							
Llŷr 1	267	245								Unknown
Llŷr 2	263	240								Unknown
Project Valorous	271.7	252.4								Unknown
Inis Ealga Marine Energy Park	288.3	282.7								Unknown

Project	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	2024	2025	2026	2027	2028	2029	2030 onward	Operational end date
Simply Blue Emerald	338.83	331.26	Unknown							
Project Ilen	392.52	395.4	Unknown							
Spiorad na Mara – Offshore Wind Project*	560.74	552.54	Unknown							
Tier 3										
Eni Hynet CCS	12.07	9.52	Unknown							
MaresConnect	16.39	0								Unknown
Mooir Vannin	34.53	59.9	Unknown							
Lir Offshore Array	85.87	90.44	Unknown							
Braymore Point	114.15	119.31	Unknown							
Realt na Mara	117.26	119.71								Unknown
Cooley Point Offshore Wind Farm	117.98	124.39	Unknown							
Setanta Offshore Wind Park	120.67	125.07								Unknown
Clogher Head Offshore Wind Farm	122.99	129.34	Unknown							
Codling Wind Park Extension Offshore Wind Farm	127.15	124.89	Unknown							

Project	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	2024	2025	2026	2027	2028	2029	2030 onward	Operational end date
Mac Lir	135.08	133.2								Unknown
Celtic Sea Array Offshore Wind Farm	239.08	231.44								Unknown
Blackwater Offshore Wind Farm	239.42	228.19	Unknown							
South Pembrokeshire Demonstration Zone	247.59	221.75	Unknown							
Bore Array	247.65	237.23								Unknown
Celtic Horizon	248.63	238.53								Unknown
Malin Sea Wind	246.77	262.37	Unknown							
Nomadic Offshore Wind*	253.95	270.98	Unknown							
East Celtic	267.36	258.44	Unknown							
Haven Offshore Array Wind Farm	268.9	290.5	Unknown							
Machair Wind – Hybrid Energy Project	276.8	300.2	Unknown							
Péarla Offshore Wind Farm	292.21	281.22	Unknown							
Aniar Offshore Array (Fixed)*	322.52	330.53	Unknown							
Voyage Offshore Array	337.89	326.93	Unknown							

Project	Distance from the Mona Array Area (km)	Distance from the Mona Offshore Cable Corridor and Access Areas (km)	2024	2025	2026	2027	2028	2029	2030 onward	Operational end date
Arranmore*	338.27	348.66	Unknown							
Aniar Offshore Array (Floating)*	341.64	350.36	Unknown							
Inis Offshore Wind Munster	383.96	387.09	Unknown							
Project Saoirse	394.19	396.73	Unknown							
Tulca Offshore Array Phase 2	409.48	403.11	Unknown							
Tralee	413.98	416.05	Unknown							
Cork Offshore wind project	427.4	420.7								Unknown
Moneypoint Offshore One	441.18	443.03	Unknown							
Urban Sea*	475.79	472.15	Unknown							
Valentia Phase 1	498.76	498.1	Unknown							
Valentia Phase 2*	501.25	501.37	Unknown							
Rian Offshore Array Phase 2	511.5	513.58	Unknown							
Talisk*	560.74	580.73								Unknown

4.10.2 Maximum design scenario

4.10.2.1 The MDSs identified in Section 9.6.1 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the Project Design Envelope provided in Volume 1, Chapter 3: Project description of the Environmental Statement as well as the information available on other projects and plans, in order to inform a MDS. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g. different wind turbine layout), to that assessed here, be taken forward in the final design scheme.

4.10.2.2 Some of the potential impacts considered within the Mona Offshore Wind Project alone assessment are specific to a particular phase of development (e.g. construction, operations and maintenance or decommissioning). Where there is no spatial or temporal overlap with the activities during certain phases of the Mona Offshore Wind Project, potential impacts associated with other projects listed in Table 4.50, may be excluded from further consideration.

4.10.2.3 The assessment of cumulative effects with relevant projects is based on information available in the public domain. Only potential impacts screened in for the assessment for the Mona Offshore Wind Project alone are considered (Table 4.16). In this regard, where an impact has been considered in the relevant projects' environmental statement (Tier 1 projects) or screened in as a result of inclusion in the available scoping report (Tier 2 projects), a potential for cumulative effects is considered and the impact will be considered further in section 4.11. Potential impacts scoped out from individual assessments of respective projects or from the Mona Offshore Wind Project alone assessment are not considered further. An example of an impact that is scoped out from further assessment is underwater sound from wind turbine operation, as this impact has not been scoped into any of the assessments of projects listed in Table 4.50 for which operations and maintenance phase overlaps with the operations and maintenance phase of the Mona Offshore Wind Project. Projects with available temporal information are listed out in individual bullet points in the MDS in Table 4.52.

4.10.2.4 Given the limited data about Tier 3 projects available at the time of writing, projects were screened in initially based on temporal and/or spatial overlap as a precautionary approach. There was limited/no information on the construction/operation dates, nor foundation types proposed, however, with which to undertake any kind of meaningful assessment. Therefore, for potential impacts arising from piling for example which require these more detailed parameters, there is not sufficient information to carry out a quantitative assessment.

Table 4.52: Maximum design scenario considered for the assessment of potential cumulative effects on marine mammals.

[a] C=construction, O=operations and maintenance, D=decommissioning

*These offshore wind projects are only included in the grey seal extended screening area (OSPAR region III) and lie outside of the CIS MU screening area.

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Injury and disturbance from underwater sound generated during piling	✓	×	×	Maximum design scenario as described for the Mona Offshore Wind Project (Table 9.15) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr Offshore Wind Farm • Project Erebus • White Cross **Tier 2** • Dublin Array Offshore Wind Farm • Inis Ealga Marine Energy Park • Llŷr 1 • Llŷr 2 • Morecambe Offshore Windfarm Generation Assets • Morgan and Morecambe Offshore Windfarms Transmission Assets • Morgan Offshore Wind Project Generation Assets • Mooire Vannin • North Channel Wind 1 • North Channel Wind 2 • North Irish Sea Array Offshore Wind Farm • Project Valorous • Shelmalere Offshore Wind Farm • Spiorad na Mara – Offshore Wind Project*	The ZOI for pile driving can extend beyond the boundaries of proposed projects listed in Table 4.50 and therefore, adopting a precautionary approach, the assessment has screened in projects within the CIS MU whose construction phases overlap temporally with the construction phase for the Mona Offshore Wind Project. Projects whose construction phase finishes in a year preceding the commencement of construction phase at the Mona Offshore Wind Project (2025) were screened in as the sequential piling at respective projects could lead to a longer duration of impact. MDS for each project is presented in section 4.11.2.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Projects with no temporal information available: Arklow Bank Wind Park Phase 2, Codling Wind Park Offshore Wind Farm, North Celtic Sea Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen, Simply Blue Emerald **Tier 3** • Celtic Sea Array Offshore Wind Farm • Cork offshore wind project • Bore Array • Celtic Horizon • Mac Lir • Talisk* • Realt na Mara • Setanta Offshore Wind Park • Projects with no temporal information available: Blackwater Offshore Wind Farm, Braymore Point, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Inis Offshore Wind Munster, MaresConnect, Project Saoirse, South Pembrokeshire Demonstration Zone, Aniar Offshore Array (Fixed), Aniar Offshore Array (Floating)*, Arranmore*, East Celtic, Lir Offshore Array, Moneypoint Offshore One, Nomadic Offshore Wind*, Machair Wind – Hybrid Energy Project*, Malin Sea Wind*, Haven Offshore Array Wind Farm*, Péarla Offshore Wind Farm, Rian Offshore Array Phase 2, Tralee, Tulca Offshore Array Phase 2, Urban Sea, Valentia Phase 1, Valentia Phase 2, Voyage Offshore Array*.	
Injury and disturbance from pre-construction site investigation surveys	✓	×	×	Maximum design scenario as described for the Mona Offshore Wind Project (Table 9.15) assessed cumulatively with the following other projects/plans:	Though none of the Tier 1 wind projects assessed pre-construction site surveys as an effect pathway, a quantitative approach has been taken to Tier 1 projects to allow assessment of this impact.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Tier 1 None of the Tier 1 wind farm projects in Table 4.50 have assessed pre-construction site investigation surveys as an effect pathway. However, there are up to 14 Tier 1 site investigation surveys identified in the CEA screening area for marine mammals: • ESB Celtic Offshore Wind - Site Investigations off Waterford and Cork • ESB Wind Development Limited Site Investigations at Sea Stacks Offshore Wind off Dublin and Wicklow • ESB Wind Development Limited Site Investigations off Waterford and Cork Coasts - Helvick Head Offshore Wind • Mainstream, Renewable Power Ltd- Site Investigations off Co, Dublin • RWE Renewables Ireland Site Investigations for Dublin Array Offshore Wind Farm • Shelmalere Offshore Wind Farm - Site Investigations off Counties Wexford and Wicklow • Site Investigations for proposed Offshore Wind Farm, off Counties Wicklow and Dublin • Site Investigations for the proposed Kinsale Project offshore wind farm, off County Cork • Site Investigations for the proposed Sunrise Offshore Wind Farm, off Counties Dublin and Wicklow • Site Investigations for the proposed Wicklow Project offshore wind farm, off County Wicklow • SSE Renewables Celtic Sea surveys • Statkraft North Irish Sea Array (NISA) Site Investigations • Simply Blue Energy (Kinsale) Limited surveys	Whilst there are 14 Tier 1 site-investigation surveys identified in the screening process, there are limitations on the number of survey vessels that could carry out such surveys at one time and therefore highly unlikely that all would overlap temporally. Potentially up to 14 site-investigations were identified during screening, within the CIS MU. Surveys typically occur over short durations (typically up to 2 months) (based on expert judgment). Therefore as a conservative approach it is assumed as a worst case scenario that up to two surveys (in addition) could overlap with the Mona site-investigation surveys, as agreed with the marine mammal EWG (Table 4.5). MDS for each project is presented in section 4.11.3.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Tier 2 • Morgan Generation Assets • Morecambe Offshore Windfarm Generation Assets • Transmission Assets	
Injury and disturbance from underwater sound from UXO detonation	✓	×	×	Maximum design scenario as described for the Mona Offshore Wind Project (Table 4.16) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr Offshore Wind Farm • Project Erebus • White Cross **Tier 2** • Inis Ealga Marine Energy Park • Llŷr 1 • Llŷr 2 • Morecambe Offshore Windfarm Generation Assets • Morgan and Morecambe Offshore Windfarms Transmission Assets • Morgan Offshore Wind Project Generation Assets • Mooire Vannin • North Channel Wind 1 • North Channel Wind 2 • Project Valorous • Shelmalere Offshore Wind Farm • Projects with no temporal information available: Codling Wind Park Offshore Wind Farm, North Celtic Sea Offshore Wind Farm, Project Ilen, Simply Blue Emerald.	The ZOI for UXO clearance can extend beyond the boundaries of other proposed offshore wind farms. Therefore, of proposed projects listed in Table 4.50, the cumulative assessment has screened in projects within the CIS MU whose construction phases (which would include pre-construction UXO clearance) overlap temporally with the construction phase for the Mona Offshore Wind Project. Note, projects with completed UXO clearance campaigns are screened out of the assessment. Projects whose construction phase finishes in a year preceding the commencement of construction phase at the Mona Offshore Wind Project (2025) were screened in as the sequential UXO clearance at respective projects could lead to a longer duration of potential impacts affecting marine mammals. MDS for each project is presented in section 4.11.4.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Tier 3 • Celtic Sea Array Offshore Wind Farm • Cork offshore wind project • • Projects with no temporal information available: Blackwater Offshore Wind Farm, Braymore Point, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Eni Hynet CCS, Inis Offshore Wind Munster, MaresConnect, Project Saoirse, South Pembrokeshire Demonstration Zone,	
Disturbance from vessel use and other (non-piling) sound producing activities	✓	✓	✓	**Construction:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 4.16) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr • Project Erebus • West Anglesey Demonstration Zone tidal site • White Cross • Twin Hub **Tier 2** • Arklow Bank Wind Park Phase 2 • Codling Wind Park Offshore Wind Farm • Dublin Array Offshore Wind Farm • Inis Ealga Marine Energy Park • Llŷr 1 • Llŷr 2	It is expected that each project will contribute to the increase of vessel traffic and hence to the amount of sound from vessel traffic in the environment during the construction, operations and maintenance and decommissioning phases. Therefore, of proposed projects listed in Table 4.50, the cumulative assessment has screened in projects within the CIS MU whose construction, operations and maintenance and decommissioning phases overlap temporally with the construction, operations and maintenance and decommissioning phases for the Mona Offshore Wind Project. MDS for each project is presented in section 4.11.5.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Morecambe Offshore Wind Farm Generation Asset • Morgan and Morecambe Offshore Wind Farms: Transmission Assets • Morgan Offshore Wind Project Generation Assets • Mooire Vannin • North Celtic Sea Offshore Wind Farm • North Channel Wind 1 • North Channel Wind 2 • North Irish Sea Array Offshore Wind Farm • Oriel Offshore Wind Farm • Project Valorous • Shelmalere Offshore Wind Farm • Simply Blue Emerald • Wind Project Ilen **Tier 3** • Blackwater Offshore Wind Farm • Braymore Point • Celtic Sea Array Offshore Wind Farm • Cork offshore wind project • Clogher Head Offshore Wind Farm • Codling Wind Park Extension Offshore Wind Farm • Cooley Point Offshore Wind Farm • Eni Hynet CCS • Inis Offshore Wind Munster • MaresConnect • Project Saoirse	

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• South Pembrokeshire Demonstration Zone • Spiorad na Mara – Offshore Wind Project **Operations and maintenance:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 4.16) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr • Project Erebus • West Anglesey Demonstration Zone tidal site • White Cross • Twin Hub **Tier 2** • Arklow Bank Wind Park Phase 2 • Codling Wind Park Offshore Wind Farm • Dublin Array Offshore Wind Farm • Inis Ealga Marine Energy Park • Llŷr 1 • Llŷr 2 • Morecambe Offshore Wind Farm Generation Asset • Morgan and Morecambe Offshore Wind Farms: Transmission Assets • Morgan Offshore Wind Project Generation Assets • Mooire Vannin • North Channel Wind 1	

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• North Channel Wind 2 • North Irish Sea Array Offshore Wind Farm • Oriel Offshore Wind Farm • Project Valorous • Shelmalere Offshore Wind Farm • Projects with no temporal information available: Oriel Offshore Wind Farm, Arklow Bank Wind Park Phase 2, Simply Blue Emerald, Wind Project Ilen, North Celtic Sea Offshore Wind Farm. **Tier 3** • Blackwater Offshore Wind Farm • Braymore Point • Celtic Sea Array Offshore Wind Farm • Cork offshore wind project • Clogher Head Offshore Wind Farm • Codling Wind Park Extension Offshore Wind Farm • Cooley Point Offshore Wind Farm • Eni Hynet CCS • Inis Offshore Wind Munster • MaresConnect • Project Saoirse • South Pembrokeshire Demonstration Zone **Decommissioning:** *There are currently no known projects which will result in a cumulative effect during this phase of the Mona Offshore Wind Project.*	

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
Injury due to increased likelihood of collision with vessels	✓	✓	✓	**Construction:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 4.16) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr • Project Erebus • West Anglesey Demonstration Zone tidal site • White Cross • Twin Hub **Tier 2** • Arklow Bank Wind Park Phase 2 • Codling Wind Park Offshore Wind Farm • Dublin Array Offshore Wind Farm • Inis Ealga Marine Energy Park • Llŷr 1 • Llŷr 2 • Morecambe Offshore Wind Farm Generation Asset • Morgan and Morecambe Offshore Wind Farms: Transmission Assets • Morgan Offshore Wind Project Generation AssetsMorgan Generation Assets • Mooir Vannin • North Channel Wind 1 • North Channel Wind 2 • North Irish Sea Array Offshore Wind Farm • Oriel Offshore Wind Farm	It is expected that each project will contribute to the increase of vessel traffic and hence to the potential likelihood of collision during the construction, operations and maintenance and decommissioning phases. However, the risk of collision would be expected to be localised to within the close vicinity of the respective projects. Nevertheless, of proposed projects listed in Table 4.50, the cumulative assessment has screened in projects within the CIS MU whose construction, operations and decommissioning phases overlap temporally with the construction, operations and maintenance and decommissioning phases for the Mona Offshore Wind Project. MDS for each project is presented in section 4.11.6.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Project Valorous • Shelmalere Offshore Wind Farm • Projects with no temporal information available: Oriel Offshore Wind Farm, Arklow Bank Wind Park Phase 2, Simply Blue Emerald, Wind Project Ilen, North Celtic Sea Offshore Wind Farm. **Tier 3** • MaresConnect **Operations and maintenance:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 4.16) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr • Project Erebus • West Anglesey Demonstration Zone tidal site • White Cross • Twin Hub **Tier 2** • Arklow Bank Wind Park Phase 2 • Codling Wind Park Offshore Wind Farm • Dublin Array Offshore Wind Farm • Inis Ealga Marine Energy Park • Llŷr 1 • Llŷr 2	

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				• Morecambe Offshore Wind Farm Generation Asset • Morgan and Morecambe Offshore Wind Farms: Transmission Assets • Morgan Offshore Wind Project Generation Assets • Mooir Vannin • North Channel Wind 1 • North Channel Wind 2 • North Irish Sea Array Offshore Wind Farm • Oriel Offshore Wind Farm • Project Valorous • Shelmalere Offshore Wind Farm • Oriel Offshore Wind Farm • Arklow Bank Wind Park Phase 2 • Simply Blue Emerald • Wind Project Ilen • North Celtic Sea Offshore Wind Farm **Tier 3** • MaresConnect **Decommissioning:** *There are currently no known projects which will result in a cumulative effect during this phase of the Mona Offshore Wind Project.*	

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Effects on marine mammals due to changes in prey availability	✓	✓	✓	**Construction:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 9.15) assessed cumulatively with projects list in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. **Operations and maintenance:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 9.15) assessed cumulatively with projects list in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. **Decommissioning:** Maximum design scenario as described for the Mona Offshore Wind Project (Table 9.15) assessed cumulatively with projects list in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement.	It is expected that potential cumulative effects on fish and shellfish communities, as identified in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, may have indirect effects on marine mammals. For the purposes of the fish and shellfish ecology assessment of effects (i.e. in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement), cumulative effects have been assessed within a representative 50 km buffer from the Mona Offshore Wind Project. This 50 km buffer applies to all potential impacts considered in the fish and shellfish assessment, except underwater sound, where a larger buffer of 100 km has been used to account for the greater zone of influence associated with construction phase. For marine mammals, MDS for each project is presented in section 4.11.7.

4.11 Cumulative effects assessment

4.11.1 Overview

4.11.1.1 A description of the significance of cumulative effects upon marine mammal receptors arising from each identified impact is given below.

4.11.2 Injury and disturbance from elevated underwater sound generated during piling

4.11.2.1 As for the assessment of the Mona Offshore Wind Project alone, the risk of injury in terms of PTS to most of the marine mammal receptors, as a result of elevated underwater sound due to piling, would be expected to be localised to within the close vicinity of the respective projects. It is also anticipated that standard offshore wind industry mitigation and monitoring methods (which include soft starts and visual and acoustic monitoring of marine mammals as standard) will be applied during construction, thereby reducing the magnitude of impact. Therefore, there is very low potential for significant cumulative impacts for injury (PTS) from elevated underwater sound during pilling and the cumulative assessment focuses on disturbance only.

Tier 1

Construction phase

4.11.2.2 The construction of Mona Offshore Wind Project, together with construction of Tier 1 projects identified in Table 4.52 may lead to disturbance to marine mammals during piling. Tier 1 projects screened into the assessment within the CEA screening area includes Awel y Môr Offshore Wind Farm, Project Erebus and White Cross.

4.11.2.3 Each of the projects screened into the cumulative assessment have different construction timelines (Table 4.51). The construction phase of the Mona Offshore Wind Project will temporally overlap with the construction phase of Awel y Môr Offshore Wind Farm (four years) and White Cross (three years). Construction of Project Erebus is likely to be completed a year before the commencement of construction activities at Mona Offshore Wind Project. These timelines are, however, indicative and may be subject to change. Piling at each of these projects will occur as a discrete stage within the overall construction phase and therefore the periods of piling may not coincide.

4.11.2.4 The assessments provided in the Environmental Statements for Awel y Môr Offshore Wind Farm, Project Erebus and White Cross did not consider effects on harbour seal, as this species was scoped out. Given, that the cumulative assessment for piling is provided on species-by-species basis, harbour seal will not be considered further for Tier 1 projects.

4.11.2.5 Where cumulative numbers of animals potentially disturbed are presented (e.g. paragraph 4.11.2.7 for harbour porpoise), the calculations consider the timelines of respective projects. Given that Project Erebus completes the construction prior to the commencement of construction activities at Mona Offshore Wind Project, animals are likely to recover from the disturbance between piling events and therefore the numbers of animals potentially disturbed at respective projects are not added together. However, since there is a potential for temporal overlap of piling phase at Mona Offshore Wind Project with construction phase at Awel y Môr, animals could be disturbed during piling for both projects simultaneously and therefore numbers of animals potentially disturbed during piling are summed. Nevertheless, to ensure the most precautionary approach, cumulative iPCoD modelling incorporates numbers of animals affected by all projects throughout construction phases (see paragraph 4.9.3.13 for more details about iPCoD modelling).

4.11.2.6 For Mona Offshore Wind Project, two scenarios are considered as per the MDS (Table 4.16); a maximum temporal scenario and a maximum spatial scenario. The maximum duration of piling at the Mona Offshore Wind Project for pin piles is 114 days over the piling phase between 2027 and 2028 (Table 4.22), representing single consecutive piling and the maximum temporal scenario. For the maximum spatial scenario based on concurrent piling between wind turbines (3,000 and 3,000 kJ), the duration of piling is 90 days (Table 4.22).

Magnitude of impact

Harbour porpoise

4.11.2.7 There is potential for a cumulative effect of piling at Awel y Môr Offshore Wind Farm with piling at the Mona Offshore Wind Project. Based on the MDS presented in the Awel y Môr Environmental Statement marine mammal chapter, there will be up to 201 days of piling over the piling phase of 12 months in 2028, within the four-year construction phase (RWE, 2022). As discussed in the Awel y Môr Environmental statement marine mammal chapter, the JCP Phase III Tool density estimate for the Awel y Môr area (0.13 porpoise per km^2) was identified as the most suitable to take forward to impact assessment, alongside a precautionary density estimate obtained from the Sea Watch Foundation (SWF) report (1.0 porpoise per km^2, averaged across coastal and offshore areas) (Evans *et al*. 2021). The maximum number of animals predicted to be disturbed, at Awel y Môr, is up to 2,112 porpoises (Table 4.53) however this was based upon the most precautionary (SWF) density estimate. Using JCP densities resulted in an estimate of 275 harbour porpoise experiencing disturbance on each day of pile driving activities (RWE, 2022), compared to 2,112 animals as a result of the highly precautionary density. The assessment concluded that an absolute maximum of 201 days of piling may temporarily affect fertility rates and probability of calf survival. However, any potential effect was not expected to result in changes in the population trajectory.

4.11.2.8 The potential for temporal overlap of piling activities between the Mona Offshore Wind Project and Awel y Môr is considered likely. Subsequently, simultaneous piling may take place, generating significant levels of underwater sound. It is predicted that during piling at the Mona Offshore Wind Project, harbour porpoise may experience disturbance over the proportion of Irish Sea between the Solway Firth and Caernarfon Bay, albeit only mild disturbance (<130 dB) where the disturbance contours extend towards the coastal area (Figure 4.8).

4.11.2.9 Cumulatively, up to 3,254 harbour porpoise (5.20% of the Celtic and Irish Seas MU) could be disturbed at any one time during piling at the Mona Offshore Wind Project (using the spatial MDS) and Awel y Môr. This is likely to be an overestimate given highly precautionary SWF densities (1.0 animals per km^2) used for the assessment at Awel y Môr. If more realistic densities (0.13 animals per km^2, based on JCP Phase III Tool estimate) are taken into account, the cumulative number of harbour porpoise potentially disturbed would be up to 1,417 individuals (2.27% of the CIS MU). In addition, it is expected that animals would be disturbed over a similar area and disturbance contours are likely to overlap to a large extent due to the proximity of the projects. However, the area of strong disturbance may be larger compared to the Mona Offshore Wind Project alone and cumulative piling will result in longer duration of the impact and subsequently affect animals over longer timescales.

4.11.2.10 Project Erebus is a demonstration scale floating offshore wind farm, comprising six to ten wind turbines and a range of foundation options, including pile driven anchors. The construction is planned to take place in 2025 with only 18 days over which piling may occur. The number of harbour porpoise predicted to be affected by disturbance is based on densities from site-specific surveys (Blue Gem Wind, 2020; Table 4.53). Since the construction phase at the Mona Offshore Wind Project and Awel y Môr commences in 2026, there is no potential for piling activity at Project Erebus to coincide with piling at Mona Offshore Wind Project and therefore, spatially, there would be no larger cumulative area of disturbance. It is, however, important to note that Project Erebus is located in close proximity to the Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC designated for protection or harbour porpoise. Temporally, Project Erebus would contribute to a slightly longer duration of piling within the cumulative marine mammal study area.

4.11.2.11 Based on the White Cross MDS, as presented in the White Cross Offshore Windfarm marine mammal and marine turtle ecology chapter, there will be up to six days of piling (five days for WTG mooring pin piles and one day for OSP pin piles) over the piling phase of six months between 2025 and 2027 (onshore and offshore construction phase) (Offshore Wind Limited, 2023). The maximum number of animals predicted to be disturbed, at White Cross Offshore Windfarm is up to 1,652 (2.6% of CIS MU) for wind turbines (800 kJ, mooring pin piles) and 2,754 (4.4% of CIS MU) for OSPs (2,500 kJ) (Table 4.53), based on TTS/moving away response as a proxy for disturbance. As such, numbers are likely to be overestimated, as this approach assumes 100% avoidance of all individuals exposed, as opposed to a dose response approach, which assumes a proportional decrease in avoidance at greater distances from the pile driving source (Brandt et al., 2011). This was the most precautionary estimate based on the APEM summer density estimate density (0.918 animals per km2), rather than the lower APEM annual density estimate (0.594 animals per km2) (see Offshore Wind Ltd. (2023) for more details about both density estimates and associated caveats). The assessment concluded a magnitude of negligible for the OSP and a magnitude of low for wind turbines.

4.11.2.12 Cumulatively (based on each projects MDS) (see paragraph 4.11.2.5 for more details) in 2025, there would be piling at Project Erebus potentially affecting 1,967 harbour porpoise and piling at White Cross potentially affecting up to 2,754 harbour porpoise over 5 days of piling or 1,652 harbour porpoise on a single day of piling of OSPs. This could be followed by piling at Mona Offshore Wind Project in 2027 affecting 1,142 (spatial MDS) harbour porpoise and piling at White Cross potentially affecting up to 2,754 harbour porpoise. In 2028 there may be piling at Awel y Môr and Mona Offshore Wind Project in 2028 which may coincide and affect up to 3,254 (if using maximum SWF density for Awel y Môr) harbour porpoise. It is important to note that piling schedule information available for White Cross Offshore Windfarm is limited; whilst piling may occur at any point in the construction phase between 2025 and 2027, piling will take place over a maximum of six days, within a six month piling phase. In addition, the higher hammer energy of 2,500 kJ will only occur on a single day and estimates of number of animals disturbed are based on TTS/moving away response as a proxy for disturbance, and as such numbers are likely to be overestimated and therefore a cumulative total presented is highly precautionary.

Table 4.53: Harbour porpoise cumulative assessment – numbers predicted to be disturbed as a result of underwater sound during piling for Tier 1 Projects.

[1] Based on realistic density of 0.13 animals/km^2

[2] Number based on TTS as a proxy for disturbance (White Cross Offshore Wind (2023)).

Project	Reference	Max number of piles	Scenario	Piling duration	Piling phase	Max number of animals disturbed	Density (animal per km^2)	% of reference population
Mona Offshore Wind Project	Section 4.9.2	454	MDS Spatial (Concurrent piling)	90	24 months	1,142	0.2773	1.83% CIS MU
		454	MDS Temporal	114 days		971 (4,400 kJ)		1.55% CIS MU
Awel y Môr Offshore Wind Farm	RWE (2022)	50	Monopile, 5,000 kJ	201 days	12 months	2,112 (275[1])	1.0 (SWF) (0.13 animals per km^2 (JCP))	3.38% CIS MU
Project Erebus	Blue Gem Wind (2020)	35	Pin-pile, 800 kJ	18 days	8 months	1,967	0.4	3.15% CIS MU
White Cross	White Cross Offshore Wind (2023)	48	WTG: pin pile 800 kJ Single piling	5 days	6 months	1,652	0.918	2.6%
		4	OSP: pin pile 2,500 kJ Single piling	1 day		2,754	0.918	4.4%

4.11.2.13 Results of the cumulative iPCoD modelling for harbour porpoise for Tier 1 projects only within the CEA screening area showed that the median ratio of impacted to unimpacted population size at a time point of six years after commencement of piling was 0.9961, and 25 years after commencement of piling at cumulative projects this was 0.9966 (Appendix A). Changes in the impacted population size over time are slightly greater than those predicted for an unimpacted population, as can be seen in Figure 4.27. The impacted population was predicted to be up to 459 individuals smaller than the unimpacted population after five years (corresponding to approximately 0.734% of the CIS MU) with the difference reducing to 261 individuals (approximately 0.417% of the CIS MU) after 25 years. Therefore, given that the difference between impacted and unimpacted populations reduces consistently across the duration of the 25-year simulation (with the difference at the 25 year timepoint 0.417% of the MU), and the unimpacted population itself is believed to exhibit a declining trend (IAMMWG, 2021), it was considered that there is low potential for long-term cumulative effects on this species as a result of cumulative piling at the Mona Offshore Wind Project and Tier 1 projects.

4.11.2.14 Given that harbour porpoise can travel over large distances and there is a potential for overlap of disturbance sound level contours within SACs designated for this species (see paragraph 4.9.3.59 for more information), the cumulative effects on the designated features and conservation objectives of designated sites has been considered in the HRA Stage 2 ISAA (Document Reference E1.2).

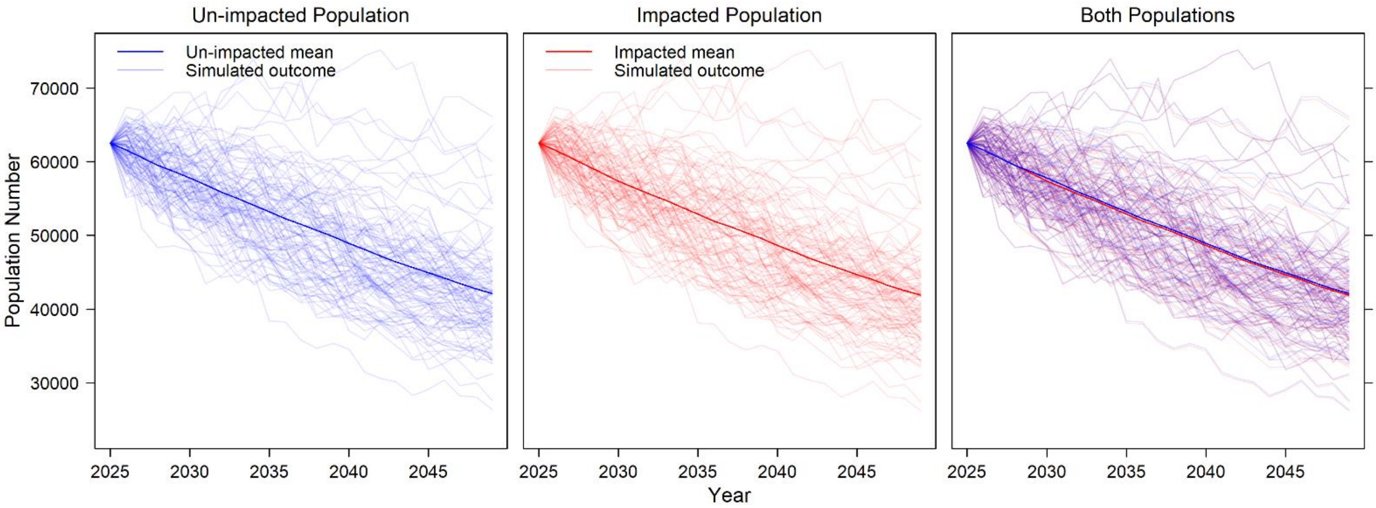


Figure 4.27: Simulated harbour porpoise population sizes for both the baseline (unimpacted) and the impacted populations under the cumulative scenario and no vulnerable subpopulation for Tier 1 projects only.

4.11.2.15 The impact (cumulative elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration and intermittent (only occurs during piling activities). Similarly, the effect of behavioural disturbance is reversible (with animals returning to baseline levels within hours/days after piling have ceased). It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however, in the context of the CIS MU the results of the iPCoD modelling suggest that over the duration of the impact and up to six years and 25 years after the start of piling there would be no long-term effects on the harbour porpoise population (see Appendix A). The magnitude is therefore considered to be **low**.

Dolphin species

4.11.2.16 As bottlenose dolphin sits within the Irish Sea MU, only projects within the Irish Sea MU will be used for the cumulative effects assessment for bottlenose dolphin, as this MU largely represents the coastal bottlenose dolphin ecotype (of which there are only a few hundred). Therefore Project Erebus and White Cross, which lie in the Offshore Channel and Southwest England MU (offshore ecotype), are not considered for this species. This approach was agreed with the marine mammal EWG (Table 4.5) (minutes and responses available in the Technical engagement plan appendicies Part 1 (Document Reference E4.1).

4.11.2.17 The number of bottlenose dolphin predicted to be exposed to sound levels that could result in behavioural disturbance at any one time during piling at the Awel y Môr Offshore Wind Farm (RWE, 2022) was based on Lohrengel *et al.* (2018) for the coastal 20 m depth contour and SCANS III data for the offshore densities (Table 4.54). The assessment found that most of the disturbance would occur in offshore waters where densities of bottlenose dolphin were lower. Even so, 23 animals (7.9% of the Irish Sea MU) could be affected by Awel y Môr, but iPCoD modelling carried out for the Awel y Môr Offshore Wind Farm suggested that, whilst there were likely to be some measurable changes in the population during piling, the trajectory of the population is expected to be stable in the long term. The impact of the Awel y Môr Offshore Wind Farm alone was assessed as being of medium magnitude where temporary changes in behaviour and/or distribution of individuals could result in potential reductions to reproductive success during an animals lifetime, although not enough to affect the population trajectory over a generational scale.

4.11.2.18 The number of short-beaked common dolphin predicted to be exposed to sound levels that could result in a behavioural disturbance at any one time during piling at the Awel y Môr Offshore Wind Farm was assessed using densities from SCANS III density estimates and the CGNS MU as a reference population (RWE, 2022) (Table 4.54). It was assumed that a low proportion (three animals) of the MU population (up to 0.02%) is expected to be repeatedly impacted and any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered. Project Erebus assessed the number of short-beaked common dolphin predicted to be affected by disturbance, based on densities from site-specific surveys and SCANS III block D (Blue Gem Wind, 2020). Whilst up to 2,067 animals (2.01% of the population) may be behaviourally disturbed, this was not anticipated to lead to changes in the population trajectory due to the short-term nature of the impact. Based on the White Cross MDS (Offshore Wind Limited, 2023) the maximum number of short-beaked common dolphin predicted to be disturbed is less than one individual for both wind turbines and the OSP (maximum 0.005% of the CCGNS MU) Table 4.54) (based on TTS as a proxy for disturbance). As highlighted for other species, numbers are likely to be overestimated, as this approach assumes 100% avoidance of all individuals exposed, as opposed to a dose response approach, which assumes a proportional decrease in avoidance at greater distances from the pile driving source (Brandt *et al*., 2011). This was the most precautionary estimate based on the APEM winter density estimate density (5.230 animals per km^2), rather than the lower APEM annual density estimate (3.833 animals per km^2) The assessment concluded a magnitude of negligible for the OSP and low for wind turbines.

4.11.2.19 Awel y Môr assessed the number of Risso’s dolphin predicted to be affected by disturbance based on SCANS III densities and the CGNS MU as the reference population to inform the assessment (RWE, 2022). A small number of animals (n = 65) were likely to be behaviourally disturbed during piling at Awel y Môr but effects were considered to be limited to small spatial and temporal scales. Given that there was very little data on Risso’s dolphin in the project Erebus area, and no density estimate was available, this species was not included in the quantitative impact assessment although the spatial scale of the effects was expected to be similar to that of bottlenose dolphin (Blue Gem Wind, 2020). Similarly, White Cross did not assess impacts on Risso’s dolphin.

4.11.2.20 It is anticipated that there will be a temporal overlap with piling at the Awel y Môr Offshore Wind Farm and White Cross with the Mona Offshore Wind Project. The consequences of potential simultaneous piling in 2028 (i.e. larger area of strong disturbance compared to the Mona Offshore Wind Project alone and longer duration of the impact) are described in more detail, for harbour porpoise, in paragraph 4.11.2.8. Bottlenose dolphin, short-beaked common dolphin and Risso’s dolphin may also be affected by strong disturbance over a larger area, however, it is important to note that all three species display seasonal variations in their distributions. Given that animals are not likely to be present in such high densities in the Celtic and Irish Seas constantly throughout the year (though they are present throughout the year (Evans and Waggitt, 2023)), it can be assumed that these species will not be continuously affected by simultaneous piling at the same level if it occurs all year round. For example, there is evidence of seasonal and breeding movement between Cardigan Bay and waters around the Isle of Man, and it is not likely to have high densities in both of these areas simultaneously (see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement for detail).

4.11.2.21 Therefore, cumulatively (see paragraph 4.11.2.5 for more details) for bottlenose dolphin (i.e. IS MU only), there would be piling at Mona Offshore Wind Project in 2027 potentially affecting 7 bottlenose dolphin (MDS spatial), and subsequently piling at Awel y Môr and Mona Offshore Wind Project in 2028 which may coincide and affect up to 30 bottlenose dolphin (10.24% of the Irish Sea MU).

4.11.2.22 For other dolphin species, there would be piling at Project Erebus in 2025 affecting 2,067 short-beaked common dolphin and piling at White Cross affecting less than one short-beaked common dolphin on a single day of piling (OSP; maximum hammer energy of 2,500 kJ) or less than one short-beaked common dolphin over 5 days of piling (wind turbines; maximum hammer energy of 800 kJ).

4.11.2.23 Subsequently piling at Mona Offshore Wind Project in 2027 would occur affecting three short-beaked common dolphin (spatial MDS) and 129 Risso's dolphin and and piling at White Cross Offshore Windfarm affecting less than one short-beaked common dolphin for both wind turbines and OSPs. In 2028, there would be piling at Awel y Môr and Mona Offshore Wind Project in 2028 which may coincide and affect up to 20 short-beaked common dolphin (0.02% of the CGNS MU) and 194 Risso's dolphin (1.58% CGNS MU). However, this is likely to be an overestimate given that the MDS for each project were used for the respective assessments (which each had levels of precaution within their own assessments) and that, due to the proximity of the sites, the sound level contours are likely to overlap thus reducing the area of ensonification.

4.11.2.24 As described above for harbour porpoise (see paragraph 4.11.2.10), the construction of Project Erebus is planned to take place in 2025 with only 18 days over which piling may occur and therefore there is no potential for piling activity to coincide with piling at Mona Offshore Wind Project or Awel y Môr. Temporally, Project Erebus would contribute to a slightly longer duration of piling within the cumulative study area.

Table 4.54: Dolphin species cumulative assessment – numbers predicted to be disturbed as a result of underwater sound during piling for Tier 1 Projects.

Project	Reference	Max number of piles	Scenario	Piling Duration	Piling phase	Density (animals per km^2)	Max No Animals Disturbed	% of Reference Population
Bottlenose dolphin								
Mona Offshore Wind Project	Section 9.8.2	454	MDS Spatial (Concurrent piling)	90	24 months	0.0017	7	2.39% IS MU
			MDS Temporal	114			6 (4,400 kJ)	2.03% IS MU
Awel y Môr Offshore Wind Farm	RWE (2022)	50	Monopile, 5,000 kJ	201 days	12 months	0.035 for the 20 m depth contour 0.008 offshore	23	7.9% (Irish Sea MU)
Short-beaked common dolphin								
Mona Offshore Wind Project	Section 9.8.2	454	MDS Spatial (Concurrent piling)	90	24 months	0.0006	3	0.002%
			MDS Temporal	114 days			3	0.002% GCNS MU
Awel y Môr Offshore Wind Farm	RWE (2022)	50	Monopile, 5,000 kJ	201 days	12 months	0.0081	17	0.02 (Celtic and Greater North Seas MU)
Project Erebus	Blue Gem Wind (2020)	35	Pin-pile, 800 kJ	18 days	8 months	1.61 site specific 0.3743 wider area	2,067	2.01% (CGNS MU)
White Cross	Offshore Wind Limited (2023)	48	Wind turbines: pin pile 800 kJ Single piling	5 days	6 months	5.23	<1	0.005% (CGNS MU)

Project	Reference	Max number of piles	Scenario	Piling Duration	Piling phase	Density (animals per km^2)	Max No Animals Disturbed	% of Reference Population
		4	OSP: pin pile 2,500 kJ Single piling	1 day		5.23	<1	0.005% (CGNS MU)
Risso's dolphin								
Mona Offshore Wind Project	Section 9.8.2	70	MDS Spatial (Concurrent piling)	90	24 months	0.0313	129	1.05% (Celtic and Greater North Seas MU)
			MDS Temporal	114 days			110 (4,400 kJ)	0.89% CGNS MU
Awel y Môr Offshore Wind Farm	RWE (2022)	50	Monopile, 5,000 kJ	201 days	12 months	0.031	65	0.53 (Celtic and Greater North Seas MU)

4.11.2.25 Cardigan Bay, and the Cardigan Bay/Bae Ceredigion SAC in particular, provide important habitats for bottlenose dolphin, with large numbers of animals inhabiting the area in the summer months. As described in more detail in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, there is an indication that bottlenose dolphin move between Manx waters and Cardigan Bay across the seasons. It has been suggested that Manx waters may provide vital winter habitat, whilst Cardigan Bay for calving. Although there has been no significant trend for Cardigan Bay/Bae Ceredigion SAC between 2001 and 2016, Lohrengel *et al.* (2018) reported that there is 90% certainty that the population in the SAC has declined over the last 10 years (2007-2016). Whilst abundance appears to be relatively stable in the IS MU (IAMMWG, 2022; Evans and Waggitt 2023), much of this region has not been well surveyed for population trends and it is difficult to determine an overall trend for the IS MU. Therefore, particular attention needs to be paid to ensure that although individuals may be disturbed in the short to medium term from specific areas of the Irish Sea, it will not have implications on long-term population trajectory. As such, future population dynamics of bottlenose dolphin are investigated using iPCoD modelling as described in paragraph 4.11.2.26.

4.11.2.26 Population modelling, using iPCoD (described in 4.9.3.13 to 4.9.3.17), was carried out for Tier 1 projects within the Irish Sea MU only for bottlenose dolphin; namely Mona Offshore Wind Project and Awel y Môr. Results of the cumulative iPCoD modelling for bottlenose dolphin and cumulative piling at Awel y Môr and Mona Offshore Wind Project against the Irish Sea MU population showed that the median ratio of the impacted population to the unimpacted population was 1.0000 at six and 25 years (see Appendix A). There was a small difference between the impacted and unimpacted population size over time, with seven fewer animals at six years (2.3% of the IS MU) and five fewer animals at time point 25 (1.7% of the IS MU), although the model suggests that this falls within the natural variation of the population and would not be expected to change the population trajectory (Figure 4.28 and Figure 4.29). It should, however, be highlighted that these small differences are predicted against a background of a modelled declining population (based on precautionary demographic parameters recommended by NRW, which uses a 0.22 fertility rate from Arso Civil *et al*., 2017) (Figure 4.28). As discussed in paragraph 4.9.3.17, it is important to highlight that whilst any model is sensitive to input parameters (as evidenced in Appendix A, by modelling with a 0.3 fertility rate from Sinclair *et al.*, 2020, Figure 4.29), the model chosen represents a conservative assessment of population changes. As discussed in paragraph 4.11.2.25, the trend for the IS MU is stable (though Cardigan Bay appears to have a declining population), and therefore the interpretation is with respect to the difference between impacted and unimpacted population.

4.11.2.27 Additionally, cumulative piling at respective projects could displace animals from important summer and winter habitats intermittently over two years. Given that bottlenose dolphin can travel over large distances, there is a possibility that a small number of individuals from SAC populations (see paragraph 4.9.3.66 for more information) may be occasionally present within the disturbance contours. As such the cumulative effects on the designated features and conservation objectives of designated sites will be considered in the ISAA (Document Reference E1.3). In addition, there is potential for overlap of the disturbance contours with a number of MNRs around the Isle of Man designated for bottlenose dolphin including Douglas Bay, Laxey Bay and Baie Ny Carrickey MNRs (although noting that for Mona Offshore Wind Project the overlap is likely to elicit a mild disturbance response only).

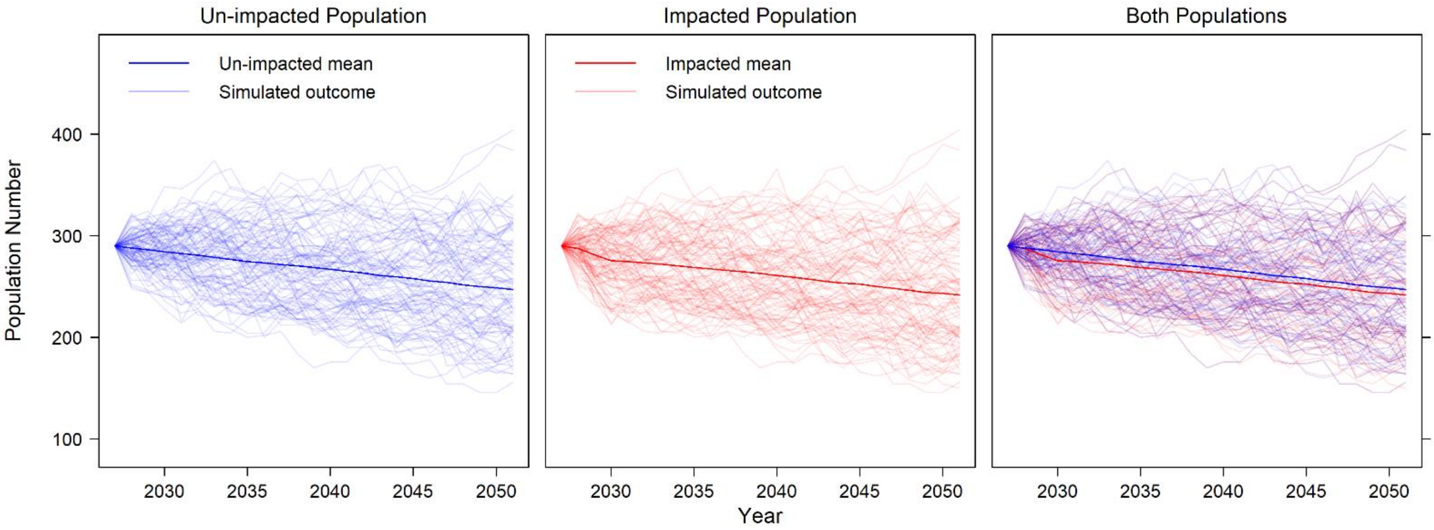


Figure 4.28: Simulated bottlenose dolphin population sizes (Irish Sea MU) for both the baseline (unimpacted) and the impacted populations under the cumulative scenario and no vulnerable subpopulation for Tier 1 projects only (lower fertility rate of 0.22).

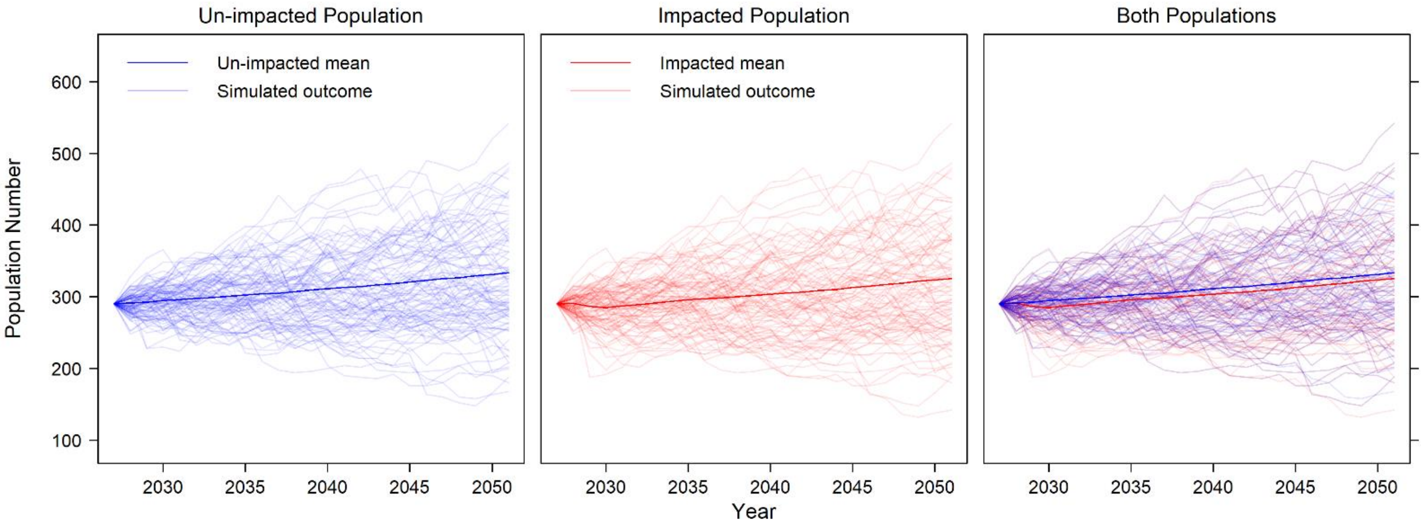


Figure 4.29: Simulated bottlenose dolphin population sizes (Irish Sea MU) for both the baseline (unimpacted) and the impacted populations under the cumulative scenario and no vulnerable subpopulation for Tier 1 projects only (higher fertility rate of 0.30).

4.11.2.28 The impact (cumulative elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration and intermittent (only occurs during piling activities). Similarly, the effect of behavioural disturbance is reversible (with animals returning to baseline levels within hours/days after piling have ceased). It is predicted that the impact will affect the receptor directly. The cumulative impact of piling at projects in the IS MU (Mona Offshore Wind Project and Awel y Môr) could result in potential reductions to lifetime reproductive success during an animals lifetime to some individuals in the IS MU population, as disturbance in offshore areas during piling could lead to a longer duration (up to 315 days if no overlap in piling) over which individuals may be displaced from key areas (in offshore areas between the mainland coast and the Isle of Man including MNRs) compared to the Mona Offshore Wind Project alone (up to 114 days for piling of pin piles for the temporal MDS). Based on the iPCoD models these changes are not enough to significantly affect the population trajectory over a generational scale (i.e. the trajectory falls within natural variation), however, there may be a small reduction in population size for the impacted population. In the context of possible declining bottlenose dolphin Irish Sea MU population, and the semi-resident population in Cardigan bay with seasonal movements across to the Isle of Man, the magnitude is conservatively considered to be **medium**.

4.11.2.29 For short-beaked common dolphin and Risso's dolphin, the magnitude is considered to be **low**.

Minke whale

4.11.2.30 The number of minke whale predicted to be exposed to sound levels that could result in behavioural disturbance at any one time during piling at Awel y Môr Offshore Wind Farm (Table 4.55) was based on SCANS III density estimates, and the Celtic and Greater North Seas MU was taken forward as the reference population to inform the assessment (RWE, 2022). With a maximum of 36 animals potentially behaviourally disturbed the assessment concluded that any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

4.11.2.31 The maximum number of animals predicted to be disturbed at White Cross Offshore Wind Farm, is up to 42 minke whale (0.21 % of the CGNS MU) for wind turbines and 61 minke whale (0.30% of the CGNS MU) for an OSP. This was the most precautionary estimate based on the SCANS-III estimate of 0.0112 animals per km^2 (Hammond *et al.,* 2021). The assessment concluded a magnitude of negligible for both wind turbines and the OSP (White Cross Offshore Wind Ltd., 2023).

4.11.2.32 It is anticipated that there will be a temporal overlap in piling at Awel y Môr Offshore Wind Farm, White Cross and Mona Offshore Wind Project. The consequences of potential simultaneous piling in 2028 (i.e. larger area of strong disturbance compared to the Mona Offshore Wind Project alone and longer duration of the impact) are described in more detail, for harbour porpoise, in paragraph 4.11.2.8. Given that minke whale show high seasonality to the area, with detections mostly over summer months (May to December, see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement for more details), it can be assumed that individuals will not be continuously affected by simultaneous piling if it occurs throughout the year. The maximum number of animals predicted to be disturbed, if piling activities at Mona Offshore Wind Project coincide with piling at Awel y Môr, is up to 108 minke whale (0.54% of the CGNS MU). However, this is likely to be an overestimate given that the MDS for each project were used for the respective assessments (which each had levels of precaution within their own assessments) and overlap of the sound level contours.

4.11.2.33 Project Erebus assessed the number of minke whale predicted to be affected by disturbance during piling based on densities from SCANS III block D (Hammond *et al.,* 2021) (Table 4.55) (Blue Gem Wind, 2020). The maximum number of minke whale predicted to be disturbed at Project Erebus is 55 (0.3% of the CGNS MU) based on a density estimate of 0.0112, from SCANS-III block D (Hammond *et al.,* 2021). As described above for harbour porpoise (see paragraph 4.11.2.10), the construction of Project Erebus is planned to take place in 2025 with only 18 days over which piling may occur and therefore there is no potential for spatial overlap of piling activity with Mona Offshore Wind Project. There is potential for temporal overlap with White Cross Offshore Windfarm in 2025. Temporally, Project Erebus would contribute to a slightly longer duration of piling within the cumulative study area.

4.11.2.34 Cumulatively, there would be piling at Project Erebus in 2025 affecting 55 minke whale and piling at White Cross affecting 42 minke whale on a single day of piling (OSP) or up to 61 minke whale over 5 days of piling (wind turbines). Subsequently, there would be piling at Mona Offshore Wind Project in 2027 affecting 72 minke whale and ; and piling at White Cross Offshore Windfarm. In 2028 there would be piling at Awel y Môr and Mona Offshore Wind Project which may coincide and affect up to 108 minke whale.

4.11.2.35 Population modelling for Tier 1 was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of effects. Results of the cumulative iPCoD modelling for minke whale against the MU population showed that the median ratio of impacted population size to unimpacted population size was 0.9988 at six years and 0.9967 at 25 years (Appendix A). Differences in the population size over time between the impacted and unimpacted population (75 individuals after 25 years, equivalent to approximately 0.373% of the CGNS MU population estimate) fall within the natural variance of the population and would not be expected to change the population trajectory, as can be seen in Figure 4.30.

Table 4.55: Minke whale cumulative assessment – numbers predicted to be disturbed as a result of underwater sound during piling for Tier 1 Projects.

Project	Reference	Max number of piles	Scenario	Piling duration	Construction period	Density (animals per km2)	Max number of animals disturbed	% Reference population
Mona Offshore Wind Project	Section 9.8.2	454	MDS Spatial (Concurrent piling)	90	24 months	0.0173	72	0.36% (CGNS MU)
			MDS Temporal	114 days			61 (4,400 kJ)	0.30% (CGNS MU)
Awel y Môr Offshore Wind Farm	RWE (2022)	50	Monopile, 5,000 kJ	201 days	12 months	0.017	36	0.18% (CGNS MU)
Project Erebus	Blue Gem Wind (2020)	35	Pin-pile, 800 kJ	18 days	8 months	0.0112	55	0.30% (CGNS MU)
White Cross	Offshore Wind Limited (2023)	48	WTG: pin pile 800 kJ Single piling	5 days	6 months	0.0112	42	0.21% (CGNS MU)
		4	OSP: pin pile 2,500 kJ Single piling	1 day		0.0112	61	0.30% (CGNS MU)

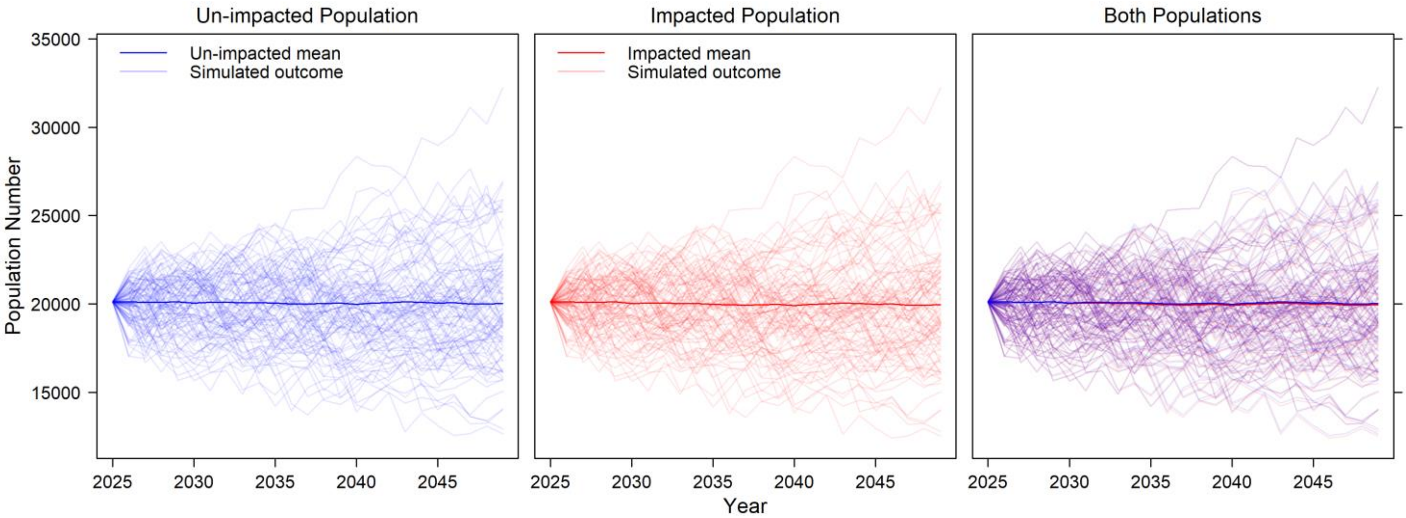


Figure 4.30: Simulated minke whale population sizes for both the baseline (unimpacted) and the impacted populations under the cumulative scenario and no vulnerable subpopulation for Tier 1 Projects.

4.11.2.36 The impact (cumulative elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration and intermittent (only occurs during piling activities). Similarly, the effect of behavioural disturbance is reversible (with animals returning to baseline levels within hours/days after piling have ceased). It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however, the results of the iPCoD modelling in the context of the CGNS MU suggest that over the duration of the impact, six years post impact and up to 25 years (Appendix A) after the start of piling there would be no long-term effects on the minke whale population. The magnitude is therefore considered to be **low.**

Grey seal

4.11.2.37 For grey seal, as discussed in paragraph 4.10.1.5, screening (for underwater sound from piling) was based on OSPAR Region III following discussions with the EWG. However, all Tier 1 Projects screened in line within the extent of the GSRP and therefore it is most relevant to present quantitative effects against the GSRP, to adopt a precautionary approach. As such population modelling was carried against both OSPAR Region III and the GSRP (see Appendix A).

4.11.2.38 The number of grey seal predicted to be exposed to underwater sound levels that could result in behavioural disturbance at any one time during piling at Awel y Môr Offshore Wind Farm (Table 4.56) was based on grid specific density estimates from Carter *et al.* (2020). The Wales and NW England Mus population of 5,000 individuals was taken forward as the reference population to inform the assessment for Awel y Môr (RWE, 2022). With up to 81 individuals potentially behaviourally disturbed the assessment concluded that any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

4.11.2.39 The maximum number of animals predicted to be disturbed at White Cross Offshore Wind Farm is up to 10 grey seal (0.48% of the SCOS SW England MU), based on grid specific density estimates from Carter *et al. 2022* and known disturbance ranges for grey seal as a result for piling (25 km; Russell *et al.,* 2016). The assessment concluded a magnitude of negligible for both wind turbines and OSPs.

4.11.2.40 It is anticipated that there will be a temporal overlap in piling at Awel y Môr, White Cross and Mona Offshore Wind Project. The consequences of potential simultaneous piling in 2028, i.e. larger area of strong disturbance compared to the Mona Offshore Wind Project alone and longer duration of the impact are described for in more detail for harbour porpoise in paragraph 4.11.2.8. The maximum number of animals predicted to be disturbed, if piling activities at Mona Offshore Wind Project coincide with piling at Awel y Môr and White Cross (in 2027), is up to 122 grey seals. This number represents 0.94% of the GSRP or 0.20% of the OSPAR Region III reference population. Although grey seals are present year-round on both the Irish and Welsh coasts, they are known to move between the southeast coast of Ireland and the southwest coast of Wales (see telemetry data in see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement for more details). Considering their ability to range over long distances, it is likely that grey seals will be able to find alternative foraging grounds if displaced during simultaneous piling at Mona Offshore Wind Project and Awel y Môr.

4.11.2.41 Project Erebus assessed the number of grey seals predicted to be affected by disturbance, based on grid specific density estimates from Carter *et al.* (2020) (Table 4.56). The Wales and Southwest England Mus populations of 6,090 individuals were taken forward as the reference population to inform the assessment (Blue Gem Wind, 2020). As described above for harbour porpoise (see paragraph 4.11.2.10), the construction of Project Erebus is planned to take place in 2025 with only 18 days over which piling may occur, therefore there is no potential for spatial overlap of piling activity with Mona Offshore Wind Project. Since the construction phases at Mona Offshore Wind Project and Awel y Môr Offshore Wind Farm commence in 2026, there is no potential for piling activity at Project Erebus to coincide with piling at these projects and therefore, spatially, there would be no larger cumulative area of disturbance as a result of Project Erebus. There is potential for temporal overlap with White Cross Offshore Windfarm in 2025. It is, however, important to note that Project Erebus is in close proximity to the Pembrokeshire Marine/Sir Benfro Forol SAC and Lundy SAC designated for protection of grey seal. Temporally, Project Erebus would contribute to a slightly longer duration of piling within the cumulative study area.

4.11.2.42 Cumulatively (see paragraph 4.11.2.5 for more details), there would be piling at Project Erebus in 2025 affecting up to 18 grey seal and piling at White Cross affecting up to 10 grey seal, followed by piling at Mona Offshore Wind Project in 2027 affecting up to 31 grey seal and piling at White Cross affecting up to 10 grey seal. In 2028, there would be piling at Awel y Môr and Mona Offshore Wind Project which may coincide and affect up to 112 grey seal (0.87% of the GSRP or 0.18% of OSPAR Region III).

Table 4.56: Grey seal cumulative assessment – numbers predicted to be disturbed as a result of underwater sound during piling for Tier 1 projects.

Project	Reference	Max number of piles	Scenario	Piling duration	Piling phase	Max number of animals disturbed	Density (animal per km^2)	% of each project reference population
Mona Offshore Wind Project	Section 9.8.2	454	MDS Spatial	90	24 months	31	N/A – Grid cell specific	0.24% of the GSRP
			MDS temporal	114 days		26 (4,400 kJ)		0.24% of the GSRP

Project	Reference	Max number of piles	Scenario	Piling duration	Piling phase	Max number of animals disturbed	Density (animal per km^2)	% of each project reference population
Awel y Môr Offshore Wind Farm	RWE (2022)	50	Monopile, 5,000 kJ	201 days	12 months	81	0.43	1.6% (Wales and NW England Mus)
Project Erebus	Blue Gem Wind (2020)	35	Pin-pile,	18 days	8 months	18	N/A – Grid cell specific	0.3% (Wales and SW England Mus)
White Cross	Offshore Wind Limited (2023)	48	WTG: pin pile 800 kJ Single piling	5 days	6 months	10	Based on 25 km known disturbance range	0.48% (of the SW MU)
		4	OSP: pin pile 2,500 kJ Single piling	1 day				0.30% (CGNS MU)

4.11.2.43 Population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the impact assessment. Modelling was carried out against OSPAR Region III and the GSRP (Appendix A). Results of the cumulative iPCoD modelling for grey seal showed that the median ratio of impacted population size to the unimpacted population size (when using both the Grey Seal Reference Population and OSPAR region III) was 1.0000 at six and 25 years (Appendix A), and simulated grey seal population sizes for both baseline and impacted populations showed no difference (Figure 4.31 and Figure 4.32). Therefore, it was considered that there is no potential for long-term effects on this species.

4.11.2.44 Given that grey seal telemetry tracks presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement demonstrated some connectivity between the Mona Offshore Wind Project and designated sites (see paragraph 4.9.3.92 for more information), the cumulative effects on the designated features and conservation objectives of designated sites will be considered in the ISAA (Document Reference E1.3).

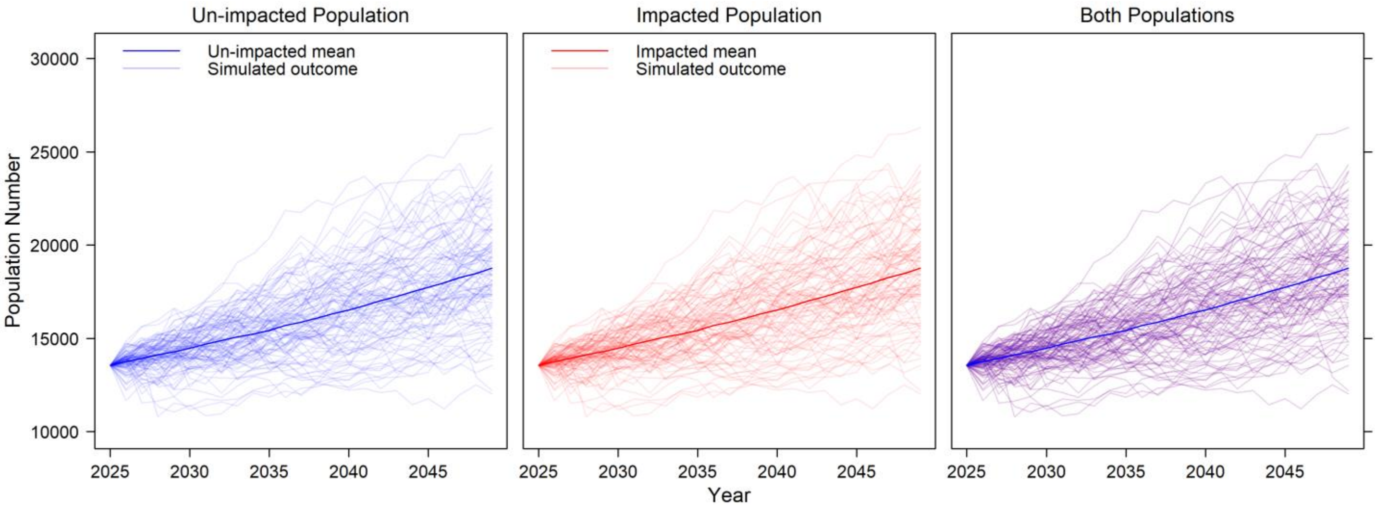


Figure 4.31: Simulated grey seal population sizes (using GSRP) for both the baseline and the impacted populations under the cumulative scenario and no vulnerable subpopulation for Tier 1 projects.

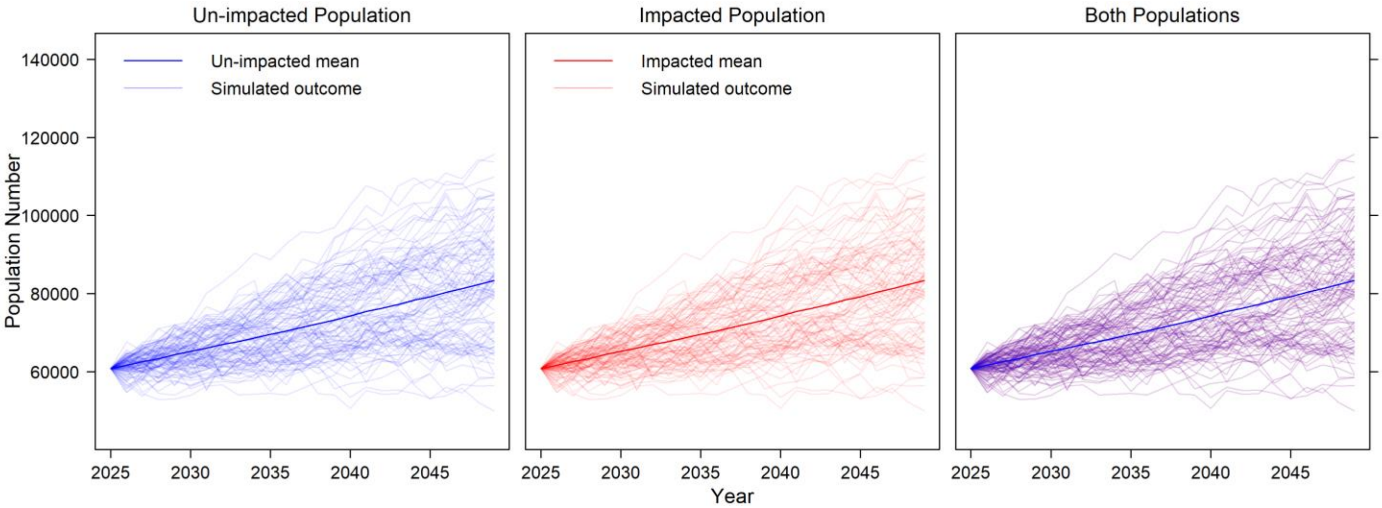


Figure 4.32: Simulated grey seal population sizes (using OSPAR Region III population) for both the baseline and the impacted populations under the cumulative scenario and no vulnerable subpopulation for Tier 1 projects.

4.11.2.45 The impact (cumulative elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration and intermittent (only occurs during piling activities). Similarly, the effect of behavioural disturbance is reversible (with animals returning to baseline levels within hours/days after piling have ceased). It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however, the results of the iPCoD modelling suggest that over the duration of the impact, six years post impact and up to 25 years after the start of piling there would be no long-term effects on the grey seal population in the context of both the OSPAR III and the Grey Seal Reference Population. The magnitude is therefore considered to be **low** in respect of both populations.

Sensitivity of the receptor

4.11.2.46 The sensitivity of the different marine mammal IEFs to behavioural disturbance from elevated underwater sound due to piling is as described in paragraph 4.9.3.113 for Mona Offshore Wind Project alone. Recovery of individual animals is anticipated to occur between piling events, which will be intermittent for cumulative projects. In particular, baseline levels of activity are anticipated to resume where the gaps between piling of respective projects are longer, such as between the end of piling at Project Erebus in 2025 and commencement of piling at the Mona Offshore Wind Project in 2027 and Awel y Môr in 2028.

4.11.2.47 It is important to note, however, that the extent to which an animal will be behaviourally affected is context-dependent and varies both inter- and intra-specifically. Behavioural disturbance may lead to the interruption of normal behaviours (such as feeding or breeding) and avoidance and therefore it may lead to displacement from the area and exclusion from potentially critical habitats, making it difficult for an animal to perform its regular functions (Goold, 1996; Weller *et al*., 2002; Castellote *et al*., 2010, 2012). Additionally, some exposures may be loud enough to trigger stress responses, which in turn can lead to a depressed immune function and reduced reproductive success (Anderson *et al*., 2011; De Soto *et al*., 2013).

4.11.2.48 All marine mammals are deemed to have some tolerance to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.2.49 The significance of effect is presented in Table 4.57, with magnitude and sensitivity presented.

4.11.2.50 The assessment of effects has determined that there is no significant effect predicted for the Mona Offshore Wind Project alone, however, recognising the potential for cumulative effects the Applicant will continue to explore options for mitigation of piling sound post consent, at a time when more detailed information is available (i.e. geotechnical data) and where further refinements to the project have been made on this basis. NAS is considered as an option as part of the Underwater sound management strategy, with an Outline underwater sound management strategy included as part of the application for consent (Document reference J16). Consequently, if NAS is required a detailed exploration of available technologies will be undertaken and information presented to demonstrate how such technology would contribute to the reduction in underwater sound from piling from the Mona Offshore Wind Project and thus reduce the potential for cumulative effects with other plans or projects.

Further mitigation measures

4.11.2.51 The cumulative impact assessment of disturbance from elevated underwater sound from piling concludes a significant effect in EIA terms, for bottlenose dolphin only. The cumulative impact assessment of injury from elevated underwater sound from piling concludes no significant effect in EIA terms, for all marine mammal receptors. Whilst the project alone assessment (4.9.3) determined there would be no significant effect in EIA terms, the Mona Offshore Wind Project may contribute to the cumulative impact in the context of the Irish Sea MU.

4.11.2.52 The assessment of cumulative effects from other plans and projects is based upon the respective MDSs presented in the Environmental Statements for Tier 1 projects or PEIR for Tier 2 Projects. The assessment does not consider any further mitigation or reduced/refined project design envelopes for other Tier 1 and/or Tier 2 projects that may be implemented post consent. However it is understood that if other projects are consented, it is reasonable to assume that they will each implement appropriate measures such that any significant effect is reduced to a non-significant level. Although this assessment cannot conclude based upon this assumption, a significant cumulative impact is considered unlikely for this reason.

4.11.2.53 Post consent, following a refined project design envelope and programme clarity, the Underwater sound management strategy (Document Reference J16) will investigate options to manage underwater sound levels (such as NAS, temporal and spatial piling restrictions, piling methods, soft start) in order to reduce the magnitude for the project alone, in order to minimise the project's contribution to any cumulative effect. The project has prepared an Outline underwater sound management strategy (Document Reference J16) which is secured in the deemed marine licence in Schedule 14 of the draft DCO.

4.11.2.54 In this case, further mitigation options may be applied to reduce the magnitude for bottlenose dolphin. The Underwater sound management strategy (Document Reference J16) will be developed in consultation with the licensing authority and SNCBs, and agreed, prior to construction, those mitigation measures which may be implemented to reduce the magntitude of impact from the project alone.

Table 4.57: Summary of disturbance assessment from underwater sound generated during piling at cumulative projects.

Species	Magnitude	Sensitivity	Significance	Justification
Harbour porpoise	Low	Medium	Minor adverse	The cumulative effects are unlikely to affect the international value of the species in the context of the CIS MU as there is no long-term decline in the regional population predicted as demonstrated with the cumulative iPCoD modelling assessment.
Bottlenose dolphin	Medium (Irish Sea MU)	Medium	Moderate adverse (Irish Sea MU)	Cumulative effects could potentially affect the international value of the species in the context of the Irish Sea MU.
Risso's dolphin, short-beaked common dolphin	Low	Medium	Minor adverse	The cumulative effects are unlikely to affect the international value of short-beaked common dolphin or Risso's dolphin in the context of the CGNS MU.
Minke whale	Low	Medium	Minor adverse	The cumulative effects are unlikely to affect the international value of the species in the context of the CGNS MU as there is no long-term decline in the regional population predicted as demonstrated with the iPCoD modelling assessment.
Grey seal	Low	Medium	Minor adverse	The cumulative effects are unlikely to affect the international value of the species in the context of the combined grey seal reference population/OSPAR Region III as there is no long-term decline in the regional population predicted as demonstrated with the cumulative iPCoD modelling assessment.

Tier 2

Construction phase

4.11.2.55 Given the temporal overlap, the construction of the Mona Offshore Wind Project, together with construction of Tier 1 projects and Tier 2 projects: Arklow Bank Wind Park Phase 2, Codling Wind Park Offshore Wind Farm, Dublin Array Offshore Wind Farm, Inis Ealga Marine Energy Park , Llŷr 1, Llŷr 2, Morecambe Offshore Windfarm Generation Assets, Morgan and Morecambe Offshore Windfarms Transmission Assets (hereafter known as 'Transmission Assets'), Morgan Offshore Wind Project Generation Assets, North Celtic Sea Offshore Wind Farm, North Channel Wind 1, North Channel Wind 2, North Irish Sea Array Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen, Project Valorous, Shelmalere Offshore Wind Farm, and Simply Blue Emerald (Table 4.50) may lead to cumulative disturbance to marine mammals from piling.

Magnitude of impact

4.11.2.56 The EIA Scoping Reports do not provide detailed information about potential impacts of underwater sound as a result of piling and therefore it is not possible to undertake full, quantitative assessment for this impact. As such, a qualitative assessment is provided below. However for the Morgan Generation Assets, Morecambe Generation Assets and Transmission Assets PEIR is available and more detailed information is included.

4.11.2.57 The EIA Scoping Reports of all projects screened into the cumulative assessment have identified potential for auditory injury and disturbance as a result of underwater sound during piling as potential impacts (SSE Renewables (2020); Codling Wind Park Limited. (2020); Dublin Array (2020); Inis Ealga Marine Energy Park Ltd. (2022); AECOM (2022); Floventis Energy Ltd. (2022); Morecambe Offshore Windfarm Ltd. (2023), Morgan Offshore Wind Ltd. and Morecambe Offshore Windfarm Ltd. (2023); Morgan Offshore Wind Project Ltd. (2023); Orsted (2023); North Celtic Sea Wind Limited (2023); North Channel Wind (2023); North Irish Sea Array Windfarm Ltd (2023); Oriel Wind Farm Ltd. (2019); Western Star Limited (2023a), Blue Gem Wind Ltd (2021), Shelmalere Offshore Wind Farm Ltd. (2022), Emerald Offshore Wind Ltd (2023) Spiorad na Mara Limited (2023)). The indicative timelines suggest that there will be a temporal overlap of construction phase of Mona Offshore Wind Project with the construction phases of all listed projects. The construction dates are unknown for Arklow Bank Wind Park Phase 2, Codling Wind Park Offshore Wind Farm, North Celtic Sea Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm and Project Ilen and Simply Blue Emerald, however, conservatively these projects were screened into the cumulative assessment in the event that a temporal overlap occurs. It is noted that the description of the projects provided in the respective EIA Scoping Reports is indicative and may be further refined or changed.

4.11.2.58 The EIA Scoping Report for the Morgan Offshore Wind Project: Generation Assets (Morgan Offshore Wind Project Ltd, 2022) identified disturbance of marine mammals resulting from underwater sound during piling as a potential effect during the construction phase of the project. Subsequently, the Morgan Offshore Wind Project: Generation Assets PEIR predicted that the disturbance during piling will have far-reaching effects across the north part of the Irish Sea. Number of animals potentially disturbed during piling at Morgan Generation Assets is presented in Table 4.58. Cumulatively, during piling at Mona Offshore Wind Project and Morgan Generation assets, up to 2,512 harbour porpoise (4.02% of the MU population), 23 bottlenose dolphin (7.85% of the MU population), 103 short-beaked common dolphin (0.1% of the

MU population), 302 Risso's dolphin (2.46% of the MU population), 168 minke whale (0.84% of the MU population), 79 grey seal (0.61% of the Grey Seal Reference Population, 0.13% of the OSPAR III region) and up to two harbour seal (0.14% of the reference population).

Table 4.58: The maximum number of animals predicted to be disturbed during concurrent piling of monopiles at the Morgan Generation Assets (Morgan Offshore Wind Project Ltd, 2023).

Species	Number of Animals	Reference Population and Abundance	% Reference Population (MU)
Harbour porpoise	1,370	Celtic and Irish Seas MU (62,517)	2.19%
Bottlenose dolphin	16	Irish Sea MU (293)	5.28%
Short-beaked common dolphin	100	Celtic and Greater North Seas MU (102,656)	0.10%
Risso's dolphin	174	Celtic and Greater North Seas MU (12,262)	1.42%
Minke whale	96	Celtic and Greater North Seas MU (20,118)	0.48%
Harbour seal	<1	Wales, NW England, N. Ireland SMUs (1,424)	0.009%
Grey seal	48	Grey seal reference population (12,910) OSPAR Region III (60,780)	0.35% Grey seal reference population/0.08% (OSPAR Region III)

4.11.2.59 Based on the MDS presented in the Morecambe Offshore Windfarm: Generation Assets PEIR marine mammal chapter, there will be up to 42 days of piling over the piling phase of 24 months between 2027 and 2028, within the 2.5 year construction phase (Morecambe Offshore Windfarm Ltd, 2023). The maximum number of animals predicted to be disturbed at the Morecambe Offshore Windfarm: Generation Assets, is presented in Table 4.59 (Morecambe Offshore Windfarm Ltd, 2023). The impact of the Morecambe Offshore Windfarm: Generation Assets alone, was assessed as being of low magnitude, based on a dose-response approach. At Morecambe Generation assets, up to 2,961 harbour porpoise (based upon the worst case numbers from the EDR approach) (4.74% of the MU population), one bottlenose dolphin (0.34% of the MU population), one short-beaked common dolphin (0.001% of the MU population), one Risso's dolphin (0.008% of the MU population), two minke whale (0.01% of the MU population), 11 grey seal (1.05% of the Combined MUs, 0.104% of the OSPAR III region) and up to three harbour seal (0.19% of the combined MUs). Population modelling was not carried out at PEIR stage and the impact of the Morecambe Offshore Windfarm: Generation Assets alone, was assessed as being of negligible magnitude, based on a dose-response approach to assessing disturbance.

4.11.2.60 Cumulatively, during piling at Mona Offshore Wind Project and Morecambe Generation assets, up to 4,103 harbour porpoise (6.56% of the MU population), eight bottlenose dolphin (2.73% of the MU population), four short-beaked common dolphin (0.004% of the MU population), 130 Risso's dolphin (1.06% of the MU population), 42 minke whale (0.21% of the MU population), 74 grey seal (0.57% of the Grey Seal Reference Population, 0.11% of the OSPAR III region) and up to four harbour seal (0.28% of the reference population).

Table 4.59: The maximum number of animals predicted to be disturbed during concurrent piling of monopiles at the Morecambe Generation Assets (Morecambe Offshore Windfarm Ltd, 2023).

[1]Based upon EDR approach, rather than TTS as for other species.

Species	Number of Animals	Reference Population and Abundance	% Reference Population
Harbour porpoise	2,961[1]	Celtic and Irish Seas MU (62,517)	4.74%
Bottlenose dolphin	1	Irish Sea MU (293)	0.34%
Short-beaked common dolphin	1	Celtic and Greater North Seas MU (102,656)	0.001%
Risso's dolphin	1	Celtic and Greater North Seas MU (12,262)	0.008%
Minke whale	2	Celtic and Greater North Seas MU (20,118)	0.01%
Grey seal	11	Combined MUs (1,044) Wider ref population (10,504)	0.99%

4.11.2.61 Based on the MDS presented in the Transmission Assets PEIR marine mammal chapter (Morgan Offshore Wind Ltd. and Morecambe Offshore Windfarm Ltd., 2023), there will be up to four days of piling over the piling phase of 12 months, within the four year construction phase. The maximum number of animals predicted to be disturbed at the Transmission Assets, is presented in Table 4.60. This combines Morgan OSPs, Morecambe OSP and Morgan Booster Station.

4.11.2.62 As presented in the Transmission PEIR, up to 2,465 harbour porpoise (4.94% of the MU population), 11 bottlenose dolphin (3.70% of the MU population), 207 short-beaked common dolphin (0.004% of the MU population), 125 Risso's dolphin (1.01% of the MU population), 69 minke whale (0.34% of the MU population), 88 grey seal (0.65% of the Grey Seal Reference Population, 0.11% of the OSPAR III region) and up to one harbour seal (0.001% of the reference population).

4.11.2.63 Cumulatively, during piling at Mona Offshore Wind Project and Transmission Assets up to 3,607 harbour porpoise (5.77% of the MU population), 18 bottlenose dolphin (6.14% of the MU population), 210 short-beaked common dolphin (0.2% of the MU population), 254 Risso's dolphin (2.07% of the MU population), 141 minke whale (0.7% of the MU population), 119 grey seal (0.92% of the Grey Seal Reference Population, 0.2% of the OSPAR III region) and up to two harbour seal (0.14% of the reference population).

Table 4.60: The maximum number of animals predicted to be disturbed during concurrent piling of monopiles at the Transmission Assets.

Species	Number of Animals	Reference Population and Abundance	% Reference Population
Harbour porpoise	2,465	Celtic and Irish Seas MU (62,517)	3.94%
Bottlenose dolphin	11	Irish Sea MU (293)	3.7%

Species	Number of Animals	Reference Population and Abundance	% Reference Population
Short-beaked common dolphin	207	Celtic and Greater North Seas MU (102,656)	0.004%
Risso's dolphin	125	Celtic and Greater North Seas MU (12,262)	1.01%
Minke whale	69	Celtic and Greater North Seas MU (20,118)	0.34%
Grey seal	88	Combined MUs (1,044) Wider ref population (10,504)	0.65%/0.14%

4.11.2.64 Cumulatively, during piling at Mona Offshore Wind Project, Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm: Generation Assets and Transmission Assets up to 7,938 harbour porpoise (12.70% of the MU population), 35 bottlenose dolphin (11.95% of the MU population), 311 short-beaked common dolphin (0.3% of the MU population), 429 Risso’s dolphin (3.50% of the MU population), 239 minke whale (1.19% of the MU population), 178 grey seal (1.38% of the GSRP, 0.29% of the OSPAR III region) and up to eight harbour seal (0.56% of the reference population). However, it must be highlighted that these values are based on conservative MDS assessments presented at PEIR and therefore may be further refined for respective Environmental Statements. Furthermore, if these projects were all to pile at the same time (which is highly unlikely), there would be a large spatial overlap and therefore the numbers presented above are considered to be a vast overestimate, and not realistic.

4.11.2.65 Most of the Tier 2 projects screened into the cumulative assessment included fixed foundations in their design envelope. Projects such as Arklow Bank Wind Park Phase 2, Codling Wind Offshore Wind Farm, Dublin Array Offshore Wind Farm, Morecambe Offshore Wind Farm Generation Assets, Morgan Offshore Wind Project Generation Assets, North Celtic Sea Offshore Wind Farm, North Irish Sea Array, Oriel Windfarm Offshore Wind Farm and Shelmalere Offshore Wind Farm considered various types of wind turbine foundations, including monopiles, jackets, gravity bases or suction bucket foundations. Given that monopiles are characterised by diameters larger than other foundation types and may need to be driven or piled into the seabed, the installation of this foundation type contributes to the greatest amount of underwater sound. Additionally, the foundation installation method depends on the seabed conditions and foundations can be installed using various methods.

4.11.2.66 The EIA Scoping Reports for nine of the cumulative projects consists of floating foundation technology for wind turbines: Inis Ealga Energy Park, Llŷr Projects (Llŷr 1/Llŷr 2), North Channel Wind 1/2, Project Llen, Project Valorous and Simply Blue Emerald. However, given that all three projects considered different technologies to ensure that the wind turbines are secured to the seabed (e.g. suction piles, driven piles or drilled and grouted piles), piling is under consideration as a possible anchoring technique. Given turbines are floating they involve piling of much smaller piles compared to the monopiles used during construction of fixed bottom foundations and therefore result in source levels of much smaller magnitude.

4.11.2.67 The number of piling days or hammer energies are unknown for most of the projects. However, the number of foundations varies from an array consisting of seven foundations (Transmission Assets) to up to 140 wind turbines (Codling Wind Park) (Table 4.61).

Table 4.61: Projects screened into the cumulative assessment for underwater sound as a result of piling and number of wind turbines/foundations

[1] This table includes numbers of foundations for wind turbines for Offshore Wind Projects. For the Morgan and Morecambe Offshore Wind Farms: Transmission Assets the Scoping Report includes the OSPs for the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm. These OSPs are also included in the EIA Scoping Reports for the Morgan Generation Assets (Morgan Offshore Wind Ltd, 2022) and the Morecambe Generation Assets (Morecambe Offshore Windfarm Ltd, 2022). This assessment therefore double counts the OSPs and is precautionary.

Project	Type of foundation	Number of wind turbines / Foundations	Closest distance to Mona Array Area (km)
Morgan Offshore Wind Project Generation Assets	Fixed	107	5.5
Morecambe Offshore Wind Farm Generation Assets	Fixed	40	8.9
Morgan and Morecambe Offshore Wind Farms: Transmission Assets[1]	OSP	7	8.92
North Irish Sea Array	Fixed	36	112.7
Codling Wind Park	Fixed	140	125.1
Dublin Array Offshore Wind Farm	Fixed	61	126.1
North Channel Wind 2	Floating	28	128.5
Oriel Offshore Wind Farm	Fixed	55	130.4
Arklow Bank Wind Park Phase 2	Fixed	76	146.7
North Channel Wind 1	Floating	68	157.25
Shelmalere Offshore Wind Farm	Fixed	67	164.6
North Celtic Sea Offshore Wind Farm	Fixed	60	256.4
Llŷr Projects (Llŷr 1/ Llŷr 2)	Floating	61	263
Project Valorous	Floating	31	271.7
Inis Ealga Marine Energy Park	Floating	70	288.3
Simply Blue Emerald	Floating	87	338.8
Project Ilen	Floating	90	394.2

4.11.2.68 In temporal terms, the first construction phases are anticipated to start in 2025, for North Irish Sea Array, Llŷr Projects (Table 4.51). The construction of some of the cumulative projects will last until 2029, including Inis Ealga Marine Energy Park, Transmission Assets, Morgan Offshore Wind Project Generation Assets, North Channel Wind 1 and 2, and Shelmalere Offshore Wind Farm (Table 4.51). This timescale constitutes a total of six years where construction activities, including piling, will occur across the CIS MU. Piling activities will occur intermittently over the construction phase of respective projects, therefore, whilst this will not result in a continuous risk of disturbance to marine mammals, it may affect multiple breeding seasons for marine mammal species. In the context of the life cycle of respective species (see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement for more details), the duration of the impact is classified as medium term, as the exposure to elevated sound levels could occur over a meaningful proportion of their lifespan.

4.11.2.69 Additionally in spatial terms, depending on the magnitude of impact (i.e. type of foundation, installation technique), piling at each wind farm is likely to affect marine mammals behaviourally over different spatial scales. Due to the proximity of Morgan Generation Assets, Morecambe Offshore Wind Farm Generation Assets, Transmission Assets, North Irish Sea Array and Oriel Wind Farm to the Mona Offshore Wind Project (Table 4.50) (i.e. within the area of ensonification for Mona), there is a potential for overlap of sound disturbance contours during piling. Animals may be displaced from an area comparable to piling contours at the Mona Offshore Wind Project alone (section 4.9.3). However, where there is a potential for simultaneous piling to take place, it is likely to generate considerable levels of underwater sound to the environment and potentially result in larger area of strong disturbance (160 dB re 1µPa SPL_{rms} as discussed in section 4.9.2) compared to piling at the Mona Offshore Wind Project alone.

4.11.2.70 In the context of the wider habitat available within the CIS MU, it is not anticipated that cumulative will result in long-term population-level effects on any of the species, except for bottlenose dolphin. The cumulative piling at Morgan Generation Assets, Morecambe Offshore Wind Farm Generation Assets, Transmission Assets, North Irish Sea Array and Oriel Wind Farm could further contribute to the potential impacts on bottlenose dolphin within the Irish Sea MU (see paragraph 4.11.2.26 for Tier 1 projects), which shows evidence of decline in the Cardigan Bay SAC.

4.11.2.71 The cumulative effects on the designated features and conservation objectives of designated sites located in the vicinity of the Mona Offshore Wind Project will be considered in the ISAA.

4.11.2.72 The impact (cumulative elevated underwater sound arising during piling) is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility (the impact itself occurs only during piling). It is predicted that the impact will affect the receptor directly. The effect of behavioural disturbance is of high reversibility (with animals returning to baseline levels within hours/days after piling have ceased). The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas).

4.11.2.73 With the exception of the bottlenose dolphin Irish Sea MU, there are no long-term population-level consequences of disturbance anticipated for harbour porpoise, short-beaked common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal (see Appendix A). There was some difference in the iPCoD models with the addition of the Tier 2 Morgan Generation Assets, Morecambe Offshore Wind Farm Generation Assets, and Transmission Assets. The median ratio for harbour porpoise at six years was 0.9928 (with a difference of 0.979% of the MU between the impacted and unimpacted population), for minke whale was 0.9988 (with a difference of 0.169% of the MU between the impacted and unimpacted population) and for grey seal was 1 (with no difference between the impacted and unimpacted population). The results of these models are presented in full, alongside estimates of all population trajectories, in Appendix A. For these species the magnitude is considered to be **low**.

4.11.2.74 However, cumulative piling of Tier 1 plus Tier 2 projects could contribute to the reduction in Irish Sea MU population size for bottlenose dolphin, although it must be noted there was a difference of only one animal in the iPCoD model with the addition of the Tier 2 projects (Morgan Generation Assets, Morecambe Offshore Wind Farm Generation Assets, and Transmission Assets) to the Tier 1 cumulative scenario for Mona Offshore Wind Project (further described in Appendix A) (i.e. a difference of eight animals or 2.7% of the IS MU population between the impacted and unimpacted populations). Therefore, in the context of possible declining population, the magnitude is conservatively, considered to be **medium** for bottlenose dolphin within the Irish Sea MU population.

Sensitivity of the receptor

4.11.2.75 The sensitivity of marine mammals to disturbance from elevated underwater sound due to piling is as described in paragraph 4.11.3.20 for Tier 1 projects.

4.11.2.76 All marine mammals are deemed to have some resilience to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.2.77 Overall, the magnitude of the impact is deemed to be **low** for harbour porpoise, short-beaked common dolphin, Risso's dolphin, minke whale, grey seal, harbour seal, and **medium** for bottlenose dolphin within the Irish Sea MU population, and the sensitivity of the receptor is considered to be **medium**.

4.11.2.78 The cumulative effects could potentially affect the international value of bottlenose dolphin in the context of the Irish Sea MU. The effect on bottlenose dolphin will, therefore, be of **moderate adverse** significance for the bottlenose dolphin Irish Sea MU population, which is significant in EIA terms. The applicant will seek to address this potential significant effect on the Irish Sea MU bottlenose dolphin population via an Underwater sound management strategy (with an Outline underwater sound management strategy submitted as part of the application, Document Reference J.16), and is discussed further in paragraphs 4.11.2.80 and 4.11.2.82 below.

4.11.2.79 For other species (harbour porpoise, short-beaked common dolphin, Risso's dolphin, minke whale, grey seal, harbour seal), the cumulative effects are unlikely to affect the international value of these species in the context of respective reference populations. The cumulative effect on all marine mammal receptors will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Further mitigation measures

4.11.2.80 The cumulative impact assessment of disturbance from elevated underwater sound from piling concludes a significant effect in EIA terms, for bottlenose dolphin only. The cumulative impact assessment of injury from elevated underwater sound from piling concludes no significant effect in EIA terms, for all marine mammal receptors. Whilst the project alone assessment determined there would be no significant effect in EIA terms, the Mona Offshore Wind Project may contribute to the cumulative impact in the context of the Irish Sea MU and therefore the project has committed to the development of an Underwater sound management strategy (with an Outline underwater sound management strategy submitted as part of the application, Document Reference J16), secured in the deemed marine licence, to reduce the magnitude associated with significant impacts such that there will be no residual significant effect for the project alone.

4.11.2.81 As discussed in paragraph 4.11.2.52, the assessment is based upon the MDSs for other projects presented at application or PEIR stages and therefore does not consider further mitigation for each project, which may be required if they have a residual significant effect. Therefore, is a significant cumulative impact is unlikely.

4.11.2.82 The Underwater sound management strategy (with an Outline underwater sound management strategy submitted as part of the application, Document Reference J16) will present a review of relevant mitigation options (such as NAS, temporal and spatial piling restrictions, piling methods, soft start) in order to reduce the magnitude for the project alone, in order to minimise the project's contribution to any cumulative effect.

4.11.2.83 In this case, relevant mitigation options may be applied to reduce the magnitude for bottlenose dolphin. The Underwater sound management strategy (Outline underwater sound management strategy, Document Reference J16) will be developed in consultation with the licensing authority and SNCBs post-consent.

Tier 3

4.11.2.84 The construction of the Mona Offshore Wind Project, together with construction phase of Tier 1, Tier 2 and Tier 3 projects (Table 4.43) may lead to cumulative injury and disturbance to marine mammals from underwater sound generated during piling. Tier 3 projects screened into the assessment within the regional marine mammal study area include: Celtic Sea Array Offshore Wind Farm, Cork offshore wind project, Bore Array, Celtic Horizon, Mac Lir, Realt na Mara, Setanta Offshore Wind Park, Blackwater Offshore Wind Farm, Braymore Point, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Inis Offshore Wind Munster, MaresConnect, Project Saoirse, South Pembrokeshire Demonstration Zone, Aniar Offshore Array (Fixed), East Celtic, Lir Offshore Array, Moneypoint Offshore One, Péarla Offshore Wind Farm, Rian Offshore Array Phase 2, Tralee, Tulca Offshore Array Phase 2, Urban Sea, Valentia Phase 1 and Valentia Phase 2.

4.11.2.85 The extended CEA area for grey seal (OSPAR Region III) was used to screen in projects and therefore additional Tier 3 projects are included (Talisk, Aniar Offshore Array (Floating), Arranmore, Nomadic Offshore Wind, Machair Wind – Hybrid Energy Project, Malin Sea Wind, Haven Offshore Array Wind Farm, and Voyage Offshore Array). However telemetry data presented in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement suggests connectivity to projects outside of the GSRP is unlikely and there is no receptor impact pathway.

4.11.2.86 As described in paragraph 4.10.1.2 the data about Tier 3 projects available at the time of writing is limited. Tier 3 projects were screened in precautionarily based on their location within the regional marine mammal study area, though there is limited/no information on the construction/operation dates or project design with regards to piling. It should be acknowledged that there is a potential for piling activities to be taking place intermittently across the Irish Sea and wider Celtic Sea. As such, although temporal and/or spatial overlap with Tier 3 projects cannot be discounted, at current time it is not possible to undertake any kind of meaningful assessment for potential cumulative impacts as a result of elevated underwater sound due to piling with Tier 3 projects.

4.11.3 Injury and disturbance from pre-construction site investigation surveys

4.11.3.1 Pre-construction site investigation surveys will be undertaken to provide detailed information on seabed conditions and morphology, to identify the presence/absence of any potential obstructions or hazards and to verify the seabed geology layers. Pre-construction site investigation surveys are likely to include geophysical and geotechnical surveys which will be conducted within, and in the vicinity of, the footprint of the Mona Offshore Cable Corridor and Access Areas, wind turbines and OSPs, where relevant, for the Mona Offshore Wind Project and projects outlined in Table 4.50.

4.11.3.2 Geophysical surveys and geotechnical surveys are detailed in section 4.9.7, presenting those commonly undertaken as best practice for offshore wind projects (note that frequencies and sound levels for sonar equipment has been included based on Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement):

4.11.3.3 The risk of injury to marine mammal receptors in terms of PTS as a result of underwater sound due to site investigation surveys would be expected to be localised to within the close vicinity of the respective projects. The assessment for the Mona Offshore Wind Project found that the injury ranges are expected to be relatively small and the magnitude of the impact has been conservatively assessed to be low (see section 4.9.7). Therefore, there is very low potential for cumulative impacts for injury from elevated underwater sound due to site investigation surveys and the cumulative assessment provided in paragraph 4.11.3.1 focuses on disturbance only. Since the cumulative assessment focuses on behavioural disturbance as a result of site-investigation activities (with animals likely to recover within hours from the disturbance), where surveys were completed prior to the commencement of construction at Mona Offshore Wind Project, these were screened out from further consideration during the CEA longlist screening exercise.

Tier 1

Construction phase

Magnitude of impact

4.11.3.4 For Tier 1 projects with temporal overlap with the construction phase of Mona Offshore Wind Project, effects as a result of underwater sound from site investigation surveys were not included in the respective Environmental Statements. Therefore, all Tier 1 projects were scoped out of the cumulative assessment at PEIR (see paragraph 4.10.2.2 for more details). However, to allow a quantitative approach to assessment, there are up to 14 Tier 1 site investigation surveys identified in the CEA screening area for marine mammals. Surveys typically occur over short durations (typically up to 2 months) (based on expert judgment) and therefore as a conservative approach it is assumed as a worst case scenario that up to two surveys (in addition) could overlap with the Mona site-investigation surveys at any one point, as agreed with the EWG (Table 4.5). There are limitations on the number of survey vessels that could carry out such surveys at one time and therefore highly unlikely that all would overlap temporally.

4.11.3.5 The project alone for Mona Offshore Wind Project predicted most of the disturbance ranges within 100s of meters with the greatest distance over which the disturbance can occur out to approximately 14.3 km during vibro-coring (section 4.9.7).

4.11.3.6 Based on the distance from the Mona Offshore Wind Project to 14 site investigation surveys (Table 4.52), if pre-construction site investigation surveys were to temporally overlap with the construction phase of the Mona Offshore Wind Project (dates are currently unknown), there is potential for a small spatial overlap of disturbance ranges to occur. However, this is highly precautionary approach which assumes the same disturbance ranges as Mona Offshore Wind Project and does not take into account differences in water column depth, pressure, temperature gradients, salinity as well as water surface and seabed conditions at the different site-investigation survey locations (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement for detail).

4.11.3.7 The duration of site-investigation surveys is considered to be short term and localised for each project. It should be noted that these will occur intermittently over a number of years with isolated surveys occurring at different points in time throughout CEA screening area, though up to two is assumed to be occurring in addition to Mona Offshore Wind Project.

4.11.3.8 The impact of site investigation surveys leading to behavioural effects is predicted to be of local to regional spatial extent, medium term duration, intermittent and high reversibility (elevated underwater sound occurs only during surveys). The effect of behavioural disturbance is reversible (with animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

4.11.3.9 The sensitivity of marine mammals to injury and disturbance from pre-construction site investigation surveys is as described in paragraph 4.9.7.22 for the Mona Offshore Wind Project alone.

4.11.3.10 The marine mammal receptors are deemed to have some resilience, high recoverability and international value. The sensitivity of the receptors to disturbance from elevated underwater sound during pre-construction site investigation surveys is therefore considered to be **medium**.

Significance of effect

4.11.3.11 Overall, the magnitude of the impact of disturbance is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Tier 2

4.11.3.12 As previously described in section 4.10.2, the potential impacts considered within the Mona Offshore Wind Project alone assessment are specific to a particular phase of development. As such, where there is no spatial or temporal overlap with the site investigation surveys during the construction phase of the Mona Offshore Wind Project, survey activities associated with Tier 2 projects listed in Table 4.50, have been excluded from further consideration. Impacts scoped out from individual assessments of respective projects or from the Mona Offshore Wind Project alone assessment are not considered further.

Tier 3

4.11.3.13 As previously described in section 4.10.2, the potential impacts considered within the Mona Offshore Wind Project alone assessment are specific to a particular phase of development. As such, where there is no spatial or temporal overlap with the site investigation surveys during the construction phase of the Mona Offshore Wind Project, survey activities associated with Tier 3 projects listed in Table 4.50, have been excluded from further consideration. Impacts scoped out from individual assessments of respective projects or from the Mona Offshore Wind Project alone assessment are not considered further.

Construction phase

4.11.3.14 Given the temporal overlap, the construction phase of the Mona Offshore Wind Project, together with the construction phase of Tier 2 Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm Generation Assets and Transmission Assets (Table 4.51), may lead to disturbance to marine mammals as a result of sound generated by pre-construction site investigation surveys. However, given the approach (described in paragraph 4.11.3.4) to assessing two additional site investigation surveys alongside those for Mona Offshore Wind Project, the conclusions for Tier 1 and Tier 2 projects is the same. Site investigation surveys located in close proximity (such as those at Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm Generation Assets and Transmission Assets) occurring at the same time would represent the maximum adverse scenario. A cumulative assessment with respect to these three projects is provided below.

Magnitude of impact

4.11.3.15 Given that EIA Scoping Reports do not provide detailed information about site investigation surveys involved, it is not possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided below. However, for Morgan Offshore Wind Project Generation Assets, and Transmission Assets both the EIA Scoping and PEIR are available (Morgan Offshore Wind Project Ltd., 2023; Mona Offshore Wind Project Ltd, 2022b). Morecambe Offshore Windfarm Generation Assets did not include pre-construction site surveys in their project alone assessment in the PEIR chapter (Royal HaskoningDHV, 2022b) and therefore is not considered further.

4.11.3.16 For Morgan Offshore Wind Project Generation Assets most of the disturbance ranges were within 100s of meters with maximum disturbance ranges predicted out to 55 km for vibro-coring for all species. For Transmission Assets disturbance ranges most of the disturbance ranges were within 100s of meters with maximum disturbance ranges predicted out to 17.3 km for vibro-coring for all species.

4.11.3.17 Based on the distance from the Mona Offshore Wind Project to the Morgan Generation Assets and Transmission Assets, if pre-construction site investigation surveys were to directly temporally overlap with the construction phase of the Mona Offshore Wind Project, it is likely that spatial overlap of disturbance ranges would occur, especially for site investigation surveys taking place in the south part of the Morgan Array Area, nearest to the Mona Array Area. Due to the small distance between projects, animals are likely to be displaced from an area comparable to disturbance ranges at the Mona Offshore Wind Project alone.

4.11.3.18 Although the duration of site-investigation surveys is likely to be short term and localised for each project, it should be noted that these will occur intermittently over a number of years with isolated surveys occurring at different points in time throughout the Irish Sea. In actuality, as described in 4.11.3.4, no more than two site investigation surveys in addition to Mona Offshore Wind Project would be considered realistic due to constraints on survey equipment.

4.11.3.19 The impact of site investigation surveys leading to behavioural effects is predicted to be of local to regional spatial extent, medium term duration, intermittent and high reversibility (elevated underwater sound occurs only during surveys). The effect of behavioural disturbance is reversible (with animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of the receptor

4.11.3.20 The sensitivity of marine mammals to injury and disturbance from pre-construction site investigation surveys is as described in paragraph 4.9.7.22 for the Mona Offshore Wind Project alone.

4.11.3.21 The marine mammal receptors are deemed to have some resilience, high recoverability and international value. The sensitivity of the receptors to disturbance from elevated underwater sound during pre-construction site investigation surveys is therefore considered to be **medium**.

Significance of effect

4.11.3.22 Overall, the magnitude of the impact of disturbance is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.11.4 Injury and disturbance from underwater sound from unexploded ordnance (UXO) detonation

4.11.4.1 As presented in paragraph 4.9.4.4, the duration of impact (elevated underwater sound) for each UXO detonation is very short (seconds) therefore behavioural effects are considered to be negligible in this context. The onset of TTS indicates a potential temporary loss in hearing, however, it may also indicate the onset of a behavioural disturbance. Given that there are no published thresholds for behavioural effects from UXO clearance, the use of the TTS-onset threshold will be considered as a proxy for disturbance and referred to as such in this section) (see paragraph 4.9.4.19 for more details).

Tier 1

Construction phase

4.11.4.2 The construction of the Mona Offshore Wind Project, together with construction of Tier 1 projects identified in Table 4.50 may lead to injury and/or disturbance to marine mammals during UXO clearance. Other Tier 1 projects screened into the assessment within the regional marine mammal study area includes Awel y Môr Offshore Wind Farm, Project Erebus and White Cross.

Magnitude of impact

4.11.4.3 Awel y Môr is located 3.6 km and 13.52 km from the Mona Offshore Cable Corridor and Access Areas and Mona Array Area, respectively. The MDS for Awel y Môr anticipated 10 expected UXOs requiring clearance, with two clearance events every 24 hours but up to 10 detonations in 10 days. The assessed clearance method was high-order detonation, though low-order is more likely. The Environmental Statement for Awel y Môr assessed both PTS and behavioural disturbance as a result of UXO clearance. Awel y Môr used both the EDR approach and TTS-onset thresholds for assessing disturbance, basing the use of the TTS onset threshold on Southall *et al*. (2007) which states ‘in the absence of empirical data on responses, the use of the TTS onset threshold may be appropriate for single pulses’. TTS-onset thresholds were taken as those proposed for different functional hearing groups by Southall *et al.* (2019).

4.11.4.4 However, the Awel y Môr Environmental Statement does highlight that there is a lack of empirical evidence from UXO detonations using the TTS metric, in particular the range-dependent characteristics of the peak sounds, and consequently challenges whether current propagation models can accurately predict the range at which these thresholds are reached (RWE, 2023). An estimation of the source level and predicted PTS ranges were modelled for a range of expected UXO sizes (5 kg TNT NEQ, 15 kg TNT NEQ and 164 kg TNT NEQ). The source level of each UXO charge weight was calculated in accordance with Soloway and Dahl (2014), Arons (1954) and Barett (1996), using conservative calculation parameters that result in the upper estimate of the source level for each charge size.

4.11.4.5 The charge sizes used for the Awel y Môr assessment are lower than the maximum modelled for Mona Offshore Wind Project, and injury ranges are smaller. For the most sensitive species (harbour porpoise) Awel y Môr assessed the effects on using two densities (JCP 0.13 per km^2 and SWF 1.0 per km^2), and the maximum number of animals estimated within the ZOI presented was considered to be highly conservative. PTS is a permanent change in hearing threshold and is not recoverable, but the magnitude of this impact was considered to be negligible adverse in the EIA, due to the commitment to implement a UXO-specific MMMP to reduce the risk of PTS to negligible. Maximum injury ranges from UXO and numbers of animals predicted to be injured as a result of underwater sound from UXO clearance for Tier 1 projects including Awel y Môr is presented in Table 4.62. The exact mitigation measures contained with the UXO MMMP for Awel y Môr are yet to be determined and agreed with NRW. Residual potential impacts for PTS from UXO were therefore considered unlikely for harbour porpoise, minke whale, grey seal and minor adverse significance for bottlenose dolphin, short-beaked common dolphin and Risso’s dolphin (RWE, 2022).

4.11.4.6 In the absence of agreed thresholds to assess the potential for behavioural disturbance in marine mammals from UXO detonations, the Awel y Môr assessment presented results for various disturbance thresholds, including 26 km EDR for high order detonations, 5 km EDR for low order and TTS-onset thresholds for high-order detonations. JNCC advised that an EDR of 26 km around the source location should be used to determine the ensonified area from UXO clearance with respect to disturbance of harbour porpoise in SACs, but this is applied for all species and should be viewed with caution as there is a lack of evidence to support this range (as per latest guidance (JNCC, Natural England, DAERA, 2020)). As such Awel y Môr suggested limited confidence for using this approach. Furthermore, Awel y Môr suggested that there is no evidence of a 5 km EDR being suitable for any species of marine mammal for the low order detonation, and therefore should be treated with caution. As such Awel y Môr used TTS-onset as a proxy for disturbance but caveated that this is likely to over-estimate true behavioural responses due to UXO comprising a single pulse source sound and not lasting a full diel cycle. Large disturbance (using TTS-onset as a proxy) ranges were predicted for harbour porpoise (16 km using SPL_{pk}) and minke whale (65 km using SEL_{cum}) for a UXO charge size of 164 kg. As highlighted in the Awel y Môr Environmental Statement, these ranges may be highly over-precautionary as these do not account for an impulsive sound losing impulsive characteristics and becoming non-impulsive as it propagates from the source (RWE, 2023). Based on the predicted disturbance ranges and numbers of animals affected Awel y Môr concluded that the magnitude of the effects of behavioural disturbance (using TTS-onset as a proxy) would be low for all species (Table 4.63).

4.11.4.7 White Cross Offshore Windfarm is located 287.7 km from the Mona Offshore Wind Project. The number of UXO requiring clearance and duration of UXO clearance operations at White Cross Offshore Windfarm was unknown at the time of publication of the Environmental Statement. A UXO Risk Assessment identified different types of

UX that may pose a threat to the study site, with a range NEQs (ranging from 0.06 kg to 309.4 kg). The assessed clearance method modelled was high-order detonation (up to 309 kg NEQ) and low-order clearance (2 kg). The Environmental Statement for White Cross Offshore Windfarm assessed PTS and TTS/moving away response as a proxy for behavioural disturbance, as well as applying a 26 km EDR for harbour porpoise, based on current SNCB guidance.

4.11.4.8 The charge sizes modelled for the White Cross Offshore Windfarm assessment are lower than the maximum modelled for Mona Offshore Wind Project, and injury ranges are smaller. With the implementation of an MMMP the significance of effect for all species was considered to be minor adverse for all species for PTS from high-order and low-order detonation. For TTS (and behavioural disturbance), from high-order detonation the significance of effect for harbour porpoise, minke whale and grey seal was considered to be minor adverse, and for HF species was considered to be negligible. For TTS (and behavioural disturbance) from low-order detonation the significance of effect for harbour porpoise was considered to be minor adverse, and for all other species was considered to be negligible. Maximum PTS ranges from UXO and numbers of animals predicted to be injured as a result of underwater sound from UXO clearance for Tier 1 projects including White Cross Offshore Wind Farm is presented in Table 4.62 and for TTS is presented in Table 4.63. The numbers presented for harbour porpoise are based on the higher APEM summer density estimate, and for short-beaked common dolphin are based on the higher APEM winter density estimate.

4.11.4.9 The number of animals predicted to experience PTS as a result of high-order detonation is 349 harbour porpoise, less than one bottlenose dolphin and up to two individuals for both minke whale and grey seal. For low-order detonation up to 11 harbour porpoise, and less than one individual for all other species, were predicted to experience PTS. For TTS, large impact ranges were predicted for minke whale, at 85 km and grey seal at 16 km, with the potential to affect up to 255 and 96 individuals, respectively. For harbour porpoise, for a 20 km disturbance range, up to 1,154 individuals were predicted to be disturbed (Table 4.63). is based on high-order detonation of the largest UXO size of 309 kg NEQ, whereas the White Cross Offshore Wind Farm Environmental Statement identified that UXO likely to be found in the site would range from 0.06 kg to 309.4 kg. Proposed mitigation measures for UXO clearance include the use of low-order clearance techniques, such as deflagration; high order clearance would only be undertaken in the event that all other options are not possible, following the identified hierarchy. As such, the numbers presented are expected to be highly precautionary.

4.11.4.10 Project Erebus anticipated one UXO detonation via low-order deflagration but included assessment for high-order detonations for completeness, highlighting this was not deemed realistic as “the Project intends to employ deflagration (low-order) as the clearance method” (Blue Gem Wind, 2020). For PTS, Southall *et al.* (2019) was used to assess potential impacts. Project Erebus assessed the number of harbour porpoise predicted to be affected by injury or disturbance based on densities from site-specific surveys (0.04 animals per km^2). Bottlenose dolphin was based on 0.063 animals per km^2 presented by Lohrengel *et al*. (2018), minke whale was based on SCANS-III block D (Hammond *et al.,* 2021) and grey seal was based on habitat preference map grid cells from Carter *et al.* (2022).

4.11.4.11 The number of marine mammals expected to experience PTS-onset as a result of low-order detonation was <1 for all species and charge sizes, apart from 0.5 kg and 2 kg NEQ, which could result in PTS in up to two and five harbour porpoises, respectively. For high-order detonation, which is not in the project design for Project Erebus, up to

212 harbour porpoises could be affected by PTS (Table 4.62). The Environmental Statement for Project Erebus highlighted that for UXO clearance there are no dose-response functions available that describe the magnitude and transient nature of the behavioural effect of UXO detonation on marine mammals and no guidance on thresholds to be used to assess disturbance, therefore they used an EDR of 5 km for low order clearance and 26 km for high-order clearance. Project Erebus also used TTS-onset as a proxy for disturbance, and the maximum predicted disturbance range is 103 km for minke whale. It has been suggested in the Erebus Environmental Statement that TTS-onset as a proxy for disturbance is expected to over-estimate the actual biological consequences (Blue Gem Wind, 2020). This is supported by Southall *et al.* (2007) which states that "*This approach is expected to be precautionary because TTS at onset levels is unlikely to last a full diel cycle or to have serious biological consequences during the time TTS persists*". For disturbance (assessed using TTS-onset as a proxy) from either low-order or high-order UXO detonation, Project Erebus concluded that the impact was unlikely to significantly affect marine mammal receptors (Blue Gem Wind, 2020).

4.11.4.12 A spatial MDS would occur where UXO clearance activities coincide at the respective projects considered in the CEA. This is, however, highly unlikely, as due to safety reasons the UXO clearance activities take place before other construction activities commence. Sequential UXO clearance is therefore more likely for Tier 1 projects noting, however, that Awel y Môr construction dates are from 2026 therefore there may be some overlap in pre-construction activities with Mona Offshore Wind Project. These timelines are, however, indicative and subject to change. UXO clearance at each of these projects will occur as a discrete stage within the overall construction phase and therefore will not coincide continuously over the duration of temporal overlap. Furthermore, each clearance event results in a very short duration of sound emission (seconds) (as mentioned in paragraph 4.9.4.4) so the impact will be short in duration and therefore the overlap is unlikely. Construction of Project Erebus is likely to be completed a year before the commencement of construction activities at Mona Offshore Wind Project and therefore will not overlap with Mona Offshore Wind Project UXO clearance. Given the project design for use of low-order UXO clearance techniques only for Project Erebus, potential cumulative impacts are considered unlikely.

4.11.4.13 The assessments provided in the Environmental Statements for the Awel y Môr Offshore Wind Farm, Project Erebus and White Cross did not consider effects on harbour seal, as this was not included as a key species in these assessments. Therefore, harbour seal has not been considered further in this cumulative assessment section.

4.11.4.14 The maximum cumulative number of animals potentially affected by PTS (harbour porpoise) in the regional marine mammal study area is 990 animals, however this is using modelled high-order UXO clearance for Project Erebus which is very unlikely to occur in practice (the maximum UXO charge weight expected in the area is 331 kg, and the project is seeking consent for one low-order detonation with a maximum of 2 kg NEQ) and based upon high-order clearance for Mona Offshore Wind Project and White Cross. The MDS also assumes all UXO will be cleared at the same time. Therefore, with measures applied at cumulative projects (i.e. use of low order clearance only for Project Erebus and White Cross, MMMPs for Awel y Môr) the residual risk of injury is likely to be very small.

Table 4.62: Number of animals with the potential to experience PTS during UXO clearance at cumulative Tier 1 projects.

Project	Species	Maximum charge size (kg)		Maximum PTS range (m)	Estimated number within PTS range	Mitigation included (per specific project)
Mona Offshore Wind Project	Harbour porpoise	907 (absolute maximum)	SPL_{pk}	15,370	206	Measures adopted (Table 4.17) and Underwater sound management strategy
	Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			890	<1	
	Minke whale		SPL_{cum}	2,720	<1	
	Grey seal		SPL_{pk}	3,015	6	
Awel y Môr	Harbour porpoise	164	SPL_{pk}	8,600	232	UXO-specific MMMP
	Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			500	<1	
	Minke whale		SPL_{cum}	5,400	2	
	Grey seal		SPL_{pk}	1,600	3	
Project Erebus	Harbour porpoise	525	SPL_{pk}	13,000	212	Low-order deflagration
	Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin		SPL_{pk}	730	3 (short-beaked common dolphin) <1 (bottlenose dolphin)	
	Minke whale		SPL_{cum}	9,500	3	
	Grey seal		SPL_{pk}	2,500	1	
White Cross Offshore Wind Farm	Harbour porpoise	309	SPL_{pk}	11,000	349	MMMP (including low-order detonation and ADD)
	Bottlenose dolphin			610	< 1	
	Short-beaked common dolphin			610	7	
	Minke whale			7,400	2	
	Grey seal			2,000	2	

4.11.4.15 Production of underwater sound during detonation of UXOs as a part of the cumulative projects as well as the Mona Offshore Wind Project have the potential to cause behavioural disturbance (using TTS-onset as a proxy) in marine mammal receptors, however, this effect will be short-lived and reversible. Since behavioural disturbance is a recoverable and the duration of impact will be very short, the potential for cumulative impact is considered to be limited, even for multiple Tier 1 projects within the regional marine mammal study area (Table 4.63). It is assumed whilst some ecological functions could be inhibited in the short-term due to behavioural disturbance (e.g. cessation of feeding), these are reversible on recovery of the animal's hearing and therefore not considered likely to lead to any long-term effects on the individual.

Table 4.63: Number of animals with the potential to experience behavioural disturbance (using TTS-onset as a proxy) during UXO clearance at cumulative Tier 1 projects.

Project	Species	Maximum charge size (kg)	Metric	Maximum range (m)	Estimated number within the range
Mona Offshore Wind Project	Harbour porpoise	907(absolute maximum)	SPL_{pk}	28,230	245
	Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			1,635	<1
	Minke whale		SEL_{cum}	34,365	65
	Grey seal		SPL_{pk}	6,470	26
Awel y Môr	Harbour porpoise	164	SPL_{pk}	16,000	804
	Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			920	<1
	Minke whale		SEL_{cum}	64,000	226
	Grey seal		SPL_{pk}	310	13
Project Erebus	Harbour porpoise	525	SPL_{pk}	23,000	665
	Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			1,300	9 (common dolphin) <1 (bottlenose dolphin)
	Minke whale		SEL_{cum}	103,000	373
	Grey seal		SPL_{pk}	20,000	52
White Cross Offshore Wind Farm	Harbour porpoise	309	SPL_{pk}	20,000	1,154
	Bottlenose dolphin			1,100	<1
	Short-beaked common dolphin			1,100	20
	Minke whale			85,000	255
	Grey seal			16,000	96

4.11.4.16 Adopting a precautionary approach, and assuming application of standard industry measures (such as MMO/PAM and ADDs), the assessment considered the magnitude of impact for a high order detonation.

PTS

4.11.4.17 The magnitude of cumulative impact (elevated underwater sound due to UXO clearance) is predicted to be of local to regional spatial extent, very short-term duration, intermittent and, although the impact itself is reversible (i.e. during the detonation event only), the effect of injury on sensitive receptors (PTS) is permanent. It is predicted that the impact will affect the receptor directly. In line with UXO guidance, assuming standard industry measures applied for each project, it is anticipated that for most species animals would be deterred from the injury zone and therefore the risk of PTS would be reduced. The magnitude is therefore considered to be **negligible** (for bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, minke whale, grey seal). For harbour porpoise the injury ranges are large (Table 4.62) and there is considered to be a residual risk of PTS to a small number of individuals even with the application of standard industry measures, therefore the magnitude is considered to be **medium** for harbour porpoise.

Behavioural disturbance (using TTS-onset as a proxy)

4.11.4.18 The magnitude of cumulative impact (elevated underwater sound due to UXO clearance) resulting from a high order detonation is predicted to be of regional spatial extent, short-term duration, intermittent and both the impact itself (i.e. during the detonation event) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low** for all species.

Sensitivity of the receptor

4.11.4.19 The sensitivity of marine mammals to PTS from elevated underwater sound due to piling is as described in paragraph 4.9.4.25 for Mona Offshore Wind Project alone, whilst behavioural disturbance (using TTS-onset as a proxy) is described in paragraph 4.9.4.31.

4.11.4.20 For a given marine mammal hearing group, exceedance of the threshold for the onset of PTS may result in a permanent hearing loss which in turn could inhibit ecological functioning, such as communication, foraging, navigation and predator avoidance. The inability to continue with these important activities could eventually lead to a decline in vital rates of an individual, including growth, reproduction and subsequently survival. Depending on the type of detonation and size of UXO, UXO clearance activities may have residual effects in respect to marine mammals and PTS injury.

4.11.4.21 Species-specific behavioural responses must also be taken into account. For example, it is likely that harbour porpoise would move away from the area upon hearing vessel sound and thus be further from the UXO source before any detonation has begun. Further mitigation measures such as ADD are designed to emit sound levels that cause marine mammals to move away and thus reduce the potential for a PTS to occur due to UXO clearance.

4.11.4.22 In terms of PTS as a result of UXO clearance, all marine mammals are deemed to have limited resilience, low recoverability and international value. The sensitivity of the receptors to PTS is therefore, considered to be **high.**

4.11.4.23 In terms of TTS as a result of UXO clearance, all marine mammals are deemed to have some resilience, high recoverability and international value. The sensitivity of the receptor to TTS is therefore, considered to be **low.**

Significance of effect

4.11.4.24 In terms of PTS, with tertiary mitigation applied, for bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, minke whale and grey seal, the magnitude of the cumulative impact is deemed to be **negligible** and the sensitivity of the receptors is considered to be **high**. There is not anticipated to be any effect on the international value of these species. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.11.4.25 For harbour porpoise, with tertiary mitigation applied, the magnitude of the cumulative impact is deemed to be **medium,** and the sensitivity of the receptors is considered to be **high**. On the basis of high order detonation, there may be some residual effect with a small number of animals potentially exposed to sound levels that could elicit PTS.

The cumulative effect will, therefore, be of **moderate adverse** significance, which is significant in EIA terms.

4.11.4.26 With the aim to reduce any potential impact from the project alone, primary and tertiary mitigation measures adopted as part of the Mona Offshore Wind Project are detailed in the Outline MMMP (Document Reference J21) to reduce the potential residual risk of injury to harbour porpoise. The applicant has also committed to an Underwater sound management strategy (with an Outline underwater sound management strategy included as part of the application, Document Reference J16) to reduce any potential residual effects from the project and is discussed further in paragraphs 4.11.4.28 and 4.11.4.29 below.

4.11.4.27 In terms of behavioural disturbance (using TTS-onset as a proxy), with standard industry measures applied, the magnitude of the cumulative impact for all species is deemed to be **low** and the sensitivity of the receptor is considered to be **low**. There is not anticipated to be any effect on the international value of any marine mammal species. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Further mitigation measures

4.11.4.28 The cumulative impact assessment of injury from elevated underwater sound from UXO clearance concludes a significant effect in EIA terms, for harbour porpoise only. The cumulative impact assessment of disturbance from elevated underwater sound from piling concludes no significant effect in EIA terms, for all marine mammal receptors. As the project alone assessment determined there would be a significant effect in EIA terms, the Mona Offshore Wind Project may contribute to the cumulative impact in the context of the CIS MU, and therefore the project has committed to the development of an Underwater sound management strategy (with an Outline underwater sound management strategy included as part of the application Document Reference J16) secured in the deemed marine licence to reduce the magnitude of impacts, such that there will be no residual significant effect for the project alone and therefore no contribution to cumulative effects.

4.11.4.29 Development of the final Underwater sound management strategy post consent (in consultation with the licensing authority and SNCBs) will present options for relevant mitigation measures (such as NAS, temporal and spatial restrictions, low order clearance methods, soft start) in order to reduce the magnitude for the project alone. Further details on the numbers and type of UXO requiring clearance will be available post consent. In this case, if required, further mitigation measures would be applied to reduce potential underwater sound impacts to a level whereby a non-significant effect for harbour porpoise could be concluded. These mitigation measures would also result in a reduction of potential underwater sound impacts to other marine mammal receptors.

Tier 2

4.11.4.30 The construction of Mona Offshore Wind Project, together with construction of Tier 1 and Tier 2 projects identified in Table 4.52 may lead to injury and/or disturbance to marine mammals during UXO clearance. Tier 2 projects screened into the assessment within the regional marine mammal study area include: Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Wind Farm Generation Assets, Morgan and Morecambe Offshore Wind Farms: Transmission Assets, Codling Wind Park, Inis Ealga Marine Energy Park, Llŷr 2, Llŷr 1, North Celtic Sea Offshore Wind Farm, North

Channel Wind 1 and North Channel Wind 2, Project Ilen, Project Valorous, Shelmalere Offshore Wind Farm and Simply Blue Emerald.

Construction phase

4.11.4.31 Potential effects of underwater sound from UXO detonations on marine mammals include mortality, physical injury or auditory injury. The risk of injury in terms of PTS to marine mammal receptors as a result of underwater sound during UXO clearance would be expected to be localised to the vicinity around the boundaries of the respective projects. The potential for a residual risk of injury was investigated based on assuming high-order UXO clearance technique. As previously presented for the Mona Offshore Wind Project alone in paragraph 4.9.4.4, the duration of impact for each UXO detonation is very short (seconds) and therefore behavioural effects are considered to be negligible in this context. However, behavioural disturbance is presented in this section using TTS-onset as a proxy.

Magnitude of impact

4.11.4.32 Projects screened in for this cumulative assessment are expected to involve similar construction activities to those described for the Mona Offshore Wind Project alone, including UXO clearance activities. It is anticipated that, for all projects, potential impacts associated with this activity will require additional assessment under EPS licensing or marine licence, however such applications are not yet available in the public domain.

4.11.4.33 For Tier 2 projects, except Morgan Generation Assets, Transmission Assets and Morecambe Offshore Windfarm: Generation Assets, beyond the EIA Scoping Report there was not enough information to conduct a quantitative assessment. The EIA Scoping Reports do not provide detailed information about the impact of sound from UXO clearance. These projects are likely to have effects similar to the Mona Offshore Wind Project and will likely have similar mitigation (e.g. MMMPs or separate marine licence) to avoid injury; but at this stage a more detailed assessment cannot be presented. Dublin Array Offshore Wind Farm, North Irish Sea Array Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm and Arklow Bank Wind Park Phase 2 scoped out UXO in their respective scoping reports.

4.11.4.34 The Transmission Assets PEIR assumed there may be up to 51 UXOs requiring clearance. Although the PEIR presents a range of potential impacts for low order clearance as well as low-yield donor charges, the assessment is based on the high order clearance of the maximum UXO size of 907 kg. An explosive mass of 907 kg (high order explosion) yielded the largest PTS ranges for all species, with the greatest injury range (15,370 m) seen for harbour porpoise (Section 4.11.4). With primary measures in place the assessment found that there would be a residual risk of injury over a range of 2,290 m that would require additional tertiary measures and therefore the Morgan and Morecambe Offshore Wind Farms: Transmission Assets will be adopting standard industry practice (JNCC, 2010b) tertiary measures as part of a MMMP, discussed and agreed with consultees post-consent. Behavioural disturbance (using TTS-onset as a proxy) could affect harbour porpoise and minke whale across largest range of up to 28 km and 34 km, respectively (4.9.4.21). Construction is expected to be from 2026 to 2029 and therefore may have three years of overlap with Mona Offshore Wind Project, though the exact dates are uncertain at this stage. Potential impacts including PTS and disturbance ranges are similar to those from Mona Offshore Wind Project and given the local proximity there is potential for cumulative effects to occur with Morgan and Morecambe Offshore Wind Farms: Transmission Assets.

4.11.4.35 It should be noted that the PEIR for the Morgan and Morecambe Offshore Wind Farms: Transmission Assets considered all UXO anticipated to require clearing within the 'Transmission Assets Red Line Boundary', which includes any UXO likely to be found within the Morgan Offshore Wind Project: Generation Assets and the Morecambe Offshore Windfarm: Generation Assets. As such, the cumulative assessment has not considered the Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets in addition to results presented in this paragraph, on the basis that this would represent duplication.

Table 4.64: Number of animals with the potential to experience onset PTS and disturbance (using TTS-onset as a proxy) during UXO clearance at Morgan and Morecambe Offshore Wind Farms: Transmission Assets.

Species	Maximum charge size leading to highest impact (kg)	Metric	Maximum range (m)	Estimated number of animals within impact area
PTS				
Harbour porpoise	907	SPL$_{pk}$	15,370	416
Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			890	<1
Minke whale			2,720	<1
Grey seal			3,015	4
Harbour seal				<1
Behavioural disturbance				
Harbour porpoise	907	SPL$_{pk}$	28,230	1,411
Bottlenose dolphin, short-beaked common dolphin and Risso's dolphin			1,635	<1
Minke whale		SEL$_{cum}$	34,365	2
Grey seal			6,470	11
Harbour seal				<1

4.11.4.36 The EIA Scoping Report for Inis Ealga Marine Energy Park proposed that UXO is scoped into the EIA, and the assessment of potential underwater sound produced by UXO detonation will be based upon a range of potential charge weights (until detailed data on the UXOs detected on site becomes available). Construction is planned in 2028, therefore it is unlikely there will be overlap in UXO clearance with the Mona Offshore Wind Project as it will be carried out after the Mona construction period. This, in combination with the distance from the Mona Offshore Wind Project (approximately 280 km; Table 4.50) means that minimal spatial overlap in UXO PTS and behavioural disturbance ranges and limited potential for cumulative effects are unlikely.

4.11.4.37 The Llŷr Projects (Llŷr 1/Llŷr 2) EIA Scoping Report confirms UXO surveys will be undertaken before construction and suggested the potential for UXO clearance will be high due to the proximity of the inshore part of the study area to Castlemartin Range. The Llŷr 1 and Llŷr 2 construction period is planned from 2024 to 2025 and therefore it is unlikely there will be overlap in UXO clearance with the Mona Offshore Wind Project. This, in combination with the distance from the Mona Offshore Wind Project (approximately 240 to 260 km; Table 4.50) mean minimal spatial overlap in UXO PTS and behavioural disturbance ranges, and limited potential for cumulative effects.

4.11.4.38 The North Celtic Sea Offshore Wind Farm EIA Scoping Report assumes that UXO clearance may result in injury and/or disturbance to marine mammals from underwater sound (North Celtic Sea Wind Limited, 2023). However, the timeline for the construction phase of the North Celtic Sea Offshore Wind Farm is unknown and therefore the temporal overlap with the Mona Offshore Wind Project UXO clearance is not possible to assess. However, given that the North Celtic Sea Offshore Wind Farm will be located approximately 250 km (Table 4.50) from the Mona Offshore Wind Project, the spatial overlap of sound contours and therefore potential cumulative impacts are unlikely.

4.11.4.39 Injury and disturbance due to UXO clearance has also been scoped in for further consideration as a potential impact to marine mammals in North Channel Wind 1 and 2 Projects EIA Scoping Report (North Channel Wind Limited, 2023). The use of low order clearance techniques (deflagration) was acknowledged as preferred approach and the project committed to appropriate mitigation measures, e.g., ADDs and soft starts (North Channel Wind Limited, 2023). The construction of North Channel Wind 1 and 2 Projects is planned to take place in 2029 and since the UXO clearance usually takes place at the beginning of its construction phase (commencing in 2026 at Mona Offshore Wind Project), the temporal overlap and therefore potential cumulative impacts are unlikely.

4.11.4.40 The Project Ilen EIA Scoping Report identified that underwater sound due to clearance of UXO detonation may have detrimental effects on marine mammals, including physical or auditory injury as well as short-term behavioural effects (Western Star Wind Ltd, 2023). The use of low order clearance techniques (deflagration) was acknowledged as preferred approach and the project committed to appropriate mitigation measures, e.g., ADDs and soft starts. However, as for Simply Blue Emerald, the timeline for the construction phase of the Project Ilen is unknown and therefore the temporal overlap with the Mona Offshore Wind Project UXO clearance is not possible to assess. However, considering that the Project Ilen will be located to the west of Ireland and approximately 390 km (Table 4.50) from the Mona Offshore Wind Project, the spatial overlap of sound contours and therefore potential cumulative impacts are unlikely.

4.11.4.41 The Project Valorous EIA Scoping Report assumes that given the proximity to the Castlemartin firing range, there is potential for UXOs to be present in the area and that their controlled detonation can cause injury to marine mammals (Blue Gem Wind, 2020). Though it is not certain that UXOs will be discovered at the scoping stage, the impact has been scoped in due to its potential severity (Blue Gen Wind, 2020). It has been acknowledged that Project Valorous would follow best practice measures to limit the potential impacts of underwater sound on sensitive receptors, such as adhering to the JNCC's guidelines on mitigation measures UXO detonation (JNCC, 2010b). The construction of Project Valorous is planned to take place in 2029 and since the UXO clearance usually takes place at the beginning of its construction phase (commencing in 2026 at Mona Offshore Wind Project), the temporal overlap and therefore potential cumulative impacts are unlikely.

4.11.4.42 The EIA Scoping Report for Shelmalere Offshore Wind Farm concluded that a detailed UXO survey would be undertaken post-consent, ahead of construction activities commencing (planned for 2023) but will not be complete by the DCO application. No further information on UXO clearance method was given. Construction activities are planned from 2028, therefore it is unlikely there will be overlap in UXO clearance with the Mona Offshore Wind Project. This, in combination with the distance from the Mona Offshore Wind Project (approximately 160 km; Table 4.50) means minimal spatial overlap in UXO PTS and behavioural disturbance ranges and limited potential for cumulative effects.

4.11.4.43 The Simply Blue Emerald EIA Scoping Report assumes that if UXO clearance will be required, disposal could be a significant source of underwater sound depending on the selected disposal methods and this impact has been scoped in for further consideration in the EIA process (Emerald Floating Wind, 2023). The EIA Scoping Reports anticipated that a number of mitigation measures could possibly be used, including methods to reduce underwater sound from the project, such as the use of low order detonation methods for UXO disposal. Nevertheless, the timeline for the construction phase of the Simply Blue Emerald project is unknown and therefore the temporal overlap with the Mona Offshore Wind Project UXO clearance is not possible to assess. However, considering that the Simply Blue Emerald will be located approximately 330 km (Table 4.50) from the Mona Offshore Wind Project, the spatial overlap of sound contours and therefore potential cumulative impacts are unlikely.

4.11.4.44 Codling Wind Park does not explicitly scope sound from UXO clearance in or out but does mention that an MMMP will be considered for any potential UXO work. The construction phase is planned to be complete by 2027 and therefore some temporal overlap with Mona Offshore Wind Project construction is possible. Despite the lack of information, the smaller proposed extent (fewer UXOs within the area) and location to the east of Ireland (approximately 123 km from the Mona Offshore Wind Project) means there is limited potential for cumulative effects with Codling Wind Park.

4.11.4.45 On the basis of information available at the time of writing, projects most likely to contribute to a cumulative effect on marine mammals due to UXO clearance for this PEIR included: Morgan Generation Assets, Morgan and Morecambe Offshore Wind Farms: Transmission Assets and Morecambe Offshore Wind Farm Generation Assets. Adopting a precautionary approach, and assuming application of standard industry measures (such as MMOs, PAM and ADDs) measures, the assessment considered the magnitude of impact for a high order detonation.

PTS

4.11.4.46 The magnitude of the cumulative impact is predicted to be of local to regional spatial extent, very short-term duration, intermittent and, although the impact itself is reversible (i.e. elevated underwater sound during the detonation event only), the effect of injury on sensitive receptors is permanent. It is predicted that the impact will affect the receptor directly. In line with UXO guidance, assuming standard industry measures applied for each project, it is anticipated that for most species animals would be deterred from the injury zone and therefore the risk of PTS would be reduced. The magnitude is therefore considered to be **negligible** (for bottlenose dolphin, short-beaked common dolphin, Risso’s dolphin, minke whale, grey seal and harbour seal).

4.11.4.47 For harbour porpoise the PTS ranges are large (Table 4.62 and Table 4.64 outline PTS ranges for Tier 1 and Tier 2 projects, respectively) and there is considered to be a residual risk of PTS to a small number of individuals, therefore the magnitude is considered to be **medium** for harbour porpoise.

TTS

4.11.4.48 The magnitude of cumulative impact (elevated underwater sound due to UXO clearance) resulting from a high order detonation is predicted to be of regional spatial extent, short-term duration, intermittent and both the impact itself (i.e. elevated underwater sound during the detonation event only) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low** for all species.

Sensitivity of the receptor

4.11.4.49 The sensitivity of marine mammals to UXO clearance was as described in paragraph 4.11.4.19.

4.11.4.50 In terms of PTS as a result of UXO clearance, all marine mammals are deemed to be of limited tolerance, low recoverability and international value. The sensitivity of the receptors to PTS is therefore, considered to be **high.**

4.11.4.51 In terms of TTS as a result of UXO clearance, all marine mammals are deemed to be of some tolerance, high recoverability and international value. The sensitivity of the receptor to TTS is therefore, considered to be **low.**

Significance of effect

4.11.4.52 In terms of PTS, with standard industry measures applied, for bottlenose dolphin, short-beaked common dolphin, Risso’s dolphin, minke whale, grey seal and harbour seal the magnitude of the cumulative impact is deemed to be **negligible** and the sensitivity of the receptors is considered to be **high**. There is not anticipated to be any effect on the international value of these species. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.11.4.53 For harbour porpoise, with tertiary mitigation applied, the magnitude of the cumulative impact is deemed to be **medium,** and the sensitivity of the receptors is considered to be **high**. On the basis of high order detonation, there may be some residual effect with a small number of animals potentially exposed to sound levels that could elicit PTS. The cumulative effect will, therefore, be of **moderate adverse** significance, which is significant in EIA terms. As discussed in 4.11.4.28, mitigation measures will be adopted via the MMMP (Document Reference J16) as an annex of the Underwater sound management strategy (Document Reference J21) to reduce any residual risk of injury to harbour porpoise from Mona Offshore Wind Project.

4.11.4.54 In terms of TTS, with standard industry measures applied, the magnitude of the cumulative impact for all species is deemed to be **low** and the sensitivity of the receptor is considered to be **low**. There is not anticipated to be any effect on the international value of any marine mammal species. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Tier 3

4.11.4.55 The construction of the Mona Offshore Wind Project, together with construction phase of Tier 1, Tier 2 and Tier 3 projects (Table 4.43) may lead to cumulative injury and disturbance to marine mammals from underwater sound generated during UXO clearance. Tier 3 projects screened into the assessment within the regional marine mammal study area include: Celtic Sea Array Offshore Wind Farm, Cork offshore wind project, Eni Hynet CCS, MaresConnect, Isle of Man Wind Farm, Braymore Point, Cooley Point Offshore Wind Farm, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Blackwater Offshore Wind Farm, South Pembrokeshire Demonstration Zone, and Project Saoirse.

4.11.4.56 As described in paragraph 4.10.1.2 the data about Tier 3 projects available at the time of writing is limited. Tier 3 projects were screened in precautionarily based on their location within the regional marine mammal study area, though there is limited/no information on the construction/operation dates or whether UXO clearance will be considered in respective EIA assessments. It should be acknowledged that there is a potential for UXO clearance activities to be taking place intermittently across the Irish Sea and wider Celtic Sea, however, it the potential impacts are anticipated to be of very short duration (i.e. elevated underwater sound during the detonation event only). As such, although temporal and/or spatial overlap with Tier 3 projects cannot be discounted, at current time it is not possible to undertake any kind of meaningful assessment for potential cumulative impacts as a result of UXO clearance with Tier 3 projects.

4.11.5 Injury and disturbance from vessel use and other (non-piling) sound producing activities

4.11.5.1 As for the assessment of the Mona Offshore Wind Project alone, the risk of injury in terms of PTS to marine mammal receptors as a result of underwater sound due to vessel use and other (non-piling) sound producing activities would be expected to be very low. The assessment for Mona Offshore Wind Project alone (section 4.9.5) identified PTS thresholds were unlikely to be exceeded (paragraph 4.9.5.13) and therefore the magnitude of the impact and associated effect (PTS) occurring in marine mammals has been assessed as negligible. Given the above, there is very low potential for potential cumulative impacts to cause injury as a result of elevated underwater sound due to vessel use and other (non-piling) sound producing activities. Instead, the cumulative assessment provided below focuses on disturbance only for this impact.

Tier 1

Construction phase

4.11.5.2 Given the temporal overlap, the construction of the Mona Offshore Wind Project, together with construction and operations and maintenance phases of Awel y Môr Offshore Wind Farm and White Cross, the operations and maintenance phase of the West Anglesey Demonstration Zone tidal site, Project Erebus and Twin Hub (Table 4.50) may lead to cumulative disturbance to marine mammals from vessel use and other (non-piling) sound producing activities.

Magnitude of impact

4.11.5.3 Awel y Môr Offshore Wind Farm is located approximately 3.6 km from the Mona Offshore Cable Corridor. The MDS for Awel y Môr anticipated up to 101 construction vessels in total, of which 35 may be on site during peak period (RWE, 2022). The assessment of potential impacts associated with underwater sound due to vessel traffic and other construction activities (such as cable laying, dredging, trenching and rock placement) presented in the Environmental Statement is based on a desktop study. The Environmental Statement assumed that based on Benhemma-Le Gall *et al.* (2021), harbour porpoise and other cetaceans may be displaced up to 4 km from construction vessels. The assessment also identified localised behavioural disturbance ranges for harbour porpoise and grey seal with avoidance reported up to 5 km from the site during dredging activities. For bottlenose dolphin dredging was predicted to cause a reduction in presence and avoidance of the area for five weeks. Similarly, minke whale presence is negatively correlated with construction related activities, including dredging.

4.11.5.4 The Environmental Statement for the West Anglesey Demonstration Zone tidal site (Royal Haskoning DHV, 2019), which is located 50.57 km from the Mona Offshore

Cable Corridor, provided a quantitative assessment of potential impacts based on a MDS of up to 16 vessels on site at any one time during the operations and maintenance phase of the project.

4.11.5.5 The Project Erebus site is located 240.23 km from the Mona Offshore Cable Corridor and Access Areas and comprises up to 10 floating wind turbines over a maximum area of 32 km^2. The MDS project anticipated a maximum of two crew transfer vessels on site per day during the operations and maintenance phase of the project (Blue Gem Wind, 2020). These vessels would be expected to be stationary or slow moving and would not be a novel impact pathway for marine mammals in the area (Blue Gem Wind, 2020).

4.11.5.6 White Cross is located up 264.1 km the Mona Offshore Cable Corridor and Access Areas, and the MDS for White Cross identified up to five vessels on site at any one time during the construction phase. The assessment concluded that the number of vessels would not exceed the Heinänen and Skov (2015) threshold (five vessels within 49.4 km^2 would equate to approximately 0.1 vessels per km^2). The Environmental Statement assumed that based on Benhemma-Le Gall et al. (2021), disturbance ranges for non-piling activities (other than vessels) would be up to 4 km from construction vessels.

4.11.5.7 Twin Hub is located 350.9 km from the Mona Offshore Cable Corridor and Access Areas, and details vessels may include anchor handling tugs, cable lay vessels but no quantification of vessel movement is included in the marine licence. Given the greatest disturbance ranges for Mona Offshore Wind Project are for survey vessel, support vessels, crew transfer vessel, scour/cable protection/seabed preparation and installation vessels, as a precautionary approach disturbance ranges are assumed to be comparable to the Mona Offshore Wind Project however the number of vessels are expected to be much lower given the project design and extent (two floating platforms hosting leaning wind turbines with potential capacity of up to 32 MW).

4.11.5.8 It is a standard practice that estimated ranges over which behavioural disturbance may occur are presented for different vessel types in isolation. For the Mona Offshore Wind Project, disturbance ranges of up to 4.08 km were predicted for survey vessel, support vessels, crew transfer vessel, scour/cable protection/seabed preparation and installation vessels. It is likely that several activities could be potentially occurring at the same time across several offshore wind projects and therefore disturbance ranges may extend from several vessels/locations where the activity is carried out. However (as discussed in paragraph 4.9.5.32) Benhemma-Le Gall *et al.* (2021) suggested increased vessel activity (and other construction activities) led to a decrease in porpoise acoustic detections and activity at distances of up to 4 km and therefore this is likely to be an overestimate of disturbance responses.

4.11.5.9 Therefore, cumulatively across the sites there may be a noticeable uplift in vessel activity within the Celtic and Irish Seas regional study area from the baseline, although noting that the assessments are based on the MDS and the number of vessels present at respective projects at any given time may in reality be lower. Additionally, vessel movements will be confined to the array areas and/or offshore cable corridor routes and are likely to follow existing shipping routes to and from port. As such, it would not be realistic to present simply the sum of all vessels anticipated within each offshore wind farm as per respective MDSs. Introduction of vessels during construction and operations and maintenance phases of the projects will not be a novel impact for marine mammals present in the area and therefore marine mammals are anticipated to demonstrate some degree of tolerance to sound from vessels (see discussion in paragraph 4.9.5.39).

4.11.5.10 Although the duration of vessel activity is considered to be medium term (e.g. throughout the construction phase of Mona Offshore Wind Farm) and localised for each project, it should be noted that vessel movements will occur intermittently over a number of years. Vessels such as boulder clearance, jack-up rigs, tug/anchor handlers and guard vessels will have smaller disturbance ranges (between 10 m to 6.5 km) and therefore the extent of effects will be local. However, where vessels may disturb animals over ranges of 4.08 km, it represents larger proportion of the Irish and Celtic Seas and may potentially affect animals over regional scales. Nevertheless, most of the vessels will be associated with the construction phases of Awel y Môr and Mona Offshore Wind Project and both projects are located within an area of relatively low marine mammal densities (except bottlenose dolphin, see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement).

4.11.5.11 The cumulative impact is predicted to be of local to regional spatial extent, long term duration, intermittent and both the impact itself (i.e. elevated underwater sound due to vessel use and other (non-piling) sound producing activities) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

4.11.5.12 The sensitivity of marine mammals to elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described in paragraph 4.9.5.31.

4.11.5.13 Scientific evidence suggests that there are interspecific differences in the potential sensitivity of cetaceans to sound from vessel traffic with different behavioural reactions to different vessel types, as some species actively avoid vessels, whilst other are attracted towards them. Of all marine mammal IEFs, harbour porpoise is likely to be particularly sensitive to sound from vessels and an avoidance response in the vicinity of vessel traffic is likely to occur (Heinänen and Skov, 2015; Hermannsen and Bedholm, 2014; Dyndo *et al*. 2015). Pirotta *et al*. (2015) combined acoustic data with visual observations to investigate whether dolphin responses varied under different disturbance, context and social conditions. The study found that there is a complex interaction between the physical presence of a boat, the sound it produces and its movement around the animals that affects the perception of risk and determines the onset of an animal's response. The visual data corroborated that the reduction of buzzing activity increased with increasing numbers of boats in the area and this effect it thought to be associated with physical boat presence (Pirotta *et al.,* 2015).

4.11.5.14 However, there may be intrinsic factors that may also contribute to a variance in distribution and abundance (e.g. changes in prey distribution and natural seasonal fluctuations) and therefore the link between vessel sound and reduced marine mammal activity is not straightforward to establish. Despite the known sensitivity of harbour porpoise, Culloch *et al*. (2016) found no detectable decrease in the numbers of harbour porpoise associated with an increase in vessel activity during pipeline construction.

4.11.5.15 The presence of boats near seal haul-outs could lead to disruption of foraging and potentially reduced pupping success. As reported in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement the closest designated grey seal haul-out site is located approximately 107 km swimming distance from the Mona Offshore Wind Project and therefore there are expected to be no potential direct impacts to grey seal on land while hauled-out at these designated sites. Given small numbers of harbour seal within the Wales and Northwest England MU, there is no information on the location of harbour seal hauled-out in in these MUs. The closest designated harbour seal haul-out site (Langness) is 40.97 km from the Mona Array

Area. Given that the vessel movements will be confined to the array areas and/or offshore cable corridor routes of respective projects and are likely to follow existing shipping routes to and from port, it is highly unlikely that harbour seal present within this, or any other designated haul-out site within the Mona marine mammal study area, would be disturbed.

4.11.5.16 Barrier effects and altered behaviour could affect the ability of phocid seal to accumulate the energy reserves prior to both reproduction and lactation (Sparling *et al.*, 2006). They may be most vulnerable to reduced foraging during this period, as maternal energy storage is extremely important to offspring survival and female fitness (Mellish *et al*., 1999; Hall *et al*., 2001). Therefore, potential exclusion from foraging grounds during this time has the potential to affect reproduction rates and probability of survival. Pen Llŷn a`r Sarnau/Llŷn Peninsula and the Sarnau SAC, Lambay Island SAC, Pembrokeshire Marine/Sir Benfro Forol SAC and Saltee Islands SAC are located within the regional marine mammal study area and support breeding colonies of grey seal. Carter *et al*. (2022) suggested that for grey seal, SACs designated based on breeding numbers cannot be reliably linked to areas where individuals may be exposed to threats at sea due to local redistribution outside of the breeding season and partial migration. Inter-regional movements within the foraging season are believed to be limited for harbour seal. Various sites designated for protection of cetaceans are also located in proximity to the Mona Offshore Wind Projects (see section 4.4.3). Given the existing levels of vessel activity within the Irish Sea, it is expected that marine mammals could tolerate the effects of vessel presence to some extent (see section 4.9.5). The potential impacts of construction will be highly localised, largely restricted to the boundaries of the respective projects and only a small area will be affected when compared to available foraging habitat. Therefore, it is anticipated that the connectivity with suitable foraging grounds and supporting habitats will not be impaired. Full consideration of potential adverse effects on the integrity (AEoI) of European Sites is given in the ISAA (Document Reference E1.3).

4.11.5.17 All marine mammals are deemed to have some tolerance to behavioural disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.5.18 Overall, with standard industry measures in place (such as vessel provisions within the offshore EMP (see Table 4.17), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.5.19 Given the temporal overlap, the operations and maintenance phase of the Mona Offshore Wind Project, together with the operations and maintenance phase of Awel y Môr Offshore Wind Farm, West Anglesey Demonstration Zone tidal site, Project Erebus and Twin Hub (Table 4.50) may lead to cumulative disturbance to marine mammals from vessel use and other (non-piling) sound producing activities.

Magnitude of impact

4.11.5.20 The range of vessels used in operations and maintenance activities will be similar to those employed during the construction phases of cumulative projects although fewer vessels are likely to be involved but over a longer duration. During the operation of Awel y Môr Offshore Wind Farm, it was anticipated that numerous different vessel types would be conducting round trips to and from port and the array area, but only two jack-up vessels and two SOVs would be present at any one time.

4.11.5.21 The West Anglesey Demonstration Zone tidal site is located 53.78 km from the Mona Array Area and the MDS anticipated up to two drilling activities, two cable installation activities, two cable protection activities and 16 vessels on site (Royal Haskoning DHV, 2019). The maximum behavioural disturbance range across all species was predicted in harbour porpoise for two percussive drilling rigs and cutter-suction dredging as up to 530 m and 580 m, respectively.

4.11.5.22 The MDS for Project Erebus anticipated a maximum of two crew transfer vessels on site per day, which would be expected to be stationary or slow moving and were not expected to be a novel impact pathway for marine mammals in the area (Blue Gem Wind, 2020). The maximum predicted behavioural disturbance range for large vessels was assessed as 480 m for minke whale.

4.11.5.23 The White Cross MDS stated vessel movement during the operations and maintenance stage will be to a lesser extent than the construction stage and used a precautionary approach based the potential for effect during the operation and maintenance phase on the construction phase assessment (up to five vessels at any one time, paragraph 4.11.5.6).

4.11.5.24 Similarly, Twin Hub does not give a quantification of vessel movement for operations and maintenance stage, however as a precautionary approach disturbance ranges are assumed to be comparable to the Mona Offshore Wind Project however the number of vessels are expected to be much lower given the project design and extent (two floating platforms hosting leaning wind turbines with potential capacity of up to 32 MW).

4.11.5.25 The MDS for the operations and maintenance phase of the Mona Offshore Wind Project is presented in Table 4.16 with up to 21 operations and maintenance vessels on site at any one time. Vessels involved in the operations and maintenance of Awel y Môr Offshore Wind Farm and West Anglesey Demonstration Zone tidal site will include a similar suite of vessels as those described for the Mona Offshore Wind project alone, such as CTVs/workboats, jack-up vessels, cable repair vessels, SOVs and excavators/backhoe dredgers.

4.11.5.26 Therefore, cumulatively across the sites there will be an increase in vessel activity within the Celtic and Irish Seas regional study area. This represents an uplift from the current baseline, although noting that the assessments are based on the MDS, the number of vessels present at respective projects at any given time will in reality be lower. Additionally, vessel movements will be confined to the array areas and/or offshore cable corridor routes and are likely to follow existing shipping routes to and from port. As such, it would not be realistic to present a simplistic sum of all vessels anticipated within each offshore wind farm as per respective MDSs. Introduction of vessels during construction and operations and maintenance phases of the projects will not be a novel impact for marine mammals present in the area and therefore marine mammals are anticipated to demonstrate some degree of tolerance to sound from vessels.

4.11.5.27 The duration of vessel activity is considered to be long term (throughout the operations and maintenance phase of the Mona Offshore Wind Project) and localised for each project with vessel movements occurring intermittently over the lifetime of the Mona Offshore Wind Project. The cumulative number of vessels at any given time is expected to be lower for the operations and maintenance phase compared to the construction phase (see paragraph 4.11.5.9) of Mona Offshore Wind Project. Therefore, the magnitude of the impact and associated effect (disturbance) as a result of elevated underwater sound due to vessel use and other (non-piling) sound producing activities, for all marine mammal receptors, is expected to be less than that assessed for the construction phase. However, considering that the duration of the impact will be longer, over the decadal operating lifetime of the project, a precautionary approach has been taken in assessing the magnitude.

4.11.5.28 The cumulative impact is predicted to be of local to regional spatial extent, long term duration, intermittent and both the impact itself (i.e. elevated underwater sound due to vessel use and other (non-piling) sound producing activities) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

4.11.5.29 The sensitivity of marine mammals to cumulative disturbance from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described in paragraph 4.11.5.12 for the construction phase.

4.11.5.30 All marine mammals are deemed to have some tolerance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.5.31 Overall, with standard industry measures in place (such as the offshore EMP), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Tier 2

Construction phase

4.11.5.32 The construction of the Mona Offshore Wind Project, together with construction and/or operations and maintenance phases of Tier 1 projects and the construction phase of the Inis Ealga Marine Energy Park, Transmission Assets, Morgan Offshore Wind Project Generation Assets, Energy Park, North Channel Wind 1 and 2, and Shelmalere Offshore Wind Farm, and both the construction and operations and maintenance phases of the Codling Wind Park Offshore Wind Farm, Dublin Array Offshore Wind Farm, Llŷr Projects (Llŷr 1 and Llŷr 2), North Irish Sea Array Offshore Wind Farm, Project Valorous (Table 4.50) may lead to disturbance to marine mammals from vessel use and other (non-piling) sound producing activities. Timelines of the construction (as well as operations and maintenance phases) of Arklow Bank Wind Park Phase 2, Morecambe Offshore Windfarm Generation Assets, North Celtic Sea Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen and Simply Blue Emerald are unknown. However, it has been conservatively assumed that there will be a temporal overlap with the construction phase of the Mona Offshore Wind Project. Potential impacts as a result of vessel use and other (non-piling) sound producing activities were screened into the assessments for all projects during the construction phase of the Mona Offshore Wind Project.

Magnitude of impact

4.11.5.33 Given that EIA Scoping Reports do not provide detailed information on vessel numbers, it is not possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided below.

4.11.5.34 However, for Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm Generation Assets and Transmission Assets, PEIR is available and vessel information is included. Behavioural disturbance ranges depend on the type of vessels used during construction and type of other (non-piling) sound producing activities. Although these ranges may extend beyond the boundaries of the projects screened into cumulative assessment, the extent to which this occurs will depend on the design parameters. The maximum range over which potential disturbance may occur as a result of underwater sound due to vessel use for the Mona Offshore Wind Project alone as a result of survey vessel, support vessels, crew transfer vessels, scour/cable protection/seabed preparation and installation vessels and is predicted out to 4.08 km (noting this is not for all vessel types).

4.11.5.35 The PEIR for the Morgan Generation Assets (Morgan Offshore Wind Project Ltd, 2023 identified underwater sound from vessels and other vessel activities as a potential impact during the construction phase of the project. As presented in the PEIR for this project, cable laying activities assessed for the Morgan Generation Assets alone have the potential to disturb marine mammals out to 18 km. The maximum range over which potential disturbance may occur for the Morgan Generation Assets alone was predicted out to 21 km for Survey vessel and support vessels, Crew transfer vessel, Scour/Cable Protection/Seabed Preparation/Installation Vessels. The Morgan Generation Assets PEIR predicted up to 63 vessels to be present on site at any given time during the construction phase, with up to 1,878 return trips during construction.

4.11.5.36 The MDS presented in PEIR for Morecambe Offshore Windfarm: Generation Assets (Morecambe Offshore Windfarm Ltd, 2023) anticipated up to 30 vessels on site at any one time, with 150 return trips for delivery of main components and installation over the construction phase, and 2,778 return trips per year for support vessels. Disturbance ranges were not modelled, but assessment for all species was based on a disturbance impact range of 2 km (based upon studies by Brandt *et al*. 2018 and Benhemma-Le Gall *et al*. (2021).

4.11.5.37 For the Transmission Assets, disturbance ranges of up to 20 km were predicted for survey and support vessels, crew transfer vessels, scour/cable protection/seabed preparation/installation vessels. The Transmission Assets PEIR predicted up to 70 vessels to be present on site at any given time during the construction phase, with up to 740 return trips during the construction phase.

4.11.5.38 The impact for the remaining Tier 2 projects is predicted to be localised to within the close vicinity of the respective projects. For the majority of the Tier 2 projects (Arklow Bank Wind Park Phase 2, Codling Wind Park Offshore Wind Farm, Dublin Array Offshore Wind Farm, Inis Ealga Marine Energy Park ,Llŷr 1, Llŷr 2, North Celtic Sea Offshore Wind Farm, North Channel Wind 1, North Channel Wind 2, North Irish Sea Array Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen, Project Valorous, Shelmalere Offshore Wind Farm and Simply Blue Emerald) the distances from the Mona Offshore Wind Project are greater than 100 km (see Table 4.50 for distances) and there is no potential for overlap in the behavioural ZOI.

4.11.5.39 Other projects, including Morecambe Offshore Windfarm Generation Assets Transmission Assets and Morgan Offshore Wind Project Generation Assets are located in close proximity to the Mona Offshore Wind Project and therefore this could lead to higher levels of traffic within the Liverpool Bay region. Vessel movements and other activities will be largely confined to the array areas and/or offshore cable corridor and vessel routes are likely to follow existing shipping routes to and from port.

4.11.5.40 The duration of vessel activity is considered to be medium term (throughout the construction phase of the Mona Offshore Wind Project) and localised for each project, however, it should be noted that vessel movements will occur intermittently over a number of years. The cumulative number of vessels for Tier 1 projects represents an increase compared to the average vessel traffic (see paragraph 4.11.5.9). Although the exact number of vessels associated with most Tier 2 projects is unknown, if the construction phase at all Tier 2 projects occurs simultaneously, vessels associated with each project will contribute further to the increase over a number of years.

4.11.5.41 Cumulatively, construction activities could lead to a larger area of disturbance to marine mammals at any one time across the Irish and Celtic seas compared to the Mona Offshore Wind Project alone assuming that projects were to conduct construction activities over similar time periods. Vessels such as boulder clearance, jack-up rigs, tug/anchor handlers and guard vessels will have smaller disturbance ranges (between <10 m to 2.195 km) and therefore the extent of effect will be local. However, where vessels may disturb animals up to 4.08 km, this represents a larger proportion of the Irish and Celtic Seas and may potentially affect animals over regional scales. However, as discussed in paragraph 4.9.5.32 and 4.9.5.23, distances of up between 2 km and 7 km (Brandt *et al.,* 2018; McQueen *et al.* 2020; Benhemma-Le Gall *et al.*, 2021; Wisniewska *et al.* 2018) have been suggested for disturbance and it is unlikely that strong disturbance will be experienced further than 4.08 km from the shipping source (Table 4.43).

4.11.5.42 Although animals may be disturbed from isolated project areas at different points in time, in the context of the wider habitat available within the Celtic and Irish Seas regional study area, the scale of the disturbance effects (which would be localised) is considered to be small.

4.11.5.43 The cumulative impact is predicted to be of local to regional spatial extent, long term duration, intermittent and both the impact itself (i.e. elevated underwater sound due to vessel use and other (non-piling) sound producing activities) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

4.11.5.44 The sensitivity of marine mammals to cumulative disturbance from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described in paragraph 4.11.5.12 for the construction phase.

4.11.5.45 All marine mammals are deemed to have some resilience to disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.5.46 Overall, with standard industry measures in place (such as EMP), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.5.47 The operations and maintenance phase of the Mona Offshore Wind Project, together with operations and maintenance phases of Tier 1 projects and operations and maintenance phases of the Codling Wind Park Offshore Wind Farm, Dublin Array Offshore Wind Farm, Inis Ealga Marine Energy Park , Llŷr 1, Llŷr 2, Morecambe Offshore Windfarm Generation Assets, Morgan and Morecambe Offshore Windfarms

Transmission Assets, Morgan Offshore Wind Project Generation Assets, North Celtic Sea Offshore Wind Farm, North Channel Wind 1, North Channel Wind 2, North Irish Sea Array Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen, Project Valorous, Shelmalere Offshore Wind Farm and Simply Blue Emerald (Table 4.50). Timelines of the construction and operations and maintenance phases of the Timelines of the construction (as well as operations and maintenance phases) of Arklow Bank Wind Park Phase 2, Morecambe Offshore Windfarm Generation Assets, North Celtic Sea Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen and Simply Blue Emerald are unknown. However, it has been conservatively assumed that there will be a temporal overlap with the operations and maintenance phase of the Mona Offshore Wind Project and therefore there is a potential for cumulative effects.

Magnitude of impact

4.11.5.48 Given that EIA Scoping Reports do not provide detailed information about numbers of vessels involved, it is not possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided below. However, for Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm Generation Assets and Transmission Assets, PEIR is available and vessel information is included.

4.11.5.49 Morgan Generation Assets predicted up to 21 vessels to be present on site at any given time during the operations and maintenance phase. Morecambe Offshore Windfarm Generation Assets predicted the maximum number of vessels at any one time on site is up to 10 vessels during the operations and maintenance phase. Transmission Assets PEIR predicted up to 19 operation and maintenance vessels on site at any one time during the operations and maintenance phase.

4.11.5.50 The range of vessel used in operations and maintenance activities will be similar to those employed during the construction phases of cumulative projects. The duration of vessel activity is considered to be long term (throughout the operational and maintenance phase of Mona Offshore Wind Project) and localised for each project; however, it should be noted that vessel movements will occur intermittently over the lifetime of the Mona Offshore Wind Project. The number of vessels present during the operations and maintenance phases of respective projects in isolation is considered to be smaller than for the construction phase. Nevertheless, cumulatively it could be expected that the total number of vessel movements will exceed the existing average traffic levels (see paragraph 4.11.5.9).

4.11.5.51 Qualitatively, the impact would lead to a larger area of disturbance within the CIS MU (see paragraph 4.11.5.26) compared to the Mona Offshore Wind Project alone. Although animals may be disturbed from isolated project areas at different points in time, in the context of the wider habitat available within the regional marine mammal study area, the scale of the disturbance effects (which would be localised) is considered to be small.

4.11.5.52 The cumulative impact is predicted to be of local to regional spatial extent, long term duration, intermittent and both the impact itself (elevated underwater sound due to vessel use and other (non-piling) sound producing activities) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

4.11.5.53 The sensitivity of marine mammals to cumulative disturbance from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described in paragraph 4.11.5.12.

4.11.5.54 All marine mammals are deemed to have some resilience to disturbance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.5.55 Overall, with standard industry measures in place (such as the offshore EMP), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Tier 3

Construction phase

4.11.5.56 The construction of the Mona Offshore Wind Project, together with construction and/or operations and maintenance phases of Tier 1 and Tier 2 projects as well as the construction and/or operations and maintenance phase of Blackwater Offshore Wind Farm, Braymore Point, Celtic Sea Array Offshore Wind Farm, Cork offshore wind project, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Eni Hynet CCS, Inis Offshore Wind Munster, Isle of Man wind farm lease area, MaresConnect, Project Saoirse and South Pembrokeshire Demonstration Zone. (Table 4.50) may lead to cumulative disturbance to marine mammals from underwater sound generated during vessel use and other (non-piling) sound producing activities. However, there are no scoping reports to give detailed information on the timescales of these projects and therefore a qualitative assessment is provided below.

Magnitude of impact

4.11.5.57 Eni Hynet CCS, Inis Offshore Wind Munster, Isle of Man wind farm lease area and MaresConnect are located within 50 km of the Mona Offshore Wind Project. Other Tier 3 Projects (Blackwater Offshore Wind Farm, Braymore Point, Celtic Sea Array Offshore Wind Farm, Cork offshore wind project, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Project Saoirse and South Pembrokeshire Demonstration Zone) are all located over 100 km away from the Mona Offshore Wind Project.

4.11.5.58 The construction timeline of the Mooir Vannin offshore windfarm is not yet available. However, given that it is in the pre-application stage, its construction phase may overlap temporally towards the end of the construction phase of the Transmission Assets (2026-2029). There is no information in the public domain on potential vessel use and other (non-piling) sound producing activities for Mooir Vannin. The construction phase of MaresConnect is anticipated to begin in 2025 (MaresConnect, 2023), with the operations phase commencing in 2026. As such, it is likely that the construction of the MaresConnect will be completed prior to the commencement of construction activities at the Mona Offshore Wind Project. Maintenance of the cable during the operations and maintenance typically involves considerably fewer vessels and round trips compared to construction. Therefore, it is anticipated that these will not add substantially to the number of vessels present during the construction of the Mona Offshore Wind Project and that the potential for cumulative effects is unlikely.

4.11.5.59 The cumulative impact is predicted to be of local to regional spatial extent, long term duration, intermittent and both the impact itself (elevated underwater sound due to vessel use and other (non-piling) sound producing activities) and effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

4.11.5.60 The sensitivity of marine mammals to cumulative disturbance from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described in paragraph 4.11.5.12 .

4.11.5.61 All marine mammals are deemed have some resilience, high recoverability and international value. The sensitivity of the receptor is, therefore, considered to be **medium**.

Significance of effect

4.11.5.62 Overall, with standard industry measures in place (such as the offshore EMP), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.5.63 The operations and maintenance phase of the Mona Offshore Wind Project, together with operations and maintenance phases of Tier 1 and Tier 2 projects as well as operations and maintenance phases of Tier 3 projects(Table 4.50) may lead to cumulative disturbance to marine mammals from underwater sound generated during vessel use and other (non-piling) sound producing activities.

Magnitude of impact

4.11.5.64 Tier 3 projects are in a pre-application phase and no Environmental Statement is available to inform a quantitative assessment. Therefore, a qualitative assessment is provided below.

4.11.5.65 As described in paragraph 4.11.5.58, maintenance of cable or offshore wind farm typically involves considerably smaller numbers of vessels and round trips compared to construction. Considering the vessel activity within the Irish Sea, it is anticipated that these will not add substantially to the number of vessels present during the operations and maintenance phases of the Mona Offshore Wind Project, Tier 1 and Tier 2 projects and that the potential for cumulative effects is unlikely.

4.11.5.66 The cumulative impact is predicted to be of local to regional spatial extent, long term duration, intermittent and both the impact itself (elevated underwater sound due to vessel use and other (non-piling) sound producing activities) and the effect of behavioural disturbance is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

4.11.5.67 The sensitivity of marine mammals to cumulative disturbance from elevated underwater sound due to vessel use and other (non-piling) sound producing activities is as described in paragraph 4.11.5.12.

4.11.5.68 All marine mammals are deemed to have some tolerance, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

4.11.5.69 Overall, with standard industry measures in place (such as the offshore EMP), the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.11.6 Increased likelihood of injury due to collision with vessels

Tier 1

Construction phase

4.11.6.1 Given the temporal overlap, the construction of the Mona Offshore Wind Project, together with Tier 1 projects and construction and operations and maintenance phases of Awel y Môr Offshore Wind Farm and White Cross and the operations and maintenance phase of the West Anglesey Demonstration Zone tidal site, Project Erebus and Twin Hub (Table 4.50) may lead to potential cumulative impacts on marine mammals from collisions with vessels.

Magnitude of impact

4.11.6.2 The number and types of vessel associated with construction and/or operations and maintenance phase of Awel y Môr Offshore Wind Farm is provided in paragraph 4.11.5.3. In the Environmental Statement, Awel y Môr committed to employ a vessel management plan and follow best practice vessel handling protocols (i.e. Codes of Conduct) to minimise the potential for any impact. As for the Mona Offshore Wind Project, it is anticipated that a proportion of vessels during construction will be slow moving or even stationary for periods of time and therefore unlikely to pose a significant collision risk to marine mammals (RWE, 2022). As discussed in paragraphs 4.11.5.6 for White Cross up to five vessels could be on site at one time, whilst for Twin Hub (paragraph 4.11.5.7) there is limited information on the number of vessels is given, but it is likely that the nnumbers of vessels are expected to be much lower given the extent of project compared to Mona Offshore Wind Project and other Tier 1 Projects.

4.11.6.3 The temporal overlap in construction activities of Mona Offshore Wind Project with construction/operations and maintenance activities in Awel y Môr and White Cross, and operations and maintenance activities for the West Anglesey Demonstration Zone tidal site, Project Erebus and Twin Hub will be approximately three years. The duration of vessel activity is considered to be medium term (throughout the construction phase of Mona Offshore Wind Farm) and localised for each project, however it should be noted that vessel movements will occur intermittently over this period. Cumulatively, as described in paragraph 4.11.5.9, the total number of vessels associated with construction and operations and maintenance of respective projects will represent an increase in vessel activity within the Celtic and Irish Seas regional study area. Considering that the assessment is based on the MDS, the number of vessels present at respective projects at any given time will, in reality, be lower.

4.11.6.4 Vessels involved in the construction phases of Awel y Môr and Mona Offshore Wind Project, and the operations and maintenance phase of Awel y Môr, the West Anglesey Demonstration Zone tidal site, Project Erebus and Twin Hub are likely to be travelling slowly, at a speed that is unlikely to cause death or serious injury (i.e. below 14 knots; Laist *et al.,* 2001; Wilson *et al.,* 2007). This would be most appropriate for species found within the marine mammal study areas, whereas guidance in the USA (NOAA, 2020) suggests lower speeds in relation to larger slow-moving species such as humpback whale (rare sightings in the Irish Sea). Awel y Môr stated a commitment to the adoption of best practice vessel handing protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme, Scottish Marine Wildlife Watching Code or Guide to Best Practice for Watching Marine Wildlife) during construction will minimise the potential for any impact. The Mona Offshore Wind Project has committed the adherence of an Offshore EMP (Table 4.17), which will include measures to minimise the risk of collision and potential injury to marine mammals from transiting vessels (Document Reference J17).

4.11.6.5 There is also a potential that the sound emissions from vessels will provide advance warning to animals at close proximity, they will show high degree of avoidance. Given that vessel movements will be confined to the array areas and/or offshore cable corridor routes and are likely to follow existing shipping routes to and from port, the risk of collision to marine mammals is expected to be localised to within the boundaries of the respective projects. Additionally, works will take place in areas characterised by relatively high levels of traffic and both projects will be adhering to best practice protocols. Therefore, it is not anticipated that the cumulative level of vessel activity during construction will cause an increase of collisions with marine mammals.

4.11.6.6 With standard industry measures in place to reduce the risk of collision, the impact is predicted to be of limited spatial extent, medium term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of the receptor

4.11.6.7 The sensitivity of marine mammals to collision risk is as described in paragraph 4.9.6.7 for Mona Offshore Wind Project alone.

4.11.6.8 Given that there may be intrinsic factors that may contribute to a variance in marine mammal distribution and abundance (e.g. changes in prey distribution and natural seasonal fluctuations), the link between vessel movements and marine mammal activity is not straightforward to establish. Collision risk could be expected to be higher in the vicinity of haul-out sites, particularly for young seal that have no previous experience of vessel traffic. Whilst there are no seal haul-out sites in the Mona marine mammal study area, there are grey seal and harbour seal haul-out sides within the cumulative marine mammal study area and therefore cumulatively there is the potential for increase in the likelihood of vessel collision.

4.11.6.9 All marine mammals are deemed to have some tolerance (largely due to avoidance), medium recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

4.11.6.10 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.6.11 Given the temporal overlap the operations and maintenance phase of the Mona Offshore Wind Project with operations and maintenance phases of the Awel y Môr Offshore Wind Farm, White Cross, West Anglesey Demonstration Zone tidal site, Project Erebus and Twin Hub (Table 4.50) may lead to potential cumulative impacts on marine mammals from collisions with vessels.

Magnitude of impact

4.11.6.12 The range of vessels used in operations and maintenance activities will be similar to those employed during the construction phases of cumulative projects although fewer vessels are likely to be involved but over a longer duration. Vessels assessed during the operations and maintenance phase of Awel y Môr and Project Erebus are described in paragraph 4.11.5.18.

4.11.6.13 The number and types of vessels associated with operations and maintenance of the West Anglesey Demonstration Zone tidal site is provided in paragraph 4.11.5.18. The Environmental Statement provided a quantitative assessment of potential impacts based on up to 16 vessels on site at any one time and the scale of effect in terms of animals potentially affected was very small.

4.11.6.14 The Project Erebus Environmental Statement provided a qualitative assessment of potential impacts based upon a maximum of two crew-transfer vessels being on site at any one time. These vessels were expected to travel slowly and were not considered to be a novel impact pathway for marine mammals in the area. This project is located 240.23 km from the Mona Offshore Wind Project and is therefore not anticipated to contribute significantly to a cumulative effect.

4.11.6.15 The duration of vessel activity is considered to be long term (throughout the operations and maintenance phase of the Mona Offshore Wind Project) and localised for each project, however, it should be noted that vessel movements will occur intermittently over the lifetime of the Mona Offshore Wind Project. The cumulative number of vessels is expected to be lower for the operations and maintenance phase compared to the construction phase (see paragraph 4.11.5.27) of the Mona Offshore Wind Project.

4.11.6.16 Although the number of vessel movements during the operations and maintenance phase represents an increase in the risk of collision for marine mammals over the existing levels of vessel traffic, there is a potential that the sound emissions from vessels will deter animals from the potential zone of impact. Additionally, given that vessel movements will be confined to the array areas and cable routes and are likely to follow existing shipping routes to and from port, the risk of collision to marine mammals is expected to be largely localised to within the boundaries of the respective projects.

4.11.6.17 With standard industry measures in place to reduce the risk of collision, the impact is predicted to be of limited spatial extent, long term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of the receptor

4.11.6.18 The sensitivity of marine mammals to collision risk is as described in paragraph 4.11.6.7.

4.11.6.19 All marine mammals, which are deemed to have some tolerance, medium recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

4.11.6.20 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Tier 2

Construction phase

4.11.6.21 The construction of the Mona Offshore Wind Project, together with construction and operations and maintenance phases of Tier 1 projects and the construction phase of the Inis Ealga Marine Energy Park, Transmission Assets, Morgan Offshore Wind Project Generation Assets, Energy Park, North Channel Wind 1 and 2 and Shelmalere Offshore Wind Farm, and both the construction and operations and maintenance phases of the Codling Wind Park Offshore Wind Farm, Dublin Array Offshore Wind Farm, Llŷr Projects (Llŷr 1 and Llŷr 2), North Irish Sea Array Offshore Wind Farm, Project Valorous (Table 4.50) may lead to potential cumulative impacts on marine mammals from collisions with vessels. Timelines of the construction (as well as operations and maintenance phases) of Arklow Bank Wind Park Phase 2, Morecambe Offshore Windfarm Generation Assets, North Celtic Sea Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen and Simply Blue Emerald are unknown. However, it has been conservatively assumed that there will be a temporal overlap with the construction phase of the Mona Offshore Wind Project. Potential impacts associated with risk of collision with vessels were screened into the assessment for all projects during the construction and operations and maintenance phases of respective projects.

Magnitude of impact

4.11.6.22 Given that EIA Scoping Reports do not provide detailed information about numbers of vessels involved, it has not been possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided below. However, for Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm Generation Assets and Transmission Assets, PEIR is available and vessel information is included.

4.11.6.23 The types of vessels involved in construction activities at the other offshore wind farms are anticipated to be similar to those identified for construction of the Mona Offshore Wind Project, such as main installation and support vessels, tug/anchor handlers, cable lay installation and support vessels, guard vessels, survey vessels, seabed preparation vessels, crew transfer vessels, scour protection installation vessels and cable protection installation vessels.

4.11.6.24 As presented in paragraph 4.11.5.35, the Morgan Generation Assets PEIR predicted up to 63 vessels to be present on site at any given time during the construction phase. As presented in paragraph 4.11.5.36, the Morecambe Offshore Windfarm: Generation Assets PEIR predicted up to 30 vessels to be present on site at any given time during the construction phase. As presented in paragraph 4.11.5.37, the Transmission Assets PEIR predicted up to 70 vessels to be present on site at any given time during the construction phase.

4.11.6.25 The duration of vessel activity is considered to be medium term (throughout the construction phase of Mona Offshore Wind Farm) and localised for each project, however it should be noted that vessel movements will occur intermittently over a number of years. As presented in paragraph 4.11.5.40, although the exact number of vessels associated with most Tier 2 projects is unknown, cumulatively across the sites there will be an increase in vessel activity within the CEA screening area. If the construction phase at all Tier 2 projects were to occur simultaneously, vessels associated with each project would contribute further to the increase over a number of years.

4.11.6.26 As previously described for the Mona Offshore Wind Project alone (see paragraph *et seq* 4.9.5.3), vessels travelling at 14 knots or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al*., 2001). As for construction of the Mona Offshore Wind Project, vessels involved in the construction phase of respective projects are likely to be travelling considerably slower than this. There is also a potential that the sound emissions from vessels will deter animals from the potential ZOI. Additionally, given that vessel movements will be confined to the array areas and/or cable routes and are likely to follow existing shipping routes to and from port, the risk of collision to marine mammals is expected to be largely localised to within the boundaries of the respective projects.

4.11.6.27 With standard industry measures in place to reduce the risk of collision, the impact is predicted to be of limited spatial extent, medium term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of the receptor

4.11.6.28 The sensitivity of marine mammals to collision risk is as described in paragraph 4.11.6.7.

4.11.6.29 All marine mammals, which are deemed to have some tolerance, medium recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

4.11.6.30 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.6.31 The operations and maintenance phase of the Mona Offshore Wind Project, together with operations and maintenance phases of Tier 1 projects and operations and maintenance phases of the Codling Wind Park Offshore Wind Farm, Dublin Array Offshore Wind Farm, Inis Ealga Marine Energy Park , Llŷr 1, Llŷr 2, Morecambe Offshore Windfarm Generation Assets, Morgan and Morecambe Offshore Windfarms Transmission Assets, Morgan Offshore Wind Project Generation Assets, North Celtic Sea Offshore Wind Farm, North Channel Wind 1, North Channel Wind 2, North Irish Sea Array Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen, Project Valorous, Shelmalere Offshore Wind Farm and Simply Blue Emerald (Table 4.50). Timelines of the construction and operations and maintenance phases of the Timelines of the construction (as well as operations and maintenance phases) of Arklow Bank Wind Park Phase 2, Morecambe Offshore Windfarm Generation Assets, North Celtic Sea Offshore Wind Farm, Oriel Windfarm Offshore Wind Farm, Project Ilen and Simply Blue Emerald are unknown. However, it has been conservatively assumed that there will be a temporal overlap with the construction phase of the Mona Offshore Wind Project and therefore there is a potential for cumulative effects.

Magnitude of impact

4.11.6.32 The operations and maintenance phase of the Mona Offshore Wind Project overlaps with the operations and maintenance phase of the respective projects. Given that EIA Scoping Reports do not provide detailed information about numbers of vessels involved in operations and maintenance phase, it has not possible to undertake full, quantitative assessment. For Morgan Generation Assets, PEIR is available and vessel information is included.

4.11.6.33 The types of vessels involved in operations and maintenance activities at the other offshore wind farms are anticipated to be similar to those identified for the Mona Offshore Wind Project, such as vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth and replacement of access ladders.

4.11.6.34 As presented in paragraph 4.11.5.49, Morgan Generation Assets predicted up to 21 vessels to be present on site at any given time during the operations and maintenance phase. Morecambe Offshore Windfarm Generation Assets predicted the maximum number of vessels at any one time on site is up to 10 vessels during the operations and maintenance phase. Transmission Assets PEIR predicted up to 19 operation and maintenance vessels on site at any one time during the operations and maintenance phase.

4.11.6.35 As presented for the construction phase in paragraph 4.11.6.4, there is a potential that the sound emissions from vessels will deter animals from the potential zone of impact. Given that vessel movements will be confined to the array areas and/or offshore cable corridor routes and are likely to follow existing shipping routes to and from port, the risk of collision to marine mammals is expected to be localised to within the boundaries of the respective projects.

4.11.6.36 The duration of vessel activity is considered to be long term (throughout the operations and maintenance phase of the Mona Offshore Wind Project) and localised for each project, however it should be noted that vessel movements will occur intermittently over the lifetime of the Mona Offshore Wind Project. The number of vessels present during the operations and maintenance phases of respective projects in isolation is considered to be smaller than for construction phase. Nevertheless, cumulatively it could be expected that the total number of vessel movements will exceed the average traffic levels (see paragraph 4.11.5.26).

4.11.6.37 With standard industry measures in place to reduce the risk of collision, the impact is predicted to be of limited spatial extent, long term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of the receptor

4.11.6.38 The sensitivity of marine mammals to collision risk is as described in paragraph 4.11.6.7.

4.11.6.39 All marine mammals, which are deemed to have some tolerance, medium recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

4.11.6.40 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Tier 3

Construction phase

4.11.6.41 The construction of the Mona Offshore Wind Project, together with construction and/or operations and maintenance phases of Tier 1 and Tier 2 projects as well as the construction and/or operations and maintenance phase of Blackwater Offshore Wind Farm, Braymore Point, Celtic Sea Array Offshore Wind Farm, Cork offshore wind project, Celtic Sea RWE Renewables, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Eni Hynet CCS, Inis Offshore Wind Munster, Isle of Man wind farm lease area, MaresConnect, Project Saoirse and South Pembrokeshire Demonstration Zone. (Table 4.50) (Table 4.50) may lead to potential cumulative impacts on marine mammals from collisions with vessels.

Magnitude of impact

4.11.6.42 Eni Hynet CCS, Inis Offshore Wind Munster, Isle of Man wind farm lease area and MaresConnect are located within 50 km of the Mona Offshore Wind Project. Other Tier 3 Projects (Blackwater Offshore Wind Farm, Braymore Point, Celtic Sea Array Offshore Wind Farm, Cork offshore wind project, Celtic Sea RWE Renewables, Clogher Head Offshore Wind Farm, Codling Wind Park Extension Offshore Wind Farm, Cooley Point Offshore Wind Farm, Project Saoirse and South Pembrokeshire Demonstration Zone) are all located over 100 km away from the Mona Offshore Wind Project.

4.11.6.43 The construction timeline of the Mooir Vannin offshore windfarm is not yet available. However, given that it is in the pre-application stage, its construction phase may overlap temporally towards the end of the construction phase of the Transmission Assets (2026-2029). There is no information in the public domain on potential vessel use and other (non-piling) sound producing activities for Mooir Vannin. The construction phase of MaresConnect is anticipated to begin in 2025 (MaresConnect, 2023), with the operations phase commencing in 2026. As such, it is likely that the construction of the MaresConnect will be completed prior to the commencement of construction activities at the Mona Offshore Wind Project. Maintenance of the cable during the operations and maintenance typically involves considerably fewer vessels and round trips compared to construction. Therefore, it is anticipated that these will not add substantially to the number of vessels present during the construction of the Mona Offshore Wind Project and that the potential for cumulative effects is unlikely.

4.11.6.44 With standard industry measures in place to reduce the risk of collision, the impact is predicted to be of limited spatial extent, medium term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of the receptor

4.11.6.45 The sensitivity of marine mammals to collision risk is as described in paragraph 4.11.6.7.

4.11.6.46 All marine mammals, which are deemed to have some tolerance, medium recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

4.11.6.47 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.6.48 The operations and maintenance phase of the Mona Offshore Wind Project, together with operations and maintenance phases of Tier 1 and Tier 2 projects as well as operations and maintenance phases of Tier 3 projects(Table 4.50) may lead to potential cumulative impacts on marine mammals from collisions with vessels.

Magnitude of impact

4.11.6.49 Tier 3 projects are in a pre-application phase and no Environmental Statement is available to inform a quantitative assessment. Therefore, a qualitative assessment is provided below.

4.11.6.50 As described in paragraph 4.11.5.58, maintenance of cable or offshore wind farm typically involves considerably smaller numbers of vessels and round trips compared to construction. Considering the vessel activity within the Irish Sea, it is anticipated that these will not add substantially to the number of vessels present during the operations and maintenance phases of the Mona Offshore Wind Project, Tier 1 and Tier 2 projects and that the potential for cumulative effects is unlikely.

4.11.6.51 With standard industry measures in place to reduce the risk of collision, the impact is predicted to be of limited spatial extent, long term duration, intermittent and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be **low**.

Sensitivity of the receptor

4.11.6.52 The sensitivity of marine mammals to collision risk is as described in paragraph 4.11.6.7.

4.11.6.53 All marine mammals, which are deemed to have some tolerance, medium recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

4.11.6.54 Overall, the magnitude of the impact is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the international value of these species. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.11.7 Effects on marine mammals due to changes in prey availability

4.11.7.1 Potential impacts on fish and shellfish receptors have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, and therefore a brief overview of potential impacts on marine mammals due to changes in prey availability, and a summary of magnitude, sensitivity and significance for each phase of the Mona Offshore Wind Project is presented in section 4.9.9 and provided in paragraph 4.11.7.2.

Construction phase

Tier 1

4.11.7.2 Potential cumulative impacts from Tier 1 projects on marine mammal prey species during the construction phase of the Mona Offshore Wind Project have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement. The construction of the Mona Offshore Wind Project, together with activities at other offshore wind farms, dredging activities, aggregate extraction activities and cables and pipelines may lead to potential cumulative impacts on marine mammals as a result of changes to the fish and shellfish community.

Magnitude of impact

4.11.7.3 Potential cumulative impacts from Tier 1 projects on marine mammal prey species during the construction phase of the Mona Offshore Wind Project include temporary subtidal habitat loss, long term subtidal habitat loss, injury and disturbance from underwater sound, increased SSC and associated sediment deposition and colonisation of hard structures.

4.11.7.4 The cumulative temporary habitat loss and disturbance across all Tier 1 plans, projects, and activities assessed in the cumulative Fish and Shellfish study area (for more details see Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement) including the Mona Offshore Wind Project, was estimated at a maximum of 96.51 km^2. The significance for temporary habitat loss on fish and shellfish was assessed as minor adverse significance, and therefore is unlikely to result in changes in prey availability in marine mammals.

4.11.7.5 The planned construction of the Tier 1 projects alongside the Mona Offshore Wind Project will introduce up to 3.32 km^2 of permanent hard structures which will act to represent a cumulative long term habitat loss impact alongside the Mona Offshore Wind Project. This will act alongside the 1.07 km^2 of hard structures introduced by the Mona Offshore Wind Project to represent a potential cumulative long term habitat loss of up to approximately 3.32 km^2. Given that the construction phase will take place over four years, colonisation of hard structures may commence within that period and continue throughout the operations and maintenance phase. The significance of long-term habitat loss for fish and shellfish has been assessed as minor adverse, and therefore resulting effects due to prey availability on marine mammals are minimal.

4.11.7.6 The construction phase of the Awel y Môr Offshore Wind Farm will have temporal and spatial overlap with the Mona Offshore Wind Project in terms of sound from construction activities and may impact fish and shellfish (noting that for these receptors the cumulative study area is smaller than the marine mammal cumulative study area). During piling at the Awel y Môr Offshore Wind Farm injury and mortality for group 2 (salmonids and some Scombridae) and 3 (gadoids and eels) fish may occur out to 1,300 m and 8,600 m (if modelled as static receptors), from the array area respectively. However, sound modelling with inclusion of a moving away response, significantly reduced mortality distances to less than 100 m for all groups. The Awel y Môr Offshore Wind Farm indicated behavioural effects to similar ranges as those predicted for the Mona Offshore Wind Project, at a range of approximately up to tens of kilometres from the piling location at the maximum hammer energies. For fish and shellfish ecology

IEFs the cumulative effect was minor adverse significance. For herring, there was no overlap between sound contours from Awel y Môr and key spawning habitats for this species in the Irish Sea, and a minor adverse significance was given in Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement for this species. However, Awel y Môr and the Mona Offshore Wind Project sit across areas of mapped high and low intensity cod spawning grounds. As detailed in Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement, if piling were to occur concurrently at the two projects, a magnitude of medium was given for cod, leading to a moderate adverse significance. Since cumulative effects of piling may also lead to changes in the distribution of marine mammals (section 4.11.2), it is likely that marine mammals will be displaced from the same or greater area as for their prey species.

4.11.7.7 Seabed preparation and installation of foundations and cables for the Mona Offshore Wind Project alongside Tier 1 projects may increase SSC and associated sediment deposition. As discussed in detail in Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement, resultant plumes from aggregate extraction or dredging would be advected on the tidal currents, travel in parallel, and not towards one another, and are unlikely to interact. Given that the Mona Offshore Cable Corridor and Access Areas runs adjacent to the Awel y Môr array area, interaction of SSC plumes on spring tide events may occur, should trenching activities be undertaken simultaneously, although this is unlikely, the cumulative significance of the effect on fish and shellfish receptors as a result of SSC was estimated as minor adverse and therefore this is unlikely to impact marine mammals.

4.11.7.8 The temporal overlap between Tier 1 projects will result in a cumulative increase in the introduction of similar new hard structures. Potential adverse/beneficial effects on fish and shellfish would be localised due to the relatively small area of new hard structures introduced during this phase, compared to the wider CEA study area. As discussed in section 4.9.9, some increased foraging activities could benefit prey availability for marine mammals although this is unlikely to be at a scale that is measurable in terms of the populations within the wider region.

4.11.7.9 No significant adverse cumulative effects were predicted to occur to most fish and shellfish species (marine mammal prey) as a result of the construction of the Mona Offshore Wind Project in combination with Tier 1 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). For cod, there was a moderate adverse cumulative effect from underwater sound, noting it is proposed to manage and reduce the effect of this impact through establishment of an Underwater sound management strategy post-consent. As discussed in paragraph 4.9.9.11 for the project alone, all marine mammals in this assessment are considered to be generalist opportunistic feeders and are thus not reliant on a single prey species. Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, intermittent/continuous and high reversibility. The magnitude was therefore, considered to be **low.**

Sensitivity of the receptor

4.11.7.10 The sensitivity of marine mammals to changes in prey availability was as described in paragraph 4.9.9.14 for Mona Offshore Wind Project alone.

4.11.7.11 Most of the marine mammals within the regional marine mammal study area are known to forage over wide areas and exploit a range of prey species. For example, as described in more detail in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement, a study of the stomach contents of 12 bottlenose dolphin in Irish waters gave total of 37 prey taxa, suggesting that they have a broad diet. For most marine mammals, the type of food taken depends on local availability and seasonal variations. Therefore, whilst there may be some potential for cumulative effects to fish and shellfish communities, these effects will be highly localised and short term and therefore marine mammals are likely to be able to compensate and move to alternative foraging grounds.

4.11.7.12 In the Irish sea, herring is an important prey species for harbour porpoise, short-beaked common dolphin, harbour seal and the key prey item for minke whale (see Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement for more detailed account for marine mammal diet), and therefore any potential significant impacts on herring may impact these predators. Sprat and sandeel are also a part of marine mammal diet (especially for harbour porpoise, minke whale, grey seal and harbour seal). As described above, most species of marine mammal prey on a wide variety of fish species and therefore are likely to be able to adapt to a minor shift in availability of some prey items. Nevertheless, minke whale may be more sensitive than other marine mammal species to changes in prey resources due to their reliance on herring, sprat and sandeel as a primary food source in the Irish Sea.

4.11.7.13 As mentioned for the Mona Offshore Wind Project alone in paragraph 4.9.9.26, following placement on the seabed, submerged parts of the wind turbines provide hard substrate for the colonisation by high diversity and biomass in the flora and fauna. Higher trophic levels, such as fish and marine mammals, are likely to profit from locally increased food availability and/or shelter and therefore have the potential to be attracted to forage within Tier 1 offshore wind project array areas. Although species such as harbour porpoise, minke whale, white-beaked dolphin, harbour seal and grey seal were frequently recorded around offshore oil and gas structures, still relatively little is known about the distribution and diversity of marine mammals around offshore anthropogenic structures.

4.11.7.14 Most marine mammals, except for minke whale, are deemed to be able to tolerate changes in prey availability, have high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **low**.

4.11.7.15 For minke whale, due to their reliance on herring, sprat and sandeel as a primary food source in the Irish Sea, they are deemed have some tolerance to changes in prey availability, have high recoverability and international value. The sensitivity of the receptor is therefore considered to be **medium.**

Significance of effect

4.11.7.16 Overall, the cumulative magnitude of the impact is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.7.17 Potential cumulative impacts from Tier 1 projects on marine mammal prey species during the operations and maintenance phase of the Mona Offshore Wind Project have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. The operations and maintenance of the Mona Offshore Wind Project, together with activities at other offshore wind farms may lead to potential cumulative impacts on marine mammals from changes in prey availability as a result of changes to the fish and shellfish community.

Magnitude of impact

4.11.7.18 Potential cumulative effects on marine mammal prey species during the operations and maintenance phase of the Mona Offshore Wind Project include long term subtidal habitat loss, EMF from subsea electrical cables and colonisation of hard structures.

4.11.7.19 In terms of long term habitat loss, the effects on fish and shellfish receptors arising during operations and maintenance activities of the Awel y Môr Offshore Wind Farm and the Mona Offshore Wind Project are likely to be very localised as described for the construction phase (paragraph 4.11.7.9). The significance of long-term habitat loss for fish and shellfish has been assessed as minor adverse. Long-term habitat loss and associated colonisation expected for the operations and maintenance phase are the key effects but these are unlikely to contribute to any measurable effects at a population level for marine mammals IEFs.

4.11.7.20 Potential cumulative impacts from EMF associated with the Tier 1 Awel y Môr Offshore Wind Farm will originate from the project's inter-array, interconnector, and offshore export cables, which have the potential for creating a cumulative impact with the cables of the Mona Offshore Wind Project. The minimum burial depth for cables for the Awel y Môr Offshore Wind Farm is expected to be 1 m, likely limiting EMF to a range of up to 10 m from the cable (RWE, 2022).

4.11.7.21 No significant adverse cumulative effects were predicted to occur to fish and shellfish species (marine mammal prey) as a result of the operations and maintenance of the Mona Offshore Wind Project in combination with Tier 1 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). Whilst most potential impacts are considered to be adverse there is the potential for some beneficial effects with respect to introduction of hard substrate which could increase prey availability for some species. Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, continuous and high reversibility. The magnitude was therefore, considered to be **low.**

Sensitivity of the receptor

4.11.7.22 Overall, the sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase in paragraph 4.11.7.10.

4.11.7.23 The sensitivity of the receptor is therefore, considered to be **low to medium.**

Significance of effect

4.11.7.24 Overall, the cumulative magnitude of the potential impacts is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Tier 2

Construction phase

4.11.7.25 Potential cumulative effects from Tier 2 projects on marine mammal prey species during the construction phase of the Mona Offshore Wind Project have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. The construction of the Mona Offshore Wind Project, together with the construction of the Tier 1 and Tier 2 projects identified (including Morgan Generation Assets, Morecambe Offshore Wind Farm Generation Assets, Morgan and Morecambe Offshore Wind Farms: Transmission Assets and ENI HyNet CCS project) (Volume 2, Chapter 3: Fish and shellfish of the Environmental Statement may lead to potential cumulative impacts on marine mammals from changes in prey availability as a result of changes to the fish and shellfish community.

Magnitude of impact

4.11.7.26 Potential cumulative effects from Tier 2 projects on marine mammal prey species during the construction phase of the Mona Offshore Wind Project include temporary and long term habitat loss, injury and disturbance from underwater sound, increased SSC and associated sediment deposition and colonisation of hard structures.

4.11.7.27 The temporary habitat disturbance and long-term habitat loss predicted to result from the Morgan Generation Assets during the construction phase is up to 85.54 km^2 and 1.52 km^2, respectively (Morgan Offshore Wind Project Ltd, 2023). The area available for colonisation for Morgan Generation Assets was estimated as up to 1.99 km^2 (Morgan Offshore Wind Project Ltd, 2023). The increases in SSC and sediment deposition predicted to result from the Morgan Generation Assets are similar to those reported for Mona Offshore Wind Project.

4.11.7.28 For Morecambe Offshore Windfarm Generation Assets and Morgan and Morecambe Offshore Wind Farms: Transmission Assets projects, temporary habitat loss is likely to result from site preparation activities in advance of installation activities, cable installation activities and placement of spud-can legs from jack-up operations. Installation of foundation structures, associated scour protection and cable protection is likely to result in long term habitat loss and provide a hard substrate for colonisation. The temporary habitat disturbance/loss predicted to result from the Morecambe Offshore Windfarm Generation Assets is up to 3.46 km^2 (Morecambe Offshore Windfarm Ltd., 2023). Increased SSC and sediment deposition is likely to occur from site preparation activities including sandwave clearance, drilling for foundation installation, and cable installation and burial activities.

4.11.7.29 For Transmission Assets, temporary habitat disturbance/loss is likely to result from jack-up events, cable installation, sandwave clearance, anchor placement and cable removal, with temporary disturbance/loss predicted to result from the Transmission Assets is up to 64.03 km^2.

4.11.7.30 Tier 1 and Tier 2 projects and the Mona Offshore Wind Project sit across areas of mapped high and low intensity cod spawning ground and therefore Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement assessed a magnitude of medium for cod for Tier 1 and Tier 2 projects. For herring, behavioural effects may overlap with mapped high and low intensity herring spawning grounds located off the east coast of the IoM at Douglas Bank from Tier 1 and Tier 2 projects, and therefore a magnitude of medium was given. Therefore, a moderate adverse significance was given for cod and herring in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement.

4.11.7.31 As assessed for Tier 1 projects in paragraph 4.11.7.3, with respect to indirect effects on marine mammals, no additional cumulative effects other than those assessed for injury and disturbance to marine mammals as a result of elevated underwater sound during piling (section 4.11.2) are predicted. This is because if prey are disturbed from an area as a result of underwater sound, it is assumed that marine mammals are likely to be disturbed from the same or greater area, and so any changes to the distribution of prey resources would not affect marine mammals as they would already be disturbed from the same (or larger) area..

4.11.7.32 No significant adverse cumulative effects were predicted to occur to most fish and shellfish species (marine mammal prey) as a result of the construction of the Mona Offshore Wind Project in combination with Tier 1 and Tier 2 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). For cod and herring, there was a moderate adverse cumulative Beffect from underwater sound, noting it is proposed to manage and reduce the effect of this impact through establishment of an Underwater sound management strategy post-consent. Furthermore, as discussed in paragraph 4.9.9.11 for the project alone, all marine mammals in this assessment are considered to be generalist opportunistic feeders and are thus not reliant on a single prey species. Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, intermittent/continuous and high reversibility. The magnitude was therefore, considered to be **low**.

Sensitivity of the receptor

4.11.7.33 The sensitivity of marine mammals to changes in prey availability was as described in paragraph 4.11.7.10 for Tier 1 projects.

4.11.7.34 The sensitivity of the receptor is therefore, considered to be **low to medium.**

Significance of effect

4.11.7.35 Overall, the cumulative magnitude of the potential impacts is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.7.36 Potential cumulative effects from Tier 2 projects on marine mammal prey species during the operations and maintenance phase of the Mona Offshore Wind Project have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement. The operations and maintenance of the Mona Offshore Wind Project, together with the activities at Tier 1 wind farms and operations and maintenance phases of the Tier 2 projects -Morecambe Offshore Windfarm Generation Assets, Morgan and Morecambe Offshore Windfarms Transmission Assets, Morgan Offshore Wind Project Generation Assets: Transmission Assets may lead to potential cumulative impacts on marine mammals from changes in prey availability as a result of changes to the fish and shellfish community.

Magnitude of impact

4.11.7.37 Potential cumulative effects from Tier 2 projects on marine mammal prey species during the operations and maintenance phase of the Mona Offshore Wind Project include long term subtidal habitat loss, EMF from subsea electrical cabling and colonisation of hard structures.

4.11.7.38 The long-term habitat loss predicted to result from the Morgan Generation Assets during operations and maintenance phase is up 1.52 km^2 (Morgan Offshore Wind Project Ltd, 2023). The area available for colonisation for Morgan Generation Assets was estimated as up to 1.99 km^2 (Morgan Offshore Wind Project Ltd, 2023). In terms of potential impacts as a result of EMF for Morgan Generation Assets, these are likely to result from the operation of the 450 km and 500 km of 66 kV to 132 kV inter-array cables respectively, and up to 60 km of 275 kV High Voltage Alternating Current

(HVAC) interconnector cable. Due to similar sizes and extents to the Mona Offshore Wind Farm Project, the effects of EMFs are likely to be similar.

4.11.7.39 At the time of writing, no detailed information was available for the extent or magnitude of the potential impacts listed above associated with the Morecambe Offshore Windfarm Generation Assets and the Morgan and Morecambe Offshore Wind Farms: Transmission Assets. Therefore, it is not possible to undertake full, quantitative assessment for these potential impacts and a summary of qualitative assessment is provided below.

4.11.7.40 Presence of foundation structures, associated scour protection and cable protection is likely to result in long term habitat loss for fish species but also provide a hard substrate for colonisation. The potential maximum EMF impacts associated with the Morecambe Offshore Windfarm Generation Assets, Transmission Assets and Morgan Offshore Wind Project Generation Assets projects will originate from the inter-array and interconnector cables and may impact prey sources themselves for marine mammals, however the magnitude is likely to be low for fish and shellfish species and therefore is unlikely to affect marine mammals in the context of their wider available foraging habitat.

4.11.7.41 No significant adverse cumulative effects were predicted to occur to fish and shellfish species (marine mammal prey) as a result of the operations and maintenance of the Mona Offshore Wind Project in combination with Tier 1 and Tier 2 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). Whilst most potential impacts are considered to be adverse there is the potential for some beneficial effects with respect to introduction of hard substrate which could increase prey availability for some species. Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, continuous and high reversibility. The magnitude was therefore, considered to be **low**.

Sensitivity of the receptor

4.11.7.42 Overall, the sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase described for Tier 1 projects in paragraph 4.11.7.10.

4.11.7.43 The sensitivity of the receptor is therefore, considered to be **low to medium.**

Significance of effect

4.11.7.44 Overall, the cumulative magnitude of the potential impacts is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Decommissioning phase

4.11.7.45 Potential cumulative effects on marine mammal prey species during the decommissioning of the Mona Offshore Wind Project have been assessed in Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement. The decommissioning of the Tier 2 projects -Morecambe Offshore Windfarm Generation Assets, Morgan and Transmission Assets and Morgan Offshore Wind Project Generation Assets will likely have temporal overlap with the decommissioning of the Mona Offshore Wind Project (Table 4.51), which may lead to potential cumulative impacts on marine mammals from changes in prey availability as a result of changes to the fish and shellfish community.

Magnitude of effect

4.11.7.46 Potential cumulative effects on marine mammal prey species during the decommissioning of the Mona Offshore Wind Project include temporary subtidal habitat loss, long term subtidal habitat loss, increased SSC and associated sediment deposition and colonisation of hard structures.

4.11.7.47 The temporary habitat disturbance and long-term habitat loss predicted to result from the Morgan Generation Assets during decommissioning phase is up to 0.47 km^2 and 1.46 km^2, respectively (Morgan Offshore Wind Project Ltd, 2023). The expected magnitude of the colonisation of hard structures and SSC will be similar or less to the construction and operations and maintenance phases, due to the leaving in place of scour protection, and cable protection, with no associated sediment clearance or drilling required.

4.11.7.48 At the time of writing, no detailed information was available for the extent or magnitude of potential impacts listed above associated with the Morecambe Offshore Windfarm Generation Assets and the Morgan and Morecambe Offshore Wind Farms: Transmission Assets. Therefore, it is not possible to undertake full, quantitative assessment for these potential impacts and a summary of qualitative assessment is provided below.

4.11.7.49 For Morecambe Offshore Windfarm Generation Assets and the Morgan and Morecambe Offshore Wind Farms: Transmission Assets, the expected cumulative magnitude of temporary habitat loss, long term habitat loss, increased SSC and associated sediment deposition and colonisation of hard structures during decommissioning is expected to be similar or less than the construction phase provided in paragraph 4.11.7.3.

4.11.7.50 No significant adverse cumulative effects were predicted to occur to fish and shellfish species (marine mammal prey) as a result of the decommissioning of the Mona Offshore Wind Project in combination with Tier 1 and Tier 2 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). Whilst most potential impacts are considered to be adverse there is the potential for some beneficial effects with respect to introduction of hard substrate which could increase prey availability for some species. Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, intermittent/continuous and high reversibility. The magnitude was therefore, considered to be **low**.

Sensitivity of the receptor

4.11.7.51 Overall, the sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase described for Tier 1 projects in paragraph 4.11.7.10.

4.11.7.52 The sensitivity of the receptor is therefore, considered to be **low to medium.**

Significance of effect

4.11.7.53 Overall, the cumulative magnitude of the potential impacts is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Tier 3

Construction phase

4.11.7.54 The construction of the Mona Offshore Wind Project, together with Tier 1 and Tier 2 projects as well as the Tier 3 projects may lead to potential cumulative impacts on marine mammals from changes in prey availability as a result of changes to the fish and shellfish community (Volume 2, Chapter 3: Fish and shellfish ecology of Environmental Statement).

Magnitude of impact

4.11.7.55 Potential cumulative effects from Tier 3 project on marine mammal prey species during the construction phase of the Mona Offshore Wind Project include temporary subtidal habitat loss, long term subtidal habitat loss, increased SSC and associated sediment deposition and colonisation of hard structures.

4.11.7.56 The laying and burying of the MaresConnect Interconnector cable may involve introduction of cable protection (assumed as the MDS) which will represent long term habitat loss and will likely follow standard jet trenching and cable protection installation, causing temporary habitat disturbance, although technical specifications will only be released at later development stages. Although no exact specifications are publicly available for the area for potential colonisation, it is expected that the cable protection will only represent a small increase of introduced hard structures and so will have only a minor cumulative impact. The likely jet trenching activities for the laying and burying of the cables for both projects will run concurrently and interaction of SSC plumes on spring tide events may occur. However, given the project is predicted to be operational in 2026, there is unlikely to be any overlap with Mona Offshore Wind Project construction phase and therefore there is a no potential for cumulative effects on marine mammal prey species.

4.11.7.57 No significant adverse cumulative effects were predicted to occur to fish and shellfish species (marine mammal prey) as a result of the construction of the Mona Offshore Wind Project in combination with Tier 1, Tier 2 and Tier 3 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, intermittent/continuous and high reversibility. The magnitude was therefore, considered to be **low**.

Sensitivity of the receptor

4.11.7.58 The sensitivity of marine mammals to changes in prey availability was as described in paragraph 4.11.7.10 for Tier 1 projects.

4.11.7.59 The sensitivity of the receptor is therefore, considered to be **low to medium.**

Significance of effect

4.11.7.60 Overall, the cumulative magnitude of the potential impacts is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operations and maintenance phase

4.11.7.61 The operations and maintenance of the Mona Offshore Wind Project, together with Tier 1 and Tier 2 projects as well as the Tier 3 projects, may lead to potential cumulative impacts on marine mammals from changes in prey availability as a result of changes to the fish and shellfish community (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement).

Magnitude of impact

4.11.7.62 Potential cumulative effects from Tier 3 projects on marine mammal prey species during the operations and maintenance phase of the Mona Offshore Wind Project include long term subtidal habitat loss, EMF from subsea electrical cabling and colonisation of hard structures.

4.11.7.63 The proposed operations and maintenance phase of the MaresConnect Wales-Ireland Interconnector Cable will likely overlap with the operations and maintenance phase of the Mona Offshore Wind Project, leading to a potential cumulative impact. At the time of writing, no specifications are publicly available. The anticipated operational lifetime is expected to start in 2026.

4.11.7.64 The installation of electrical cables is likely to involve introduction of cable protection which will represent long term habitat loss and areas available for colonisation. It is expected that the cable protection will only represent a small increase of introduced hard structures proportional to the entire CEA fish and shellfish ecology study area, and so will have only a minor cumulative impact. Effects of EMF on fish and shellfish receptors are expected to be small and limited to directly around the cable.

4.11.7.65 No significant adverse cumulative effects were predicted to occur to fish and shellfish species (marine mammal prey) as a result of the operations and maintenance of the Mona Offshore Wind Project in combination with Tier 1, Tier 2 and Tier 3 projects (Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement). Whilst most potential impacts are considered to be adverse there is the potential for some beneficial effects with respect to introduction of hard substrate which could increase prey availability for some species. Therefore, changes in prey availability on marine mammals were predicted to be of local spatial extent, medium-term duration, continuous and high reversibility. The magnitude was therefore, considered to be **low**.

Sensitivity of the receptor

4.11.7.66 Overall, the sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the sensitivity of the receptors during the construction phase described for Tier 1 projects in paragraph 4.11.7.10.

4.11.7.67 The sensitivity of the receptor is therefore, considered to be **low to medium.**

Significance of effect

4.11.7.68 Overall, the cumulative magnitude of the potential impacts is deemed to be **low** for all species**,** and the sensitivity of the receptor is considered to be **low** for all species except minke whale, which is **medium**. There would be no change to the international value of these species. Taking into account the medium sensitivity of minke whale to changes in herring, sprat and sandeel stocks, the cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

4.12 Future monitoring

4.12.1.1 No marine mammal monitoring to test the predictions made within the impact assessment is considered necessary.

4.13 Transboundary effects

4.13.1.1 A screening of potential transboundary impacts has been carried out and has identified that there was potential for significant transboundary effects with regard to marine mammals from the Mona Offshore Wind Project upon the interests of other states. This was due to the highly mobile nature of marine mammal species.

4.13.1.2 Screening of transboundary effects are given in Volume 5, Chapter 5.2: Transboundary impacts screening of the Environmental Statement. Potential transboundary effects could occur where elevations in underwater sound, particularly during construction piling, could ensonify large areas causing wide-ranging disturbance of marine mammals. The underwater sound disturbance contours predicted for piling extended across the Irish Sea and therefore animals transiting between these waters could be behaviourally disturbed across different states. The assessment of the Mona Offshore Wind Project alone considered the effects on marine mammal populations within relevant MUs which covered, at a minimum, the population within the Irish Sea and therefore in this respect captures the effects at transboundary level. Although, it is noted that these are not closed populations and there is likely to be mixing of individuals between other MUs. The assessment concluded that disturbance could occur intermittently during piling within the two year piling phase and the magnitude for the project alone was considered to be low. Sensitivity of marine mammal IEFs to disturbance was assessed as medium. Therefore, the significance of disturbance from piling at a transboundary level is considered to be minor adverse which is not significant in terms of EIA Regulations.

4.13.1.3 UXO clearance could also lead to large ranges over which elevations in underwater sound occur where there is high order detonation of the largest charge size. For example, injury in the form of PTS was predicted up to 15.3 km (for harbour porpoise) whist a moving away response, using the TTS metric, was predicted up to 34.36 km (for minke whale). Ranges of this extent could therefore affect individuals transiting between transboundary nations. These predictions are, however, highly precautionary since the low order clearance techniques may be used, which would considerably reduce the potential injury and/or disturbance ranges. For injury, also tertiary mitigation measures will be applied to reduce the risk of PTS (see Table 4.17) and with these in place the assessment concluded the magnitude for the project alone for most species, with respect to the relevant MUs, would be negligible. For harbour porpoise, there may be a risk of PTS from high order clearance, and therefore the magnitude was medium for this species only. Marine mammals are considered to be of high sensitivity to PTS and therefore the significance of effects for PTS and TTS for all species (except harbour porpoise) are of minor adverse significance. For harbour porpoise, the significance of effects for PTS was of moderate adverse significance which is significant in EIA terms. Therefore, the significance of both auditory injury and disturbance from UXO clearance at a transboundary level is considered to be minor adverse for all species, except harbour porpoise, which is not significant in terms of EIA Regulations. For harbour porpoise, as there is a potential significant effect from UXO clearance. However, it must be noted that the project has committed to the development of an Underwater sound management strategy (Document Reference J16) to reduce the magnitude of underwater sound levels associated with residual significant potential impacts from the project, to a non-significant level, and therefore any potential transboundary level impact will be reduced. Therefore, the significance of injury from UXO clearance at a transboundary level is considered to be minor adverse with the application of tertiary mitigation (Table 4.17, with further detail in the MMMP (Document Reference J21)) and the Outline underwater sound management strategy (Document Reference J16), which is not significant in terms of EIA Regulations.

4.13.1.4 Geophysical and geotechnical surveys, vessel use and other (non-piling) (sound producing activities could also lead to large disturbance ranges. For vibro-coring, the range of disturbance could extend out to 72 km and for SBP (chirp/pinger) disturbance could extend out to 17.3 km (all species). Ranges of this extent could therefore affect individuals transiting between transboundary nations. For vessels such as survey and support vessels, crew transfer vessels, and installation vessels the range of disturbance could extend out to 23 km and for cable trenching the range of disturbance could extend out to 20 km. These predictions are, however, highly precautionary since the modelled ranges represent the distance beyond which no animals would be disturbed. Given that ranges for disturbance for non-impulsive sound sources are presented up to the 120 dB re 1 µPa (rms) threshold, and there is only a single available threshold (120 dB re 1 µPa (rms)), (the Level B harassment threshold) (NMFS, 2005), (no distinction between mild and strong disturbance), it can be assumed that not all animals found within those ranges would be disturbed at the same level. Moreover, for those animals disturbed, there is likely to be a proportional response (i.e. not all animals will be disturbed to the same extent). The assessment concluded the magnitude for the project alone, with respect to the relevant MUs, would be low, and the significance of the effect to be of minor adverse significance. Therefore, the significance of disturbance from geophysical and geotechnical surveys at a transboundary level is considered to be minor adverse which is not significant in terms of EIA Regulations.

4.13.1.5 For other potential impacts, including elevated underwater sound from vessel use and other (non-piling) sound producing activities, increased likelihood of injury due to collision with vessels, changes in prey availability and operation related sound emissions, the effects on marine mammals were predicted to be very localised and are therefore considered unlikely to result in significant transboundary effects on marine mammal IEFs.

4.14 Inter-related effects

4.14.1.1 Inter-relationships are considered to be the potential impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Mona Offshore Wind Project (construction, operations and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases (e.g. underwater sound effects from piling, operations wind turbines, vessels and decommissioning)
- Receptor-led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on marine mammals, such as underwater sound from piling, UXO, or vessels, collision risk, changes in prey communities, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

4.14.1.2 A description of the likely interactive effects arising from the Mona Offshore Wind Project on marine mammals is provided in Volume 2, Chapter 11: Inter-related effects of the Environmental Statement.

4.14.1.3 For marine mammals, the following potential impacts have been considered within the inter-related assessment:

- Injury and disturbance from elevated underwater sound during piling
- Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys
- Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance
- Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities
- Increased potential to experience injury by marine mammals due to collision with vessels
- Changes in fish and shellfish communities affecting prey availability.

4.15 Summary of impacts, mitigation measures and monitoring

4.15.1.1 Information on marine mammals within the Mona marine mammals study area was collected through desktop review, site surveys and consultation with the EWG.

4.15.1.2 Table 4.65 presents a summary of the potential impacts, measures adopted as part of the project and residual effects in respect to marine mammals. The potential impacts assessed include:

- Injury and disturbance from elevated underwater sound during piling
- Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance
- Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities
- Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys
- Increased likelihood of injury of marine mammals due to collision with vessels
- Underwater sound from wind turbine operation
- Changes in fish and shellfish communities affecting prey availability.

4.15.1.3 Overall**, for most potential impacts** it is concluded that there will be **no significant effects** arising from the Mona Offshore Wind Project alone during the construction, operations and maintenance or decommissioning phases.

4.15.1.4 However, for harbour porpoise only, a **potential significant impact** was concluded for elevated underwater sound during **UXO clearance** when assessed using high order clearance of a 907 kg UXO (the absolute maximum). Therefore, whilst the assessment is based upon the absolute maximum UXO as per the MDS, it is acknowledged that this is very precautionary. Detailed surveys post-consent will inform the Mona Offshore Wind Project's understanding of the type and size of UXOs that require clearance and consequently the most appropriate method for clearance. There is a general hierarchy of preferred mitigation with regard to UXO: avoid UXO, clear UXO with low order techniques and then clear with high order techniques where low order is not possible (dependent upon the individual situations surrounding each UXO). The project has committed to the development of and adherence to a MMMP (Document Reference J21), which forms an annex to the Underwater sound management strategy (Document Reference J16) and both of which are secured within the deemed marine licence in Schedule 14 of the draft DCO and expected to be secured within the standalone NRW marine licence.

4.15.1.5 Specifically, the MMMP (Document Reference J21) will secure the primary and tertiary mitigation measures (e.g. low order clearance, use of ADDs and soft start charges), with an outline MMMP included as part of the application (Document Reference J21). The Outline underwater sound management strategy (Document Reference J16) establishes a process of investigating options to manage underwater sound levels in consultation with the licensing authority and SNCBs and agreeing, prior to construction of those works which would lead to underwater sound impacts, which mitigation measures will be implemented to reduce the magnitude of impacts such that there will be no residual significant effect for the project (such as from elevated underwater sound during UXO clearance). Whilst the focus is on harbour porpoise (as a significant effect was concluded for this species from elevated underwater sound during UXO clearance) these measures would also result in a reduction of underwater sound impacts to other marine mammal receptors.

4.15.1.6 Table 4.66 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The potential cumulative impacts assessed include:

- Injury and disturbance from underwater sound generated during piling
- Injury and disturbance from pre-construction site investigation surveys
- Injury and disturbance from underwater sound from UXO detonation
- Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities
- Injury due to increased likelihood of collision with vessels
- Effects on marine mammals due to changes in prey availability.

4.15.1.7 Overall it is concluded that **for most impacts** there will be **no significant cumulative effects** from the Mona Offshore Wind Project alongside other projects/plans, except as a result of **behavioural disturbance during piling** for **bottlenose dolphins** within the Irish Sea MU and **potential injury from UXO clearance** for **harbour porpoise,** which have a **significant cumulative effect**.

4.15.1.8 Cumulative impact of piling at projects across the Irish Sea could result in potential reductions to reproductive success during an animals lifetime to some individuals in the Irish Sea MU population, as disturbance in offshore areas during piling could lead to a longer duration over which individuals may be displaced from key feeding areas and therefore there may be a further reduction in the size of declining MU population. The assessment of cumulative effects from other plans and projects is based upon the respective MDSs presented in the Environmental Statements for Tier 1 projects or PEIR for Tier 2 Projects. The assessment does not consider any further mitigation or reduced/refined project design envelopes for other Tier 1 and/or Tier 2 projects that may be implemented post consent. However it is understood that if other projects are consented, they will each implement appropriate measures such that any significant effect is reduced to a non-significant level. Therefore whilst this assessment cannot conclude based upon this assumption, a significant cumulative impact is considered unlikely for this reason.

4.15.1.9 Whilst the project alone assessment determined there is no potential for a significant effect from elevated underwater sound during piling in EIA terms, it is acknowledged the project may contribute to the cumulative impact within the CEA area. As such an Outline underwater sound management strategy (Document Reference J16) has been submitted with the application for consent (alongside the Outline MMMP (Document Reference J21)). The Outline underwater sound management strategy (Document Reference J16) establishes a process for investigating options to manage underwater sound levels in consultation with NRW and SNCBs and agreeing, prior to construction of those works which would lead to underwater sound impacts, which mitigation measures will be implemented to reduce the magnitude of impacts such that there will be no residual significant effect for the project. The final Underwater sound management strategy (Document Reference J16) will set out the measures agreed with NRW and SNCBs to reduce sound levels associated with residual significant impacts from the project to a non-significant level, and to minimise the Mona Offshore Wind Project's contribution to any cumulative effect.

4.15.1.10 As a result of UXO clearance, on the basis of the MDS (absolute maximum 907 kg UXO) high order detonation, there may be some residual effect in-combination with other projects with a small number of animals potentially exposed to sound levels that could elicit PTS. However, the likelihood of UXO clearance being undertaken simultaneously with other projects is considered to be very low.

4.15.1.11 No potential for significant transboundary impacts has been identified for the Mona Offshore Wind Project.

Table 4.65: Summary of potential environmental effects, mitigation and monitoring.

[a] C=construction, O=operational and maintenance, D=decommissioning. Where the environmental effects are the same for all phases, they are not repeated.

Description of impact	Phase C	O	D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Injury and disturbance from elevated underwater sound during piling	✓	×	×	Implementation of initiation stage, soft start, ramp up (primary measures); use of MMO, PAM, ADD (tertiary measures). secured through the Outline MMMP	Harbour porpoise	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)	None	Minor adverse (injury/disturbance)	None.
					Bottlenose dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Minke whale	Low (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Grey seal	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Harbour seal	Negligible (injury) Negligible (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance	✓	×	×	Inclusion of low order techniques as a clearance option (primary measures); use of MMO, PAM, ADD and soft start charges (tertiary measures).	Harbour porpoise	Medium (injury)[4] Low (disturbance)	High (injury) Low (disturbance)	Moderate adverse (injury) Minor adverse (disturbance)	Further details on UXO requiring clearance will be available post consent. On the basis that details are not available at this time the residual effect remains the same, however, with appropriate measures as agreed in consultation with the licensing authority and SNCBs and secured for the DCO and NRW marine licence via the UWSMS, it is anticipated that the magnitude of effect would reduce.	Moderate adverse (injury) Minor adverse (disturbance)	None
					Bottlenose dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Minke whale	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Grey seal	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Harbour seal	Negligible (injury)	High (injury)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	

[4] Based on the absolute maximum UXO size of 907 kg, noting that for the most likely maximum UXO size of 130 kg, with project designed-in measures the risk of injury could be mitigated (see Outline MMMP Document Reference J21).

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
						Low (disturbance)	Low (disturbance)				
Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities	✓	✓	✓	Offshore Environmental Management Plan (EMP) with measures to minimise injury and disturbance to marine mammals from transiting vessels (tertiary measures).	Harbour porpoise	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)	None	Minor adverse (injury/disturbance)	None
					Bottlenose dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Minke whale	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Grey seal	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	
					Harbour seal	Negligible (injury)	High (injury) Medium (disturbance)	Minor adverse (injury/disturbance)		Minor adverse (injury/disturbance)	

Description of impact	Phase C	O	D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
						Low (disturbance)					
Increased likelihood of injury of marine mammals due to collision with vessels	✓	✓	✓	Offshore EMP with measures to minimise disturbance to marine mammals from transiting vessels (tertiary measures).	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys	✓	×	×	Implementation of soft start and ramp up where possible (primary measures), use of MMO, PAM, (tertiary measures).	Harbour porpoise	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Minke whale	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Grey seal	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Harbour seal	Negligible (injury) Low (disturbance)	High (injury) Medium (behaviour)	Minor adverse		Minor adverse	
Underwater sound from wind turbine operation	×	✓	×	None.	Harbour porpoise	Negligible (injury) Low (disturbance	High (injury) Medium (disturbance)	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Negligible (injury) Low (disturbance	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Minke whale	Negligible (injury) Low (disturbance	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Grey seal	Negligible (injury) Low (disturbance	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
					Harbour seal	Negligible (injury) Low (disturbance	High (injury) Medium (disturbance)	Minor adverse		Minor adverse	
Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	None.	Harbour porpoise	Low	Low	Minor adverse	None.	Minor adverse	None
					Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Low	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Low	Minor adverse		Minor adverse	
					Minke whale	Low	Medium (for construction only)	Minor adverse		Minor adverse	

Description of impact	Phase			Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D								
					Grey seal	Low	Low	Minor adverse		Minor adverse	
					Harbour seal	Low	Low	Minor adverse		Minor adverse	

Table 4.66: Summary of potential cumulative environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase			Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D								
Tier 1											
Injury and disturbance from elevated underwater sound during piling	✓	×	×	Implementation of initiation stage, soft start, ramp up, (primary measures); use of MMO, PAM, ADD (tertiary measures).	Harbour porpoise	Low	Medium	Minor adverse	The Underwater sound management strategy (with Outline underwater sound management strategy included as part of the application, Document Reference J16) will reduce the Mona Offshore Wind Project's contributions to the cumulative assessment, if required post consent. Requirements for management measures and mitigation will be discussed in consultation with the licensing authority and SNCBs.	Minor adverse	None
					Bottlenose dolphin	Medium (in context of Irish Sea MU)	Medium	Moderate Adverse		Moderate Adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	O	D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance	✓	×	×	Inclusion of low order techniques as a clearance option (primary measures); use of MMO, PAM, ADD and soft start charges (tertiary measures).	Harbour porpoise	Medium (injury) Low (disturbance)	High (injury) Low (disturbance)	Moderate adverse	Further details on UXO requiring clearance will be available post consent. On basis that details are not available at this time the residual effect remains the same, however, with appropriate measures as agreed in consultation with the licensing authority and SNCBs and secured for the DCO and NRW marine licence via the UWSMS it is anticipated that the magnitude of effect would reduce for the project alone and therefore reduce the cumulative effect.	Moderate adverse	None
					Bottlenose dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Minke whale	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Grey seal	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
Injury and disturbance to marine mammals from elevated underwater sound	✓	✓	×	Offshore EMP with measures to minimise injury and disturbance to marine	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
due to vessel use and other (non-piling) sound producing activities				mammals from transiting vessels (tertiary measures).	Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Increased risk of injury of marine mammals due to collision with vessels	✓	✓	×	Offshore EMP with measures to minimise injury to marine mammals from transiting vessels (tertiary measures).	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	None.	Harbour porpoise	Low	Low	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Low	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Low	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Low	Minor adverse		Minor adverse	
					Harbour seal	Low	Low	Minor adverse		Minor adverse	
Tier 2											
Injury and disturbance from elevated underwater sound during piling	✓	×	×	Implementation of initiation stage, soft start, ramp up, (primary measures); use of MMO, PAM, ADD (tertiary measures).	Harbour porpoise	Low	Medium	Minor adverse	The Underwater sound management strategy (with Outline underwater sound management strategy included as part of the application, Document Reference J16) will reduce the project alone contributions to the cumulative assessment if required post consent.	Minor adverse	None
					Bottlenose dolphin	Medium (Irish Sea MU)	Medium	Moderate Adverse		Moderate Adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
					Minke whale	Low	Medium	Minor adverse	Requirements for management measures and mitigation will be agreed in consultation with the licensing authority and SNCBs post consent.	Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance	✓	×	×	Inclusion of low order techniques as a clearance option (primary measures); use of MMO, PAM, ADD and soft start charges (tertiary measures).	Harbour porpoise	Medium (injury) Low (disturbance)	High (injury) Low (disturbance)	Moderate Adverse	Further details on UXO requiring clearance will be available post consent. On basis that details are not available at this time the residual effect remains the same, however, with appropriate measures as agreed with in consultation with the licensing authority and SNCBs, and secured for the DCO and NRW marine licence via the UWSMS it is anticipated that the magnitude of effect would reduce for the project alone and therefore reduce the cumulative effect.	Minor adverse	None
					Bottlenose dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Risso's dolphin	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Minke whale	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
					Grey seal	Negligible (injury)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
						Low (disturbance)					
					Harbour seal	Negligible (injury) Low (disturbance)	High (injury) Low (disturbance)	Minor adverse		Minor adverse	
Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities	✓	✓	×	Offshore EMP with measures to minimise injury and disturbance to marine mammals from transiting vessels.	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Increased likelihood of injury of marine mammals due to	✓	✓	✓	Offshore EMP with measures to minimise injury to marine mammals	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
collision with vessels				from transiting vessels.	Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Injury and disturbance from pre-construction site-investigation surveys	✓	×	×	Implementation of soft start and ramp up where possible (primary measures), use of MMO and PAM (tertiary measures).	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	O	D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	None.	Harbour porpoise	Low	Low	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Low	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Low	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Low	Minor adverse		Minor adverse	
					Harbour seal	Low	Low	Minor adverse		Minor adverse	
Tier 3											
Increased likelihood of injury of marine mammals due to collision with vessels	✓	✓	×	Offshore EMP with measures to minimise injury to marine mammals from transiting vessels.	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	

Description of impact	Phase C	O	D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other (non-piling) sound producing activities	✓	✓	×	Offshore EMP with measures to minimise injury and disturbance to marine mammals from transiting vessels (tertiary measures).	Harbour porpoise	Low	Medium	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Medium	Minor adverse		Minor adverse	
					Short-beaked common dolphin	Low	Medium	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Medium	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Medium	Minor adverse		Minor adverse	
					Harbour seal	Low	Medium	Minor adverse		Minor adverse	
Changes in fish and shellfish communities	✓	✓	✓	None.	Harbour porpoise	Low	Low	Minor adverse	None	Minor adverse	None
					Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse	

Description of impact	Phase C	Phase O	Phase D	Measures adopted as part of the project	Species	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
affecting prey availability					Short-beaked common dolphin	Low	Low	Minor adverse		Minor adverse	
					Risso's dolphin	Low	Low	Minor adverse		Minor adverse	
					Minke whale	Low	Medium	Minor adverse		Minor adverse	
					Grey seal	Low	Low	Minor adverse		Minor adverse	
					Harbour seal	Low	Low	Minor adverse		Minor adverse	

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Appendix A. Marine Mammal population modelling report

A.1. Introduction

A.1.1 Overview

A.1.1.1.1 An EIA has been carried out to determine the potential effects of the Mona Offshore Wind Project on sensitive marine mammal receptors from a range of different potential impacts. A key impact assessed is the potential for elevations in underwater sound during piling to lead to injury and behavioural/or disturbance to individual marine mammals.

A.1.1.1.2 Underwater sound modelling was undertaken to predict the potential spatial scale of the impact for piling associated with the installation of three foundation types for up to 74 wind turbines (including up to 10 GBF with ground strengthening pin piles) and four OSPs (see Volume 1, Chapter 3: Project Description of the Environmental Statement).

A.1.1.1.3 Across the three foundation types, one pile type, pin piles, has been assessed in the EIA, with two piling scenarios considered across the Mona Offshore Wind Project (Table 4.16); consecutive piling (i.e. one pile installed at a time), and concurrent piling (i.e. up to two piles installed simultaneously). The impact of consecutive piling is expected to occur over the greatest temporal scale, and the impact of concurrent piling is expected to occur over the greatest spatial scale. The piling scenarios are hereafter referred to as the 'maximum temporal scenario' and the 'maximum spatial scenario', respectively. For both scenarios a maximum of 454 pin piles are expected to be installed (see Table A. 1 and Table A. 1).

A.1.1.1.4 Population modelling was carried out to determine the potential for a short to medium term exposure to piling, which could occur intermittently within a 24-month piling period during the four-year offshore construction timeframe (expected to occur between 2026 and 2029, inclusive), to result in long term population level effects on any species.

A.1.1.1.5 The interim Population Consequences of Disturbance (iPCoD) model (developed by the Sea Mammal Research Unit (SMRU) with a team of researchers at the University of St Andrews), was adopted to simulate the potential changes in the population over time and is described within this appendix.

A.1.2 Interim Population Consequences of Disturbance modelling

A.1.2.1.1 The iPCoD model simulates the potential changes in a population over time, for both a disturbed and an undisturbed population. This provides a comparison of the type of changes that may result from natural environmental variation, demographic stochasticity (i.e. variability in population growth rates) and anthropogenic disturbance (Harwood *et al*., 2014; King *et al*., 2015). This approach has been used in previous offshore wind applications, and consented projects (e.g. Awel y Môr Offshore Wind Farm (RWE, 2023), Hornsea Four Offshore Wind Project (Ørsted Hornsea Project Four Ltd, 2021) and Hornsea Project Three Offshore Wind Farm (Ørsted Hornsea Project Three Ltd, 2018).

A.1.2.1.2 The iPCoD model is based on expert elicitation, a widely accepted process in conservation science whereby the opinions of many experts are combined when there is an urgent need for decisions to be made but a lack of empirical data with which to inform them (Donovan et al., 2016). In the case of the iPCoD model, the marine mammal experts (detailed in Sinclair *et al*. 2020) were asked for their opinion on how changes in hearing resulting from Permanent Threshold Shift (PTS) and behavioural disturbance (equivalent to a score of 5* or higher on the 'behavioural severity scale' described by Southall *et al*. (2007)) associated with offshore renewable energy developments affect calf and juvenile survival, and the probability of giving birth (Harwood *et al*., 2014). Experts were asked to estimate values for two parameters which determine the shape of the relationships between the number of days of disturbance experienced by an individual and its vital rates, thus providing parameter values for functions that form part of the iPCoD model (Harwood et al., 2014).

A.1.2.1.3 The relationship between disturbance and survival/reproduction assumes that individual animals would have a limited ability to alter their activity budget to compensate for a reduction in e.g. time spent feeding (Houston *et al*., 2012; King *et al*., 2015). The individual's ability to provision/care for young, evade predation or resist disease would likely be affected, and it is expected that effects would be reflected in changes to vital rates. It is important to note, however, that this relationship is highly simplified (Harwood *et al*., 2014), and an individual's response to disturbance will depend on factors including the context of the disturbance, the individual's existing condition and its exposure history (Ellison *et al*. 2011). The iPCoD framework applies simulated changes in vital rates to infer the number of animals that may be affected by disturbance as a means to iteratively project the size of the population.

A.1.2.1.4 Following the initial development of the iPCoD model a study was undertaken to update the transfer functions on the effects of PTS and disturbance on the probability of survival and giving birth to viable young for harbour porpoise, harbour seal and grey seal (again via expert elicitation) (Booth and Heinis, 2018; Booth et al., 2019). The iPCoD model has been updated in light of additional work undertaken since it was originally launched in February 2014 (version 1) and iPCoD version 5.2 was used in the modelling for this report (Sinclair et al., 2019).

A.1.2.1.5 A potential limitation of the iPCoD model is that no form of density dependence has been incorporated into the model due to the uncertainties as to how to estimate carrying capacity or how to model the mechanism of density dependence. As discussed in Harwood et al. (2014), the concept of density dependence is fundamental to understanding how animal populations respond to a reduction in population size. Density-dependent factors, such as resource availability or competition for space, can limit population growth. If the population declines, these factors no longer become limiting and therefore, for the remaining individuals in a population, there is likely to be an increase in survival rate and reproduction. This then allows the population to expand back to previous levels at which density-dependent factors become limiting again (i.e. population remains at carrying capacity).

A.1.2.1.6 The limitations for assuming a simple linear ratio between the maximum net productivity level and carrying capacity have been highlighted by Taylor and DeMaster (1993) as simple models demonstrate that density dependence is likely to involve several biological parameters which themselves have biological limits (e.g. fecundity and survival). For UK populations of harbour porpoise (and other marine mammal species) however, there is no published evidence for density dependence and, therefore, density dependence assumptions are not currently included within the iPCoD protocol.

A.2. Methodology

A.2.1 Piling parameters

A.2.1.1 Maximum design scenario

A.2.1.1.1 The maximum design scenario (MDS) for piling at Mona Offshore Wind Project has been developed on the basis that pile driving operations would be required for the installation of up to 454 piles across:

- 48 wind turbine jacket foundations with hammer energy up to 3,000 kJ
- 16 wind turbine jacket foundations with hammer energy up to 4,400 kJ
- 4 OSPs with hammer energy up to 4,400 kJ
- 10 wind turbine GBFs with ground strengthening pin piles with hammer energy up to 3,000 kJ.

A.2.1.1.2 The maximum temporal scenario is represented by piling occurring over the greatest number of days, resulting from piling at only one location at a time. Sound introduced into the marine environment over a longer period may increase the risk for disturbance to marine mammals, with potential effects during multiple stages of a species' annual cycle.

A.2.1.1.3 The maximum temporal scenario was assessed on the number of piles that could be installed within one 24-hour period. For pin piles, a maximum of four piles could be installed in a single location, in a single day, equating to 113.5 days for the installation of 454 piles.

A.2.1.1.4 A summary of the maximum temporal scenario for the Mona Offshore Wind Project is presented in Table A. 1.

Table A. 1: Summary of the maximum temporal scenario for piling of offshore foundations at the Mona Offshore Wind Project.

Structure	Number of piled locations	Number of legs	Piles per leg	Number of piles	Max hammer energy (kJ)	Max piles per day	Number of vessels	Max piling days
Wind turbine (jacket foundation)	48	4	1	192	3,000	4	1	48
Wind turbine (jacket foundation)	16	4	1	64	4,400	4	1	16
OSP	4	4	3	48	4,400	4	1	12
Wind turbine (GBF with ground strengthening pin piles)	10	1	15	150	3,000	4	1	37.5
Total	**78**	**-**	**-**	**454**	**-**	**-**		**113.5**

A.2.1.1.5 For the maximum spatial scenario the largest hammer energy and maximum spacing between concurrent piling events would reduce the time required for piling operations but would lead to the largest spatial extent of ensonification at any one time. Minimum spacing between concurrent piling represents the highest risk of injury to marine mammals as sound from adjacent foundations could combine to produce a greater radius of effect compared to a single piling event.

A.2.1.1.6 Concurrent piling for wind turbine foundations (i.e. at two wind turbines on the same day) with a maximum hammer energy of 3,000 kJ would occur over 24 days. The 26 foundations that will not be piled concurrently (16 jacket foundations piled a maximum hammer energy of 4,400 kJ and up to 10 GBFs with ground strengthening pin piles installed at a maximum hammer energy of 3,000 kJ) would be installed, one location at a time, over 53.5 days. The maximum duration of piling for the maximum spatial scenario would be 89.5 days.

A.2.1.1.7 A summary of the maximum spatial scenario for the Mona Offshore Wind Project is presented in Table A. 1.

Table A. 1: Summary of the maximum spatial scenario for piling of offshore foundations at the Mona Offshore Wind Project.

Structure	Number of piled locations	Number of legs	Piles per leg	Number of piles	Maximum hammer energy (kJ)	Max piles per day	Number of vessels	Max piling days
Wind turbine (jacket foundation)	48	4	1	192	3,000	4	2	24.0
Wind turbine (jacket foundation)	16	4	1	64	4,400	4	1	16.0
OSP	10	4	3	48	4,400	4	1	12.0
Wind turbine (GBF with ground strengthening pin piles)	4	1	15	150	3,000	4	1	37.5
Total	**78**	**-**	**-**	**454**	**-**	**-**	**-**	**89.5**

A.2.1.1.8 It is estimated that piling activity at Mona Offshore Wind Project will take place within a two-year timeframe (2027 and 2028). Piling could potentially take place at any point within the four-year offshore construction timeframe (between 2026 and 2029) however, for the purposes of developing the piling schedule for iPCoD (a requirement of the model) an indicative programme has been developed based on a realistic installation approach with piling spread across the two years, discussed in section A.3.7.

A.3. Model inputs

A.3.1 Key species

A.3.1.1.1 Species for inclusion in iPCoD modelling were determined in consultation with the marine mammal EWG, and were selected on the basis of their distribution, abundance and conservation status within the regional marine mammal study area. These species are:

- Harbour porpoise *Phocoena phocoena*
- Bottlenose dolphin *Tursiops truncatus*
- Minke whale *Balaenoptera acutorostrata*
- Grey seal *Halichoerus grypus*.

A.3.1.1.2 It is also possible for iPCoD to model potential effects of piling upon harbour seal *Phoca vitulina*, however this species does not occur in the region in numbers considered high enough to be at risk of a population-level effect and has therefore not be included for analysis.

A.3.2 Demographic parameters

A.3.2.1.1 The iPCoD model v5.2 (Harwood *et al.*, 2014) was set up using the program R v4.3.0 (R Core Team, 2023) with RStudio v 2023.6.2.561 (Posit team, 2023) as the user interface. To enable the iPCoD model to be run, the following data were provided:

- Demographic parameters for the key species
- User specified input parameters:
  - Vulnerable subpopulations
  - Residual days of disturbance
- Number of animals predicted to experience PTS and/or disturbance during piling
- Estimated piling schedule during the proposed construction programme.

A.3.2.1.2 Demographic parameters for the key species in the population model are presented in Table A. 2, and were chosen from Sinclair *et al*. (2020) and using parameters from sources as recommended by Natural Resources Wales (NRW) following consultation (NRW *pers. Comm,* 21.10.22), with parameters from additional sources to build in a more conservative, precautionary approach. Additionally-sourced parameter values included survival and reproductive rates for harbour porpoise (Murphy *et al*. 2015; 2020), calf survival (Pesante *et al*., 2008; Feingold and Evans, 2012) and fertility rate (Arso Civil *et al*., 2017) for bottlenose dolphin.

A.3.2.1.3 Whilst the importance of iPCoD modelling is to look at unimpacted versus impacted populations, it must be highlighted that the model is very sensitive to the parameters the user inputs and with small alterations to parameters leading to large changes in population trajectories (e.g. populations increasing or decreasing). For instance, small changes in fertility rates or stage-specific survival rates can change the population trajectories for both unimpacted and impacted populations. In the case of the bottlenose dolphin population modelled here, using a fertility rate parameter of 0.22 (Arso Civil *et al*., 2017), the population appears to decline in the unimpacted scenario (as well as the impacted scenario), however if a higher parameter for fertility rate (0.30: Sinclair *et al*., 2020) is used, the population trajectory is stable.

Table A. 2: Marine mammal management units, population estimates and vital rates used to parameterise iPCoD models. Note that growth rate is not an input parameter, but is derived as a model output, and is included for information.

[1] Higher fertility rate of 0.30 recommended by NRW for inclusion in modelling (NRW, pers. comm. 21.10.22).

[2] Population estimates for GSRP are taken from Sinclair *et al.* (2022), Ireland regions from Duck and Morris (2019) and Isle of Man population from Howe (2018).

[3] OSPAR Region III included following consultation with NRW.

Species	Management Unit/ Seal Management Unit	Population estimate	Calf/ Pup Survival	Juvenile Survival	Adult Survival	Fertility	Age of independence	Age of First Birth	Growth Rate
Harbour porpoise	Celtic and Irish Seas (CIS)	62,517	0.60	0.85	0.90	0.50	1	5	0.98
Bottlenose dolphin	Irish Sea (IS)	293	0.87	0.93	0.94	0.22	2	9	0.99
						0.30[1]			1.01
Minke whale	Celtic and Greater North Sea (CGNS)	20,118	0.70	0.77a	0.96a	0.91	1	9	1.00
Grey seal	Grey Seal Reference population (GSRP)[2]	12,910	0.22	0.94a	0.94a	0.90	1	9	1.01
	OSPAR Region III[3]	60,780							

A.3.3 Reference populations

A.3.3.1.1 Populations based upon Management Units (MUs) were specified in the iPCoD models as the reference populations against which the effects (i.e. number of animals experiencing disturbance or PTS) were assessed.

A.3.3.1.2 The relevant MUs were determined by their coincidence with the location of the Mona Offshore Wind Project in the east Irish Sea, and were agreed during the Marine Mammals Expert Working Group process (EWG Meeting 02, Table 4.X). Table A. 3 summarises the reference populations used in the iPCoD models.

A.3.3.1.3 During consultation, multiple reference populations were suggested for pinniped species, to allow assessment to be conducted over different spatial scales. The boundaries of the grey seal SMUs only extend to UK waters, but in southwest Britain photo-ID data and recent telemetry studies demonstrate movements of seals not only around the Irish Sea, but also encompassing southwest England, northwest France and Ireland (Vincent *et al*., 2017, Russell *et al*., 2019, Carter *et al*., 2020, Langley *et al*., 2020; Luck *et al*., 2020). Therefore, iPCoD modelling has been undertaken for two reference populations: OSPAR Region III area (west coast of UK + Ireland) and the four SMUs which cover the Irish Sea (12: Wales, 13: NW England, 14: Northern Ireland, 1: SW Scotland) plus the 'Southeast of Ireland' and 'East of Ireland' survey regions in the Republic of Ireland which border the Irish Sea, and the Isle of Man population. This combined reference population is hereafter referred to as the 'Grey Seal Reference Population' (GSRP).

Table A. 3: Reference populations used in the iPCoD modelling.

Species	Management Unit/ Seal Management Unit	Population estimate	References
Harbour porpoise	Celtic and Irish Seas (CIS)	62,517	IAMMWG (2015; 2021)
Bottlenose dolphin	Irish Sea MU (IAMMWG, 2021)	293	SCANS-III estimate from IAMMWG (2021)
Minke whale	Celtic and Greater North Seas MU	20,118	IAMMWG (2021)
Grey seal	OSPAR Region III	60,780	OSPAR Region III area (west coast of UK + Ireland) as outlined in NRW position statement (NRW, 2022)
	Grey Seal Reference Population (GSRP) consisting of four UK SMUs, IoM and RoI estimates:		
	SMU 12: Wales	3,579	Four SMUs from SCOS (2021), reported in Sinclair et al. (2022). IoM estimate fom Howe (2018). RoI esimates from Duck and Morris (2019).
	SMU 13: NW England	994	
	SMU 14: Northern Ireland	2,008	
	SMU 1: SW Scotland	2,056	
	Isle of Man estimate	400	
	East of Ireland	1,662	
	Southeast of Ireland	2,211	
	GSRP total	12,910	

A.3.4 Residual days disturbance

A.3.4.1.1 Empirical evidence from the constructed Beatrice and Horns Rev 2 offshore wind farms (Graham et al., 2019; Brandt et al., 2011) suggests that the detection of animals returns to baseline levels in the hours following a disturbance from piling and therefore, for the most part, it can be assumed that the disturbance occurs only on the day (24 hours) that piling takes place.

A.3.4.1.2 Due to the potential duration of piling occurring at the Mona Offshore Wind Project (e.g. up to 4.5 hours each for up to four pin piles per day, associated with jacket foundations required for wind turbines and OSPs), piling could occur for up to 18 hours in a 24 hour period. Therefore, the number of residual days of disturbance has, conservatively, been selected as one, meaning that the model assumes that disturbance occurs on the day of piling and persists for a period of 24 hours after piling has ceased.

A.3.5 Years of simulation

A.3.5.1.1 Whilst the operational lifetime of the Mona Offshore Wind Project is 35 years, technical documentation for the iPCoD model (Sinclair *et al*., 2019) highlights that the predictions of the model become increasingly uncertain as the number of years to be simulated is increased, and suggests that values in excess of 25 years are not usually recommended. This iPCoD parameter (‘years’) was therefore set at 25 years in all iPCoD models.

A.3.6 Number of animals (PTS/disturbance)

A.3.6.1.1 The number of animals predicted to experience disturbance or PTS was based on the density values provided as part of the baseline assessment in Volume 6, Annex 4.1: Marine mammal technical report of the Environmental Statement.

A.3.6.1.2 Where a range has been used for densities, maximum values were taken forward to the assessment in a conservative approach. For harbour porpoise, the maximum density is based upon the aerial digital surveys for the Mona marine mammal study area. For bottlenose dolphin, the maximum density uses comparable coastal (6 km region from coast) high densities from outer Cardigan Bay (Lohrengel et al., 2018). For pinnipeds, offshore densities are given for average and inshore densities are used for maximum, both taken from Carter et al. (2022) maps.

A.3.6.1.3 When assessing disturbance, the highest densities were also used for harbour porpoise and minke whale. For bottlenose dolphin, it can be reasonably assumed that most bottlenose dolphins will be located within a 6 km region from the coastline, and those coastal areas may be comparable to other high use areas in the regional marine mammal study area (such as in outer Cardigan Bay which has higher densities, as described in Lohrengel et al., 2018). The assessment for bottlenose dolphin therefore considered the overlap of the ensonified area with the coastal areas; applying the density value of 0.0017 animals/km2 (Evans and Waggitt, 2023). Proportional response was again applied for the predicted SELss levels which overlapped the coastal areas as per Graham et al., (2019).

A.3.6.1.4 For grey seal the quantitative assessment was undertaken by overlaying the unweighted SELss contours on at-sea density maps produced by Carter et al. (2022). The number of animals in each 5x5 km grid cell was summed for each isopleth and corrected using the proportional response as per Whyte *et al*. (2020).

A.3.6.1.5 For all scenarios, primary mitigation was applied (Section 4.9.3). The piling campaign was developed with the lowest achievable hammer energy, slow initiation phase, followed by a soft start and ramp up to reduce the potential risk of injury (see Volume 5, Annex 3.1: Underwater sound technical report of the Environmental Statement).

A.3.6.1.6 With these primary measures in place, the residual number of individuals potentially affected by PTS was taken forward for the iPCoD model. This is a conservative approach since tertiary mitigation (i.e. application of MMMP, as part of the Underwater sound management strategy) will reduce the risk of PTS further. Due to the large injury ranges predicted for some species (e.g. up to 3,290 m SELcum for minke whale) (Section 4.9.3), this more conservative approach was deemed appropriate.

Currently the models for the Mona Offshore Wind Project alone assume one animal experiencing PTS for minke whale only. Maximum numbers of animals disturbed and injured (PTS) for the maximum temporal scenario is presented in Table A. 4 and maximum numbers of animals disturbed and injured (PTS) for the maximum spatial scenario is presented in

A.3.6.1.7 Table A. 5.

Table A. 4: Estimated number of animals predicted to be disturbed or injured (PTS) at any one time during piling for the maximum temporal scenario.

Species	Operation	Number of animals disturbed	Number of animals injured (PTS)
Harbour porpoise	Wind turbine (jacket foundation: 3,000 kJ)	803	0
	Wind turbine (jacket foundation: 4,400 kJ)	971	0
	OSP (4,400 kJ)	971	0
	Wind turbine (GBF: 3,000 kJ)	803	0
Bottlenose dolphin	Wind turbine (jacket foundation: 3,000 kJ)	5	0
	Wind turbine (jacket foundation: 4,400 kJ)	6	0
	OSP (4,400 kJ)	6	0
	Wind turbine (GBF: 3,000 kJ)	5	0
Minke whale	Wind turbine (jacket foundation: 3,000 kJ)	51	1
	Wind turbine (jacket foundation: 4,400 kJ)	61	1
	OSP (4,400 kJ)	61	1
	Wind turbine (GBF: 3,000 kJ)	51	1
Grey seal	Wind turbine (jacket foundation: 3,000 kJ)	17	0
	Wind turbine (jacket foundation: 4,400 kJ)	27	0
	OSP (4,400 kJ)	27	0
	Wind turbine (GBF: 3,000 kJ)	17	0

Table A. 5: Estimated number of animals predicted to be disturbed or injured (PTS) at any one time during piling for the maximum spatial scenario.

Species	Operation	Number of animals disturbed	Number of animals injured (PTS)
Harbour porpoise	Wind turbine (jacket foundation: 3,000 kJ, concurrent)	1,142	0
	Wind turbine (jacket foundation: 4,400 kJ)	971	0
	OSP (4,400 kJ)	971	0
	Wind turbine (GBF: 3,000 kJ)	803	0
Bottlenose dolphin	Wind turbine (jacket foundation: 3,000 kJ, concurrent)	7	0
	Wind turbine (jacket foundation: 4,400 kJ)	6	0
	OSP (4,400 kJ)	6	0
	Wind turbine (GBF: 3,000 kJ)	5	0
Minke whale	Wind turbine (jacket foundation: 3,000 kJ, concurrent)	72	1
	Wind turbine (jacket foundation: 4,400 kJ)	61	1
	OSP (4,400 kJ)	61	1
	Wind turbine (GBF: 3,000 kJ)	51	1
Grey seal	Wind turbine (jacket foundation: 3,000 kJ, concurrent)	31	0
	Wind turbine (jacket foundation: 4,400 kJ)	27	0
	OSP (4,400 kJ)	27	0
	Wind turbine (GBF: 3,000 kJ)	17	0

A.3.7 Piling schedule

A.3.7.1.1 The piling schedule used in the iPCoD modelling was developed from the Project Design Envelope (PDE). This provides an estimate of the maximum number of days of piling required for the foundations of the wind turbines and OSPs, within a defined piling window.

A.3.7.1.2 The piling phase for the Mona Offshore Wind Project is expected to occur across the 24-month period in years two and three of the four-year construction phase (i.e. in 2027 and 2028).

A.3.7.1.3 For the purposes of developing the piling schedule for iPCoD (a required input for all models) an indicative programme has been developed for each scenario, based on a realistic installation approach, with piling spread across the two years.

A.3.7.1.4 For the maximum temporal scenario, piling was scheduled to occur over the greatest time frame. The 113.5 piling days (Table 4.16) have been rounded to 114 days for the purposes of modelling and have been spread as evenly as practicable across the two-year construction period, with an interval of approximately eight days between piling days.

A.3.7.1.5 For the maximum spatial scenario, concurrent piling has been assumed at the 48 wind turbine jacket foundations for which the maximum hammer energy will be 3,000 kJ. Subsequently, all piling at these locations has been assumed to occur across 24 days (i.e. two locations piled on the same day). Piling for the remaining structures has been assumed to be identical to that for the maximum temporal scenario, so the maximum number of days of piling for the maximum spatial scenario is 89.5 days (Table A. 1). For the purposes of modelling this has been rounded to 90 days.

A.3.7.1.6 Details of the piling schedules for the maximum temporal scenario and maximum spatial scenario are presented in Table A. 6, and the time points selected from the iPCoD model outputs to coincide with key periods in the piling schedule, and with statutory reporting periods for Special Areas of Conservation (SAC), are summarised in Table A. 7.

Table A. 6: Indicative two-year piling programme for each piling scenario in the Mona Offshore Wind Project within the four-year offshore construction phase.

Year	Month	Days piling per month	
		Maximum temporal scenario	Maximum spatial scenario
2026	No piling		
2027	January	5	4
	February	5	4
	March	4	3
	April	5	4
	May	5	4
	June	5	4
	July	4	3
	August	5	4
	September	5	4
	October	5	4
	November	4	3
	December	5	4
2028	January	5	4
	February	4	3
	March	5	4
	April	5	4
	May	5	4
	June	4	3
	July	5	4
	August	5	4
	September	4	3

Year	Month	Days piling per month	
		Maximum temporal scenario	Maximum spatial scenario
	October	5	4
	November	5	4
	December	5	4
2029	No piling		
Total piling days		**114**	**90**

Table A. 7: Selected time points from simulation output, corresponding years, and corresponding events.

Time point	Year	Corresponding event
1	2027	Start of piling phase
2	2028	End of first year of piling phase
3	2029	**End of two-year piling phase**
7	2033	Six-year Habitats Directive reporting period (start of piling)
9	2035	Six-year Habitats Directive reporting period (end of piling)
11	2037	Ten years after start of piling
13	2039	Ten years after end of piling
21	2047	Twenty years after start of piling
26	2052	**Twenty-five years after start of piling phase** Maximum capacity of iPCoD model predictions

A.3.8 Cumulative projects

A.3.8.1.1 Cumulative projects for marine mammal species were considered across the regional marine mammal study area, which encompasses the Irish Sea and Celtic Seas. A summary of indicative offshore piling scenarios and schedules is provided in Table A. 8.

Table A. 8: Indicative offshore piling programmes and schedules for cumulative projects. Green shading indicates construction phases, and blue shading indicates the anticipated start of respective operation and maintenance phases.

[1] Piling for White Cross Offshore Windfarm to be undertaken over six months at any time between 2025 and 2027

Project		Tier	Max piles	Piling duration (days)	2025	2026	2027	2028	2029	2030 onward
Mona Offshore Wind Project		N/A	454	90			Piling	Piling		
Awel y Môr		1	50	201				Piling		
Project Erebus		1	35	18	Piling					
White Cross Offshore Windfarm	Wind turbines	1	64	5	Piling[1]	Piling[1]				
	OSP	1	4	1	Piling[1]	Piling[1]				
Morgan Offshore Wind Project Generation Assets		2	70	35			Piling	Piling		
Morecambe Offshore Wind Farm Generation Assets		2	42	42			Piling			
Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Morgan OSP	2	2	2			Piling	Piling		
	Morecambe OSP		2	2			Piling	Piling		
	Morgan booster station		2	2			Piling	Piling		

A.3.8.1.2 The Mona Offshore Wind Project piling scenario carried forward to the cumulative assessment was the maximum spatial scenario as this represented the highest number of animals potentially disturbed in a 24-hour period.

A.3.8.1.3 There is no potential for significant cumulative impacts for injury (PTS) from elevated underwater sound during piling for the cumulative projects presented in Table A. 8 as iPCoD simulations for these projects have modelled zero animals experiencing PTS.

A.3.8.1.4 The iPCoD models were set up as described in sections A.3.2 and A.3.3 for demographic parameters and reference populations, respectively, and with the same days of residual disturbance specified in section 0.

A.3.8.1.5 Cumulative models were run in two stages: one set of models incorporating the Mona Offshore Wind Project and only Tier 1 projects in the regional marine mammal study area, and one set incorporating all Tier 1 and Tier 2 projects. Cumulative projects were only included in species' models if they overlap spatially with the species-specific management units described in Table A. 2.

A.3.8.1.6 Since the IS MU for bottlenose dolphin does not overlap with Project Erebus, this project was not included in iPCoD models for bottlenose dolphin.

A.3.8.1.7 The number of animals affected for each of the key species and number of days on which piling occurred was taken from the MDS for each of the cumulative projects. A summary of the number of animals for each species affected and number of piling days for each of cumulative projects is provided in Table A. 9. In cases for which less than one animal was expected to experience disturbance, this was rounded up to one animal for the relevant models.

Table A. 9: Summary of number of animals estimated to experience disturbance for cumulative iPCoD models.

Project		Piling days	Maximum number of animals disturbed			
			Harbour porpoise	Bottlenose dolphin	Minke whale	Grey seal
Mona Offshore Wind Project	Wind turbine (3,000 kJ, concurrent)	24	1,142	7	72	31
	Wind turbine (4,400 kJ)	16	971	6	61	27
	OSP (4,400 kJ)	12	971	6	61	27
	Wind turbine (GBF: 3,000 kJ)	38	803	5	51	17
Tier 1 projects						
Awel y Môr		201	2,112	23	36	81
Project Erebus		18	1,967	n/a	55	18
White Cross Offshore Windfarm		6	2,754	n/a	61	10
Tier 2 projects						
Morgan Offshore Wind Project Generation Assets		35	1,370	16	96	48
Morecambe Offshore Wind Farm Generation Assets		42	2,961	<1	2	<1
Morgan and Morecambe	Morgan OSP	2	2,465	11	69	88

Project		Piling days	Maximum number of animals disturbed			
			Harbour porpoise	Bottlenose dolphin	Minke whale	Grey seal
Offshore Wind Farms: Transmission Assets	Morecambe OSP	2	2,465	<1	2	88
	Morgan booster station	2	1,793	4	17	28

A.3.8.1.8 As precise piling schedules for the Mona Offshore Wind Project were unknown, the piling days were distributed as discussed in section A.3.7, and those for cumulative projects were spread evenly throughout the offshore construction phases shown in Table A. 8, with care taken to ensure that piling days for each project did not coincide.

A.3.8.1.9 The starting year for all cumulative models except those for bottlenose dolphin (see paragraph A.3.8.1.6) was 2025 as this is the anticipated start of piling at Project Erebus. For bottlenose dolphin all cumulative models started in 2027.

A.3.8.1.10 The time points selected from the iPCoD model outputs for cumulative projects were chosen to coincide with key periods in the piling programmes, and with statutory reporting periods for SACs, and are summarised in Table A. 10 and Table A. 11.

Table A. 10: Selected time points from simulation output, and corresponding events, for cumulative projects for harbour porpoise, minke whale and grey seal.

Time point	Year	Corresponding event/s
1	2025	Start of piling for Project Erebus Start of piling for White Cross Offshore Windfarm
3	2027	Start of piling for Mona Offshore Wind Project Start of piling for Morgan Offshore Wind Project Generation Assets Start of piling for Morecambe Offshore Wind Farm Generation Assets Start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets End of piling for White Cross Offshore Windfarm (six month piling window between 2025 to 2027)
4	2028	End of piling for Morecambe Offshore Wind Farm Generation Assets Start of piling for Awel y Môr Second year piling for Mona Offshore Wind Project Second year piling for Morgan Offshore Wind Project Generation Assets Second year piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
5	2029	**End of piling phase at all cumulative projects**
7	2031	Six years after start of piling for Project Erebus Six years after start of piling for White Cross Offshore Windfarm
9	2033	Six years after start of piling for Mona Offshore Wind Project Six years after start of piling for Morgan Offshore Wind Project Generation Assets Six years after start of piling for Morecambe Offshore Wind Farm Generation Assets Six years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets.
10	2034	Six years after start of piling for Awel y Môr

Time point	Year	Corresponding event/s
11	2035	Ten years after start of piling for Project Erebus Ten years after start of piling for White Cross Offshore Windfarm Six years after end of piling for Mona Offshore Wind Project Six years after end of piling for Morgan Offshore Wind Project Generation Assets Six years after end of piling for Morecambe Offshore Wind Farm Generation Assets Six years after end of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
13	2037	Ten years after start of piling for Mona Offshore Wind Project Ten years after start of piling for Morgan Offshore Wind Project Generation Assets Ten years after start of piling for Morecambe Offshore Wind Farm Generation Assets Ten years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
15	2039	**Ten years after end of piling phase at all cumulative projects**
23	2047	Twenty years after start of piling for Mona Offshore Wind Project Twenty years after start of piling for Morgan Offshore Wind Project Generation Assets Twenty years after start of piling for Morecambe Offshore Wind Farm Generation Assets Twenty years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
26	2050	Twenty-five years after start of piling for Project Erebus Twenty-five years after start of piling for White Cross Offshore Windfarm **Maximum capacity of iPCoD model predictions**

Table A. 11: Selected time points from simulation output, and corresponding events, for cumulative projects for bottlenose dolphin.

Time point	Year	Corresponding event/s
1	2027	Start of piling for Mona Offshore Wind Project Start of piling for Morgan Offshore Wind Project Generation Assets Start of piling for Morecambe Offshore Wind Farm Generation Assets Start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
2	2028	End of piling for Morecambe Offshore Wind Farm Generation Assets Start of piling for Awel y Môr Second year piling for Mona Offshore Wind Project Second year piling for Morgan Offshore Wind Project Generation Assets Second year piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
3	2029	**End of piling phase at all cumulative projects**
7	2033	Six years after start of piling for Mona Offshore Wind Project Six years after start of piling for Morgan Offshore Wind Project Generation Assets Six years after start of piling for Morecambe Offshore Wind Farm Generation Assets Six years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets.
8	2034	Six years after start of piling for Awel y Môr

Time point	Year	Corresponding event/s
9	2035	Six years after end of piling for Mona Offshore Wind Project Six years after end of piling for Morgan Offshore Wind Project Generation Assets Six years after end of piling for Morecambe Offshore Wind Farm Generation Assets Six years after end of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
11	2037	Ten years after start of piling for Mona Offshore Wind Project Ten years after start of piling for Morgan Offshore Wind Project Generation Assets Ten years after start of piling for Morecambe Offshore Wind Farm Generation Assets Ten years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
13	2039	**Ten years after end of piling phase at all cumulative projects**
21	2047	Twenty years after start of piling for Mona Offshore Wind Project Twenty years after start of piling for Morgan Offshore Wind Project Generation Assets Twenty years after start of piling for Morecambe Offshore Wind Farm Generation Assets Twenty years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets
26	2052	Twenty-five years after start of piling for Mona Offshore Wind Project Twenty-five years after start of piling for Morgan Offshore Wind Project Generation Assets Twenty-five years after start of piling for Morecambe Offshore Wind Farm Generation Assets Twenty-five years after start of piling for Morgan and Morecambe Offshore Wind Farms: Transmission Assets **Maximum capacity of iPCoD model predictions**

A.3.9 Summary of iPCoD scenarios.

A.3.9.1.1 A total of 24 iPCoD modelling scenarios were run for the Mona Offshore Wind Project and relevant cumulative projects, and these are summarised in Table A. 12 for each of the four key species.

Table A. 12: Summary of iPCoD scenarios modelled for key species associated with the Mona Offshore Wind Project and relevant cumulative projects.

Scenario		Population unit	Population estimate	Calf survival	Juvenile survival	Adult survival	Fertility	Age at independence	Age at first offspring
Harbour porpoise									
HP-01	Maximum temporal scenario	CIS	62,517	0.60	0.85	0.90	0.50	1	5
HP-02	Maximum spatial scenario	CIS	62,517	0.60	0.85	0.90	0.50	1	5
HP-C1	Cumulative scenario: Tier 1 projects within boundary of CIS MU	CIS	62,517	0.60	0.85	0.90	0.50	1	5
HP-C2	Cumulative scenario: Tier 1 and Tier 2 projects within boundary of CIS MU	CIS	62,517	0.60	0.85	0.90	0.50	1	5
Bottlenose dolphin									
BND-01a	Maximum temporal scenario	IS	293	0.87	0.93	0.94	0.22	2	9
BND-01b	Maximum temporal scenario, with higher 0.30 fertility rate.	IS	293	0.87	0.93	0.94	0.30	2	9
BND-02a	Maximum spatial scenario	IS	293	0.87	0.93	0.94	0.22	2	9
BND-02b	Maximum spatial scenario, with higher 0.30 fertility rate.	IS	293	0.87	0.93	0.94	0.30	2	9
BND-C1a	Cumulative scenario: Tier 1 projects within boundary of IS MU.	IS	293	0.87	0.93	0.94	0.22	2	9
BND-C1b	Cumulative scenario: Tier 1 projects within boundary of IS MU, with higher 0.30 fertility rate.	IS	293	0.87	0.93	0.94	0.30	2	9
BND-C2a	Cumulative scenario: Tier 1 and Tier 2 projects within boundary of IS MU.	IS	293	0.87	0.93	0.94	0.22	2	9
BND-C2b	Cumulative scenario: Tier 1 and Tier 2 projects within boundary of IS MU, with higher 0.30 fertility rate.	IS	293	0.87	0.93	0.94	0.30	2	9

Scenario		Population unit	Population estimate	Calf survival	Juvenile survival	Adult survival	Fertility	Age at independence	Age at first offspring
Minke whale									
MW-01	Maximum temporal scenario	CGNS	20,118	0.70	0.77	0.96	0.91	1	9
MW-02	Maximum spatial scenario	CGNS	20,118	0.70	0.77	0.96	0.91	1	9
MW-C1	Cumulative scenario: Tier 1 projects within boundary of CIS MU	CGNS	20,118	0.70	0.77	0.96	0.91	1	9
MW-C2	Cumulative scenario: Tier 1 and Tier 2 projects within boundary of CIS MU	CGNS	20,118	0.70	0.77	0.96	0.91	1	9
Grey seal									
GS-01a	Maximum temporal scenario	GSRP	12,910	0.94	0.94	0.90	0.22	1	5
GS-01b	Maximum temporal scenario, OSPAR Region III population	OSPAR Region III	60,780	0.94	0.94	0.90	0.22	1	5
GS-02a	Maximum spatial scenario	GSRP	12,910	0.94	0.94	0.90	0.22	1	5
GS-02b	Maximum spatial scenario, OSPAR Region III population	OSPAR Region III	60,780	0.94	0.94	0.90	0.22	1	5
GS-C1a	Cumulative scenario: Tier 1 projects within boundary of MUs corresponding to GSRP	GSRP	12,910	0.94	0.94	0.90	0.22	1	5
GS-C1b	Cumulative scenario: Tier 1 projects within boundary of MUs corresponding to OSPAR Region III	OSPAR Region III	60,780	0.94	0.94	0.90	0.22	1	5
GS-C2a	Cumulative scenario: Tier 1 and Tier 2 projects within boundary of MUs corresponding to GSRP	GSRP	12,910	0.94	0.94	0.90	0.22	1	5
GS-C2b	Cumulative scenario: Tier 1 and Tier 2 projects within boundary of MUs corresponding to OSPAR Region III	OSPAR Region III	60,780	0.94	0.94	0.90	0.22	1	5

A.3.10 Model outputs

A.3.10.1.1 The outputs of the iPCoD models are focussed on describing the potential impact to a given marine mammal population under the relevant development scenario, relative to the population in the absence of the development. An estimate is provided for every time step in the scenario (here given as 25 years after commencement of piling), for each simulation (n = 1,000) and is presented in Figure A. 1 to Figure A. 24. The ratio of the impacted to the un-impacted population sizes can then be expressed as a ratio, termed the counterfactual of population size.

A.3.10.1.2 The mean estimate (plus 95% confidence interval) of impacted and un-impacted population sizes across all simulations, and the corresponding counterfactuals, are reported for each species, and each scenario (Table A. 13 to Table A. 36). The median counterfactual is also presented since this measure can be less sensitive to outliers. However, it is important to note that the median counterfactual may not always be representative of overall projections, and should be interpreted with caution, since this is calculated simply as the central value in the ordered set of counterfactuals from all simulations.

A.4. Results

A.4.1 Harbour porpoise

A.4.1.1 Project alone

A.4.1.1.1 Results of the iPCoD modelling at the time points described in Table A. 7 for harbour porpoise under the maximum temporal and maximum spatial scenarios are presented in Table A. 13 and Table A. 14, and illustrated in Figure A. 1 and Figure A. 2, respectively.

A.4.1.1.2 Both un-impacted and impacted populations of harbour porpoise appear to be reducing in size, and there has been a suggested 4% per annum declining trend in the CIS MU (IAMMWG, 2021) and thus this is not unexpected. However, iPCoD models can be very sensitive to the parameters chosen, and since conservative parameters were selected this may be reflected in simulated population trajectories.

Scenario HP-01: maximum temporal scenario

A.4.1.1.3 For the maximum temporal scenario the results indicate a very small difference in the growth trajectory of harbour porpoise between the un-impacted population and impacted population (Table A. 13). At all time points there was very little difference in the mean size of the impacted and unimpacted populations (Figure A. 1).

A.4.1.1.4 For example, at time point 3, which represents the end of the two-year piling phase, the impacted population was predicted to be 57 animals smaller than the unimpacted population. At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is 52 animals.

Table A. 13: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for harbour porpoise under the maximum temporal scenario.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	62,514	**62,514**	62,514	62,514	**62,514**	62,514	1.0000	1.0000
2	56,131	**61,470**	65,566	56,112	**61,455**	65,542	0.9997	1.0000
3	53,881	**60,428**	66,167	53,881	**60,371**	66,086	0.9991	0.9999
7	47,721	**56,463**	66,285	47,609	**56,411**	66,227	0.9991	0.9999
9	44,437	**54,503**	65,526	44,405	**54,450**	65,257	0.9990	0.9999
11	41,858	**52,595**	64,129	41,839	**52,544**	64,129	0.9990	0.9999
13	39,962	**50,746**	63,600	39,934	**50,697**	63,600	0.9990	0.9999
21	31,851	**44,592**	59,458	31,851	**44,548**	59,187	0.9990	0.9999
26	28,400	**40,893**	56,675	28,400	**40,853**	56,627	0.9990	0.9999

A.4.1.1.5 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of piling (and 23 years after the cessation of piling), this difference has reduced to 40 animals, corresponding to approximately 0.064% of the reference population (Table A. 13). This suggests that there would not be a long-term increase in any potential effect from piling upon the harbour porpoise population within the CIS MU.

A.4.1.1.6 The median counterfactual for scenario HP-01 reduced from 1.0000 to 0.9999 through the 26-year simulation, whereas the mean counterfactual reduced to 0.9990. Therefore, given that the differences in disturbed to un-disturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term effect from this piling scenario upon harbour porpoise.

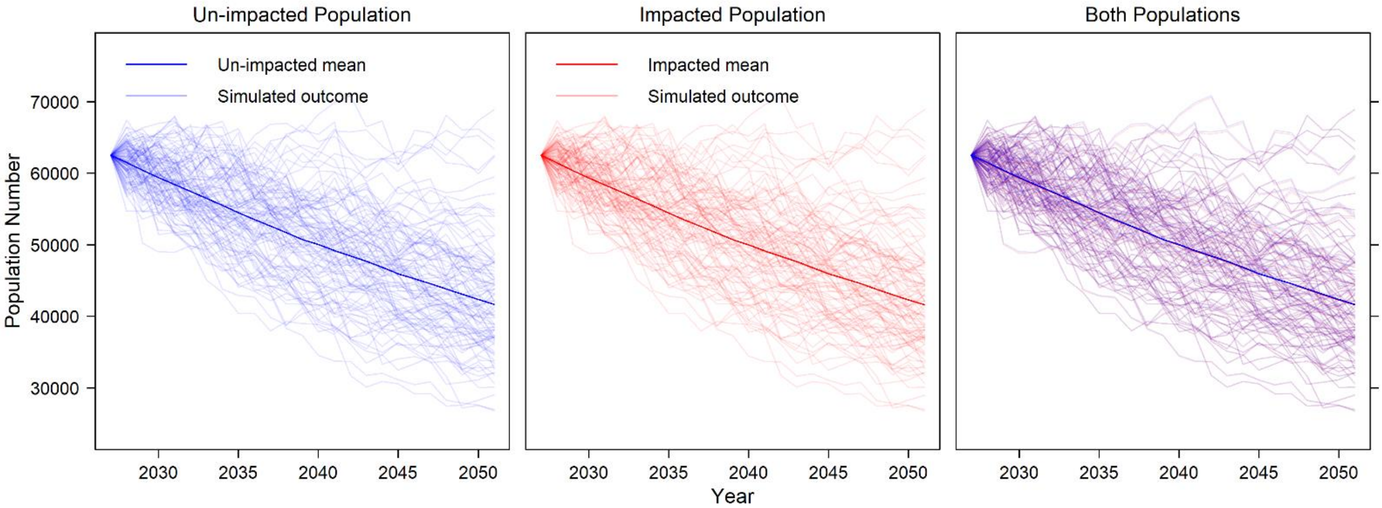

Figure A. 1: Simulated harbour porpoise population trajectories in an un-impacted versus impacted population, for the maximum temporal scenario.

Scenario HP-02: maximum spatial scenario

A.4.1.1.7 For the maximum spatial scenario the results indicate a very small difference in the population trajectory of harbour porpoise between the un-impacted population and impacted population (Table A. 14 and Figure A. 2).

A.4.1.1.8 At all time points there was very little difference in the mean size of the impacted and unimpacted populations. For example at time point 3, corresponding to the end of the two-year piling phase, the impacted population was predicted to be 50 fewer than the un-impacted population, corresponding to approximately 0.083% of the reference population. At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations was 45 animals.

A.4.1.1.9 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of piling (and 23 years after the cessation of piling), this difference was 35 animals (Table A. 14), corresponding to approximately 0.056% of the reference population. This suggests that there would not be a long-term increase in any potential effect from piling upon the harbour porpoise population within the CIS management unit. Indeed, the effect appears to have reduced in magnitude over the modelled time series.

Table A. 14: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for harbour porpoise under the maximum spatial scenario.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	62,514	**62,514**	62,514	62,514	**62,514**	62,514	1.0000	1.0000
2	56,263	**61,398**	66,124	56,251	**61,386**	66,120	0.9998	1.0000
3	53,742	**60,312**	66,077	53,699	**60,262**	66,051	0.9992	0.9999
7	47,453	**56,748**	66,518	47,453	**56,703**	66,512	0.9992	0.9999
9	44,760	**55,017**	66,029	44,760	**54,970**	65,861	0.9992	0.9999
11	42,259	**53,199**	65,334	42,257	**53,154**	65,318	0.9992	0.9999
13	39,836	**51,486**	64,169	39,831	**51,442**	64,168	0.9992	0.9999
21	32,243	**45,068**	59,335	32,243	**45,030**	59,278	0.9992	1.0000
26	29,153	**41,604**	56,054	29,153	**41,569**	55,943	0.9992	1.0000

A.4.1.1.10 The median counterfactual of population size for scenario HP-02 was 1.0000 throughout the 26-year simulation, whereas the mean counterfactual ratio at time point 26 had reduced from 1.0000 to 0.9992. Therefore, given that the differences in disturbed to undisturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term effect from this piling scenario upon harbour porpoise.

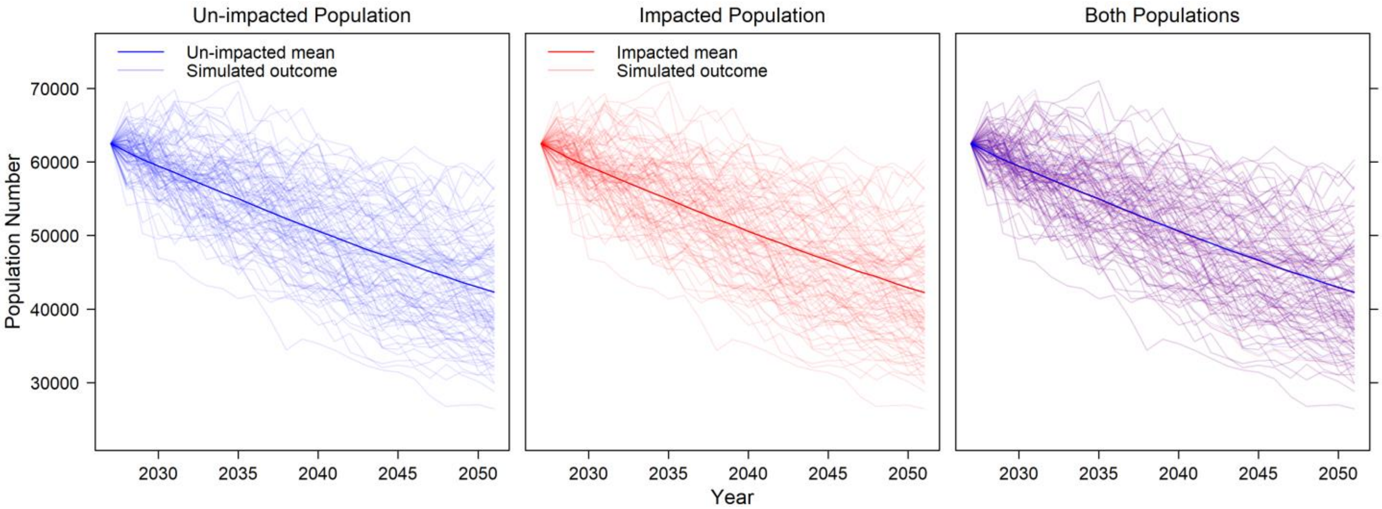

Figure A. 2: Simulated harbour porpoise population trajectories in an un-impacted versus impacted population, for the maximum spatial scenario.

A.4.1.2 Cumulative projects

A.4.1.2.1 Results of the iPCoD modelling at the time points described in Table A. 10 for harbour porpoise using the maximum spatial cumulative scenarios are presented in Table A. 15 and Table A. 16 and illustrated in Figure A. 3 and Figure A. 4, respectively.

A.4.1.2.2 As for the two scenarios for the Mona Offshore Wind Project alone, there appears to be a decline in both impacted and un-impacted populations for harbour porpoise (see section A.4.1.1). However, when compared directly, a slightly lower population trajectory is visible in the third panel of Figure A. 3 and Figure A. 4 for the impacted population in both the HP-C1 and HP-C2 cumulative scenarios.

Scenario HP-C1: Tier 1 projects

A.4.1.2.3 For scenario HP-C1, in which a total of 90 days of piling occur at the Mona Offshore Wind Project alongside a total of 225 piling days across Tier 1 cumulative projects (18 days at Project Erebus, six days at White Cross Offshore Windfarm and 201 days at Awel y Môr), these results indicate a difference of 261 fewer animals in the impacted population at time point 26, compared to the un-impacted population (Table A. 15).

A.4.1.2.4 At time point 7, which corresponds to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is 393 animals (0.63% of the reference population). When compared to the equivalent time point from scenario HP-02 (maximum spatial scenario for the Mona Offshore Wind Project alone: n = 45), this is a difference of 348 animals.

A.4.1.2.5 This suggests that after an initial effect of disturbance upon the harbour porpoise population from the cumulative projects, peaking approximately five years after the start of piling (n = 459), this effect is expected to stabilise across the duration of the modelled time series (i.e. the counterfactual of population size is not expected to reduce after six years).

Table A. 15: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for harbour porpoise for cumulative piling scenario HP-C1.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	62,514	**62,514**	62,514	62,514	**62,514**	62,514	1.0000	1.0000
3	53,682	**60,489**	66,403	53,674	**60,467**	66,361	0.9996	1.0000
4	52,107	**59,569**	66,426	52,107	**59,539**	66,368	0.9995	1.0000
5	50,568	**58,633**	66,190	50,221	**58,377**	65,959	0.9956	0.9977
7	47,280	**56,651**	66,011	47,058	**56,258**	65,803	0.9931	0.9961
9	44,841	**54,922**	65,974	44,481	**54,602**	65,549	0.9942	0.9969
10	43,820	**54,001**	65,298	43,764	**53,668**	65,074	0.9939	0.9967
11	42,528	**53,081**	64,518	42,240	**52,745**	63,839	0.9937	0.9966
13	39,737	**51,191**	63,775	39,591	**50,865**	63,474	0.9937	0.9966
15	38,305	**49,602**	63,047	37,975	**49,289**	62,714	0.9938	0.9966
23	30,794	**43,472**	57,813	30,752	**43,198**	57,569	0.9938	0.9965
26	29,299	**41,368**	56,637	29,182	**41,107**	56,442	0.9938	0.9966

A.4.1.2.6 As for scenarios HP-01 and HP-02 for the Mona Offshore Wind Project alone, there appears to be a decline in both impacted and un-impacted populations for harbour porpoise (see section A.4.1.1). However, when compared directly, a slightly lower population trajectory is visible in the third panel of Figure A. 3 for the impacted population for cumulative scenario HP-C1.

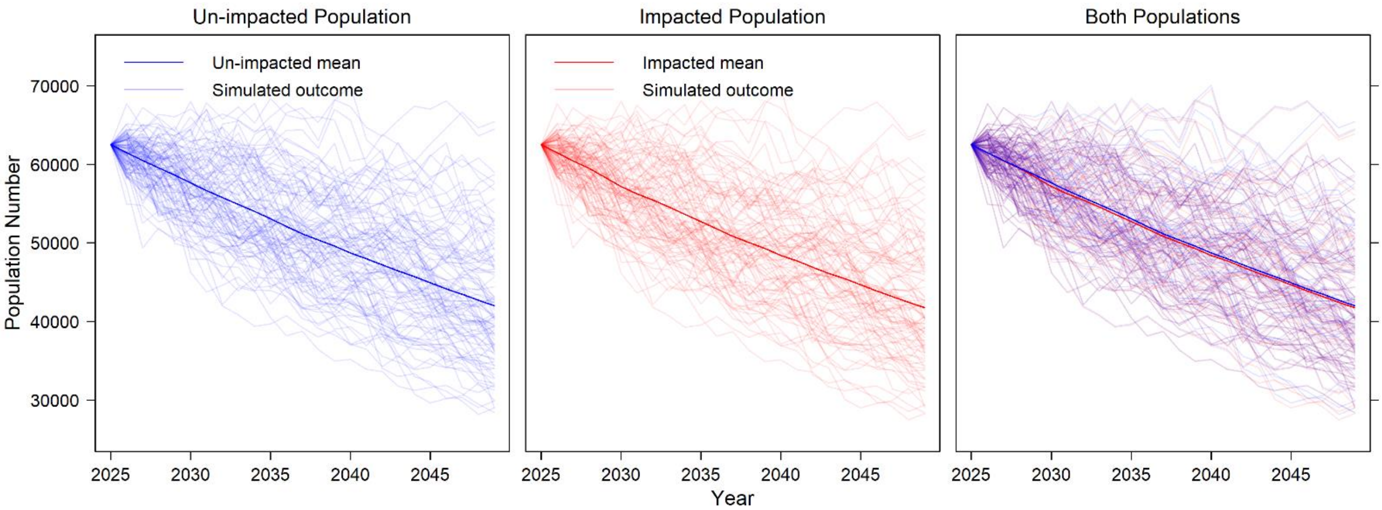

Figure A. 3: Simulated harbour porpoise population trajectories in an un-impacted versus impacted population, for cumulative scenario HP-C1 (Tier 1 projects only).

A.4.1.2.7 The median counterfactual of population size for scenario HP-C1 was 0.9966 at the end of the 26-year simulation, while the mean counterfactual was 0.9938. Therefore, given that the differences in disturbed to undisturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term MU population-level effect from this cumulative piling scenario upon harbour porpoise.

Scenario HP-C2: Tier 1 and Tier 2 projects

A.4.1.2.8 The results for scenario HP-C2 (i.e. 90 days of piling for the Mona Offshore Wind Project alongside up to 308 piling days from Tier 1 and Tier 2 cumulative projects) indicate a similar pattern in the population trajectory as scenario HP-C1 (Table A. 16), although the magnitude of effect appears to be lower.

A.4.1.2.9 The impacted population size at time point 26 is estimated to be 416 animals fewer than the un-impacted population (0.67% of the reference population), and for time point 7, this is 612 animals fewer than the un-impacted population. As for scenario HP-C1, an initial peak in the effect after five years (n = 712) appears to reduce and stabilise over the longer term (Figure A. 4).

Table A. 16: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for harbour porpoise for cumulative piling scenario HP-C2.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	62,514	**62,514**	62,514	62,514	**62,514**	62,514	1.0000	1.0000
3	53,885	**60,481**	66,180	53,885	**60,453**	66,176	0.9995	1.0000
4	52,214	**59,451**	66,772	52,102	**59,351**	66,772	0.9983	0.9996
5	50,488	**58,456**	66,579	49,944	**57,995**	66,188	0.9921	0.9950
7	47,256	**56,641**	66,468	46,708	**56,029**	65,533	0.9892	0.9928
9	45,055	**54,621**	65,710	44,294	**54,109**	65,537	0.9907	0.9941
10	43,349	**53,733**	64,781	43,054	**53,205**	64,664	0.9902	0.9938
11	42,538	**52,762**	64,007	41,624	**52,232**	63,456	0.9900	0.9937
13	39,917	**51,223**	63,378	39,730	**50,709**	63,004	0.9900	0.9937
15	37,705	**49,579**	62,040	37,322	**49,085**	61,357	0.9901	0.9937
23	31,041	**43,639**	57,433	30,934	**43,203**	57,220	0.9900	0.9937
26	28,994	**41,389**	55,885	28,746	**40,973**	55,138	0.9900	0.9938

A.4.1.2.10 The median counterfactual of population size for scenario HP-C2 was 0.9938 at the end of the 26-year simulation, while the mean counterfactual at the same time point was 0.9900. Therefore, given that the differences in disturbed to undisturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term MU population-level effect from this cumulative piling scenario upon harbour porpoise.

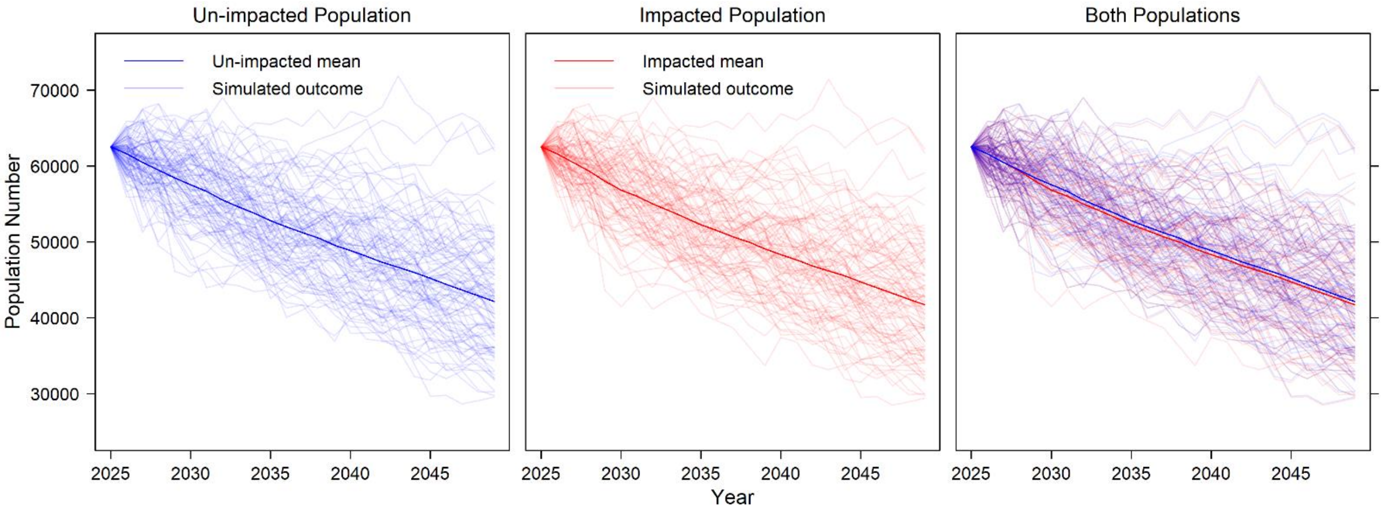

Figure A. 4: Simulated harbour porpoise population trajectories in un-impacted versus impacted populations, for cumulative scenario HP-C2 (Tier 1 and Tier 2 projects).

A.4.2 Bottlenose dolphin

A.4.2.1 Project alone

A.4.2.1.1 Results of the iPCoD modelling at the time points described in Table A. 7 for bottlenose dolphin under the maximum temporal and maximum spatial piling scenarios are presented in Table A. 17 and Table A. 18 and illustrated in Figure A. 5 and Figure A. 6.

A.4.2.1.2 As for harbour porpoise, there appears to be a decline in both impacted and un-impacted populations for bottlenose dolphin across the modelled time series, when the fertility rate is set at 0.22 (scenarios BND-01a and BND-02a, after Arso Civil et al., 2017). Reported estimates of bottlenose dolphin abundance in the IS MU suggest an existing decline in the population, from 379 individuals in 2012 (Evans, 2012 in IAMMWG, 2021) to approximately 293 individuals in 2018 (Rogan et al., 2018; Hammond et al., 2021 in IAMMWG, 2021), representing declining trend of 4.2% per annum in the IS MU.

A.4.2.1.3 However, when the fertility parameter is set to 0.30 (scenarios BND-01b and BND-02b, after Sinclair *et al*., 2020), the decline is reversed, and the population appears to be modestly increasing in size.

Scenario BND-01a: maximum temporal scenario, 0.22 fertility rate

A.4.2.1.4 For the maximum temporal scenario applying a fertility rate of 0.22, the results of iPCoD modelling indicate a very small difference in the population trajectory of bottlenose dolphin between the un-impacted population and impacted population (Table A. 17 and Figure A. 5). At all time points there was a maximum difference of one animal in the mean size of the impacted and un-impacted populations.

A.4.2.1.5 For example, at time point 2, which represents the end of the first year of piling for the Mona Offshore Wind Project, the impacted population was predicted to be the same size as the un-impacted population (n = 288). At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference was predicted to be 279 animals in the impacted population, compared to 280 animals in the un-impacted population (Table A. 17).

A.4.2.1.6 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of the two-year piling phase (and 23 years after the cessation of piling), this difference was also one animal. This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the bottlenose dolphin population within the IS management unit.

Table A. 17: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum temporal scenario, with fertility rate of 0.22.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	258	**288**	314	258	**288**	314	0.9993	1.0000
3	246	**287**	322	244	**286**	320	0.9969	1.0000
7	216	**280**	342	216	**279**	340	0.9970	1.0000
9	206	**276**	344	206	**275**	342	0.9974	1.0000
11	200	**271**	350	198	**271**	348	0.9974	1.0000
13	194	**267**	348	192	**266**	348	0.9972	1.0000
21	170	**252**	356	170	**251**	352	0.9970	1.0000
26	148	**242**	354	148	**241**	354	0.9970	1.0000

A.4.2.1.7 The median counterfactual of population size for scenario BND-01a was 1.0000 throughout the 26-year simulation, whereas the mean counterfactual ratio at time point 26 was 0.9970. Therefore, given that the differences in impacted to un-impacted populations approaches a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon bottlenose dolphin.

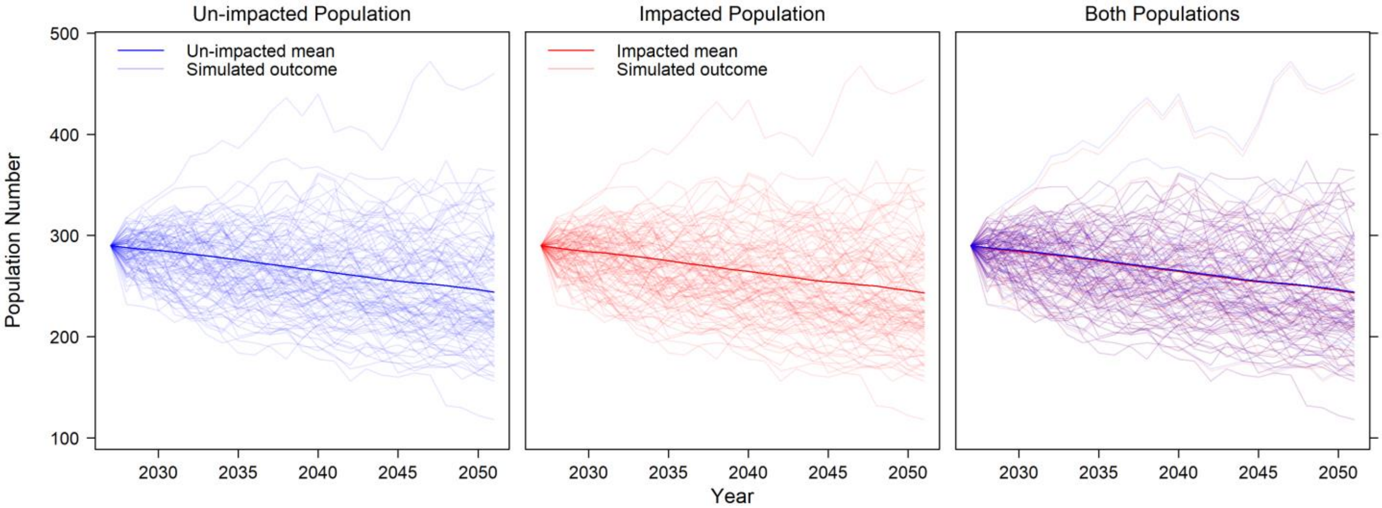

Figure A. 5: Simulated bottlenose dolphin population trajectories (fertility rate = 0.22) in an un-impacted versus impacted population, for the maximum temporal scenario.

Scenario BND-01b: maximum temporal scenario, 0.30 fertility rate

A.4.2.1.8 For the maximum temporal scenario applying a fertility rate of 0.30, the results of iPCoD modelling again indicate a very small difference in the population trajectory of bottlenose dolphin between the un-impacted population and impacted population (Table A. 18 and Figure A. 6). At all time points there was a maximum difference of one animal in the mean size of the impacted and un-impacted populations, although compared to scenario BND-01a, there was no difference at some time points.

Table A. 18: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum temporal scenario, with fertility rate of 0.30.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	258	**291**	316	258	**291**	316	0.9992	1.0000
3	248	**293**	330	248	**292**	328	0.9967	1.0000
7	226	**298**	364	226	**297**	364	0.9968	1.0000
9	222	**300**	376	222	**300**	374	0.9974	1.0000
11	214	**304**	392	214	**303**	390	0.9974	1.0000
13	210	**307**	404	210	**306**	402	0.9973	1.0000
21	194	**319**	446	194	**319**	446	0.9972	1.0000
26	190	**327**	480	190	**326**	478	0.9972	1.0000

A.4.2.1.9 At time point 2, which represents the end of the first year of piling for the Mona Offshore Wind Project, the impacted population was predicted to be the same size as the un-impacted population (n = 291). At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference was predicted to be 297 animals in the impacted population, compared to 298 animals in the un-impacted population (Table A. 18).

A.4.2.1.10 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of the two-year piling phase (and 23 years after the cessation of piling), this difference was also one animal. This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the bottlenose dolphin population within the IS management unit.

A.4.2.1.11 The median counterfactual of population size for scenario BND-01b was 1.0000 throughout the 26-year simulation, whereas the mean counterfactual ratio at time point 26 was 0.9972: marginally higher than for scenario BND-01a, with a higher fertility rate. Therefore, given that the differences in impacted to un-impacted populations approaches a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon bottlenose dolphin.

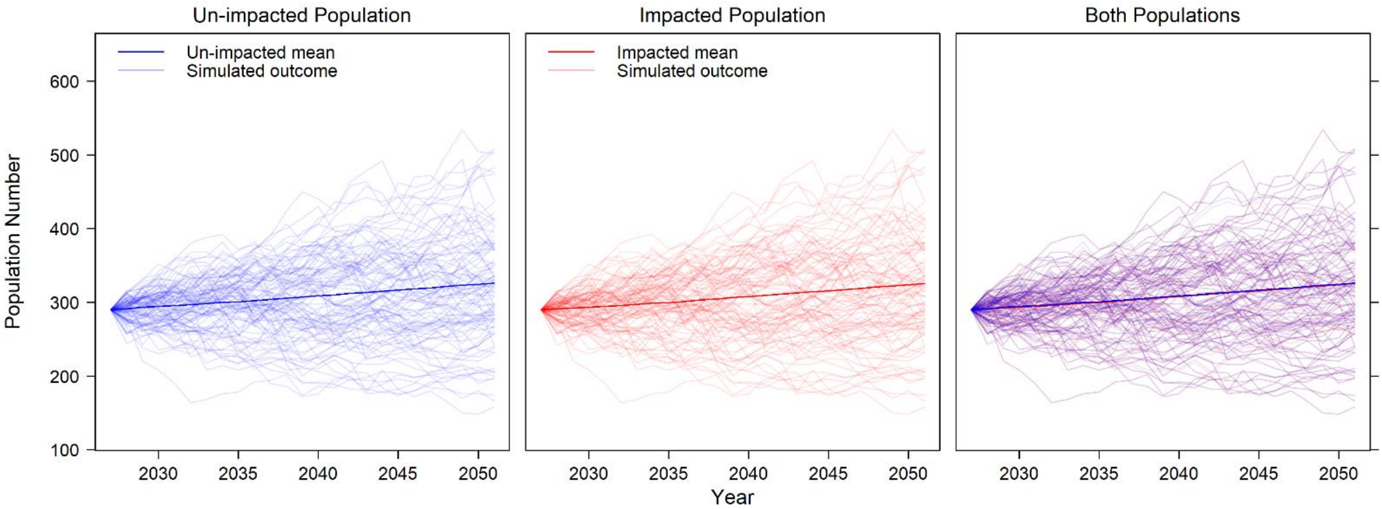

Figure A. 6: Simulated bottlenose dolphin population trajectories (fertility rate = 0.30) in an un-impacted versus impacted population, for the maximum temporal scenario.

Scenario BND-02a: maximum spatial scenario, 0.22 fertility rate

A.4.2.1.12 For the maximum spatial scenario applying a fertility rate of 0.22, the results of iPCoD modelling indicate a similarly small difference in the population trajectory of bottlenose dolphin between the un-impacted population and impacted population as for scenario BND-01a (Table A. 19 and Figure A. 7). At all time points there was a maximum difference of one animal in the mean size of the impacted and un-impacted populations.

Table A. 19: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum spatial scenario, with fertility rate of 0.22.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	254	**288**	314	254	**288**	314	0.9993	1.0000
3	246	**286**	324	244	**286**	324	0.9976	1.0000
7	218	**279**	340	218	**278**	338	0.9977	1.0000
9	208	**276**	344	208	**275**	342	0.9981	1.0000
11	204	**271**	348	204	**271**	346	0.9980	1.0000
13	194	**267**	348	192	**267**	348	0.9980	1.0000
21	162	**252**	356	162	**252**	356	0.9978	1.0000
26	150	**244**	366	150	**243**	362	0.9976	1.0000

A.4.2.1.13 At time point 3, corresponding to the end of the two-year piling phase for the Mona Offshore Wind Project, the impacted population was predicted to be the same size as the un-impacted population (n = 286). At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference was predicted to be 278 animals in the impacted population, compared to 279 animals in the un-impacted population (Table A. 19).

A.4.2.1.14 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of the two-year piling phase (and 23 years after the cessation of piling), this difference was also one animal. This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the bottlenose dolphin population within the IS management unit.

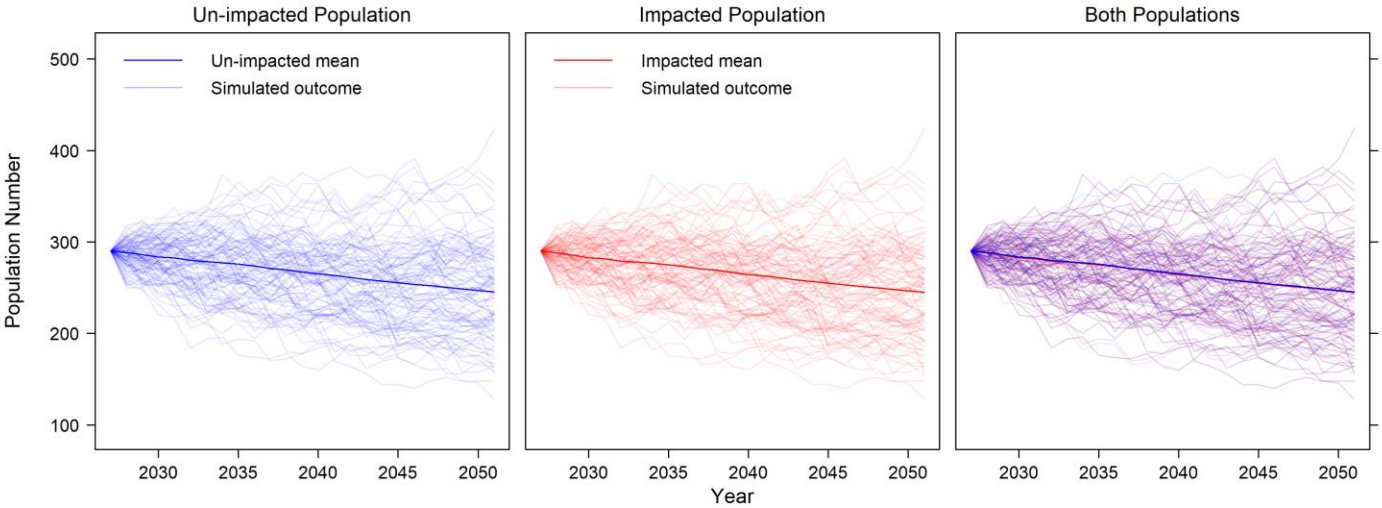

Figure A. 7: Simulated bottlenose dolphin population trajectories (fertility rate = 0.22) in an un-impacted versus impacted population, for the maximum spatial scenario.

A.4.2.1.15 The median counterfactual of population size for scenario BND-02a was 1.0000 throughout the 26-year simulation, whereas the mean counterfactual ratio at time point 26 was 0.9976. Therefore, given that the differences in impacted to un-impacted populations approaches a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon bottlenose dolphin.

Scenario BND-02b: maximum spatial scenario, 0.30 fertility rate

A.4.2.1.16 For the maximum temporal scenario applying a fertility rate of 0.30, the results of iPCoD modelling again indicate a very small difference in the population trajectory of bottlenose dolphin between the un-impacted population and impacted population (Table A. 20 and Figure A. 8). At all time points there was a maximum difference of one animal in the mean size of the impacted and un-impacted populations, with no difference in simulated population size at the first two time points.

A.4.2.1.17 At time point 3, which represents the end of the two-year piling phase for the Mona Offshore Wind Project, the impacted population was predicted to be the one individual smaller the un-impacted population (n = 292). At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference was predicted to be 299 animals in the impacted population, compared to 300 animals in the un-impacted population (Table A. 20).

Table A. 20: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum spatial scenario, with fertility rate of 0.30.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	258	**292**	320	258	**292**	318	0.9989	1.0000
3	252	**293**	332	250	**292**	330	0.9962	1.0000
7	234	**300**	364	234	**299**	364	0.9966	1.0000
9	228	**303**	378	226	**302**	378	0.9971	1.0000
11	224	**305**	390	224	**304**	390	0.9970	1.0000
13	218	**308**	410	218	**307**	410	0.9967	1.0000
21	214	**324**	466	210	**323**	462	0.9969	1.0000
26	210	**333**	494	208	**332**	494	1.0000	1.0000

A.4.2.1.18 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of the two-year piling phase (and 23 years after the cessation of piling), this difference was also one animal. This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the bottlenose dolphin population within the IS management unit.

A.4.2.1.19 The median counterfactual of population size for scenario BND-02b was 1.0000 throughout the 26-year simulation, whereas the mean counterfactual reduced to 0.9989 at time point 2, before returning to 1.0000 at time point 26. Therefore, given that the differences in impacted to un-impacted populations returned to a ratio of 1 there is not considered to be a potential for an effect from piling scenario BND-02b upon bottlenose dolphin.

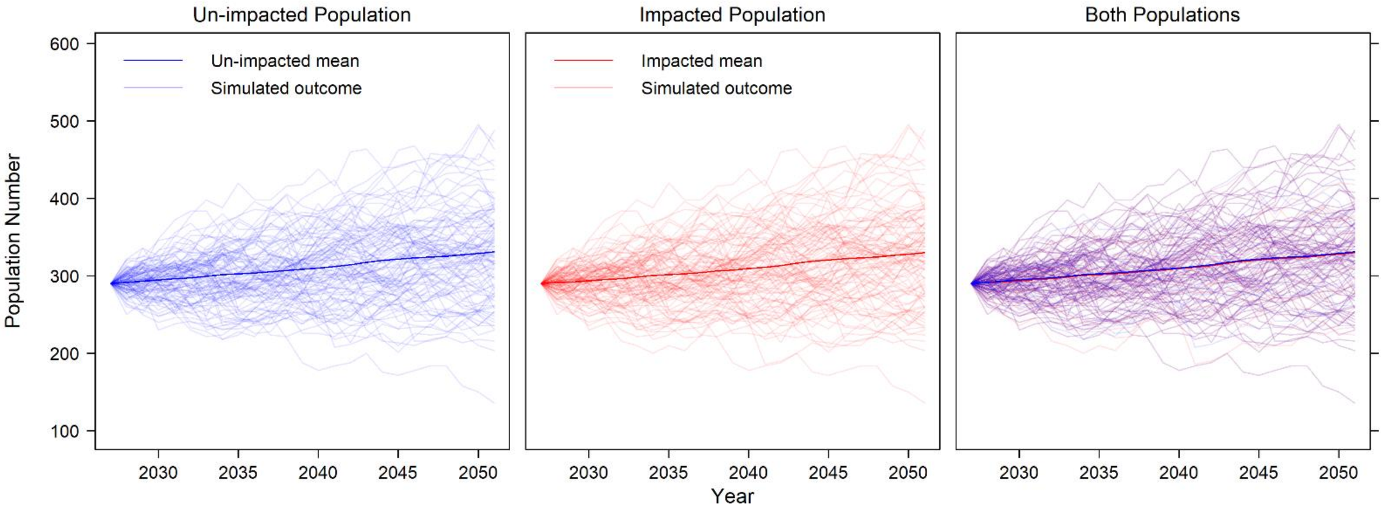

Figure A. 8: Simulated bottlenose dolphin population trajectories (fertility rate = 0.30) in an un-impacted versus impacted population, for the maximum spatial scenario.

A.4.2.2 Cumulative projects

A.4.2.2.1 Results of the iPCoD modelling at the time points described in Table A. 11 for bottlenose dolphin using the maximum spatial cumulative scenarios are presented in Table A. 21 to Table A. 24 and illustrated in Figure A. 9 to Figure A. 12.

A.4.2.2.2 As for the two project-alone scenarios for bottlenose dolphin based upon a fertility rate of 0.22, there appears to be a decline in both impacted and un-impacted populations (see section A.4.2.1) in cumulative scenarios BND-C1a and BND-C2a, for which models were also parameterised with a fertility rate of 0.22. However, when compared directly, a lower population trajectory is visible in the third panel of Figure A. 9 to Figure A. 12 for the impacted population in all cumulative scenarios for bottlenose dolphin, regardless of fertility rate.

Scenario BND-C1a: Tier 1 projects, 0.22 fertility rate

A.4.2.2.3 For scenario BND-C1a, in which a total of 90 days of piling occur at the Mona Offshore Wind Project alongside a total of 201 piling days at the Awel y Môr Tier 1 cumulative project, these results indicate a difference of five fewer animals in the impacted population at time point 26, compared to the un-impacted population (Table A. 21).

A.4.2.2.4 At time point 7, which corresponds to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is seven animals (2.39% of the reference population). When compared to the equivalent impacted population estimate from scenario BND-02a (i.e. the maximum spatial scenario for the Mona Offshore Wind Project alone: n = 278), this is a difference of five animals.

A.4.2.2.5 This suggests that after an initial effect of disturbance upon the bottlenose dolphin population from the cumulative projects, peaking approximately seven years after the start of piling (i.e. time point 8), this effect is expected to stabilise across the duration of the modelled time series (i.e. the counterfactual of population size is not expected to reduce after six years).

Table A. 21: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum spatial scenario BND-C1a, with fertility rate of 0.22.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	256	**288**	316	256	**287**	316	0.9992	1.0000
3	244	**286**	324	236	**281**	322	0.9819	1.0000
7	216	**279**	342	208	**272**	336	0.9758	1.0000
8	212	**277**	342	204	**270**	338	0.9772	1.0000
9	208	**275**	348	204	**269**	340	0.9784	1.0000
11	204	**272**	356	200	**266**	348	0.9791	1.0000
13	190	**269**	358	188	**263**	354	0.9778	1.0000
21	164	**254**	366	162	**248**	364	0.9777	1.0000
26	152	**245**	366	144	**240**	362	0.9781	1.0000

A.4.2.2.6 As for scenarios BND-01a and BND-02a for the Mona Offshore Wind Project alone, there appears to be a decline in both impacted and un-impacted populations for bottlenose dolphin (see section A.4.2.1). However, when compared directly, a slightly lower population trajectory is visible in the third panel of Figure A. 9 for the impacted population for cumulative scenario BND-C1a.

A.4.2.2.7 The potential effect from cumulative piling upon the bottlenose dolphin population within the IS MU would be expected to reduce over the longer term, although this should be considered against a background of an already contracting population (given a fertility rate of 0.22).

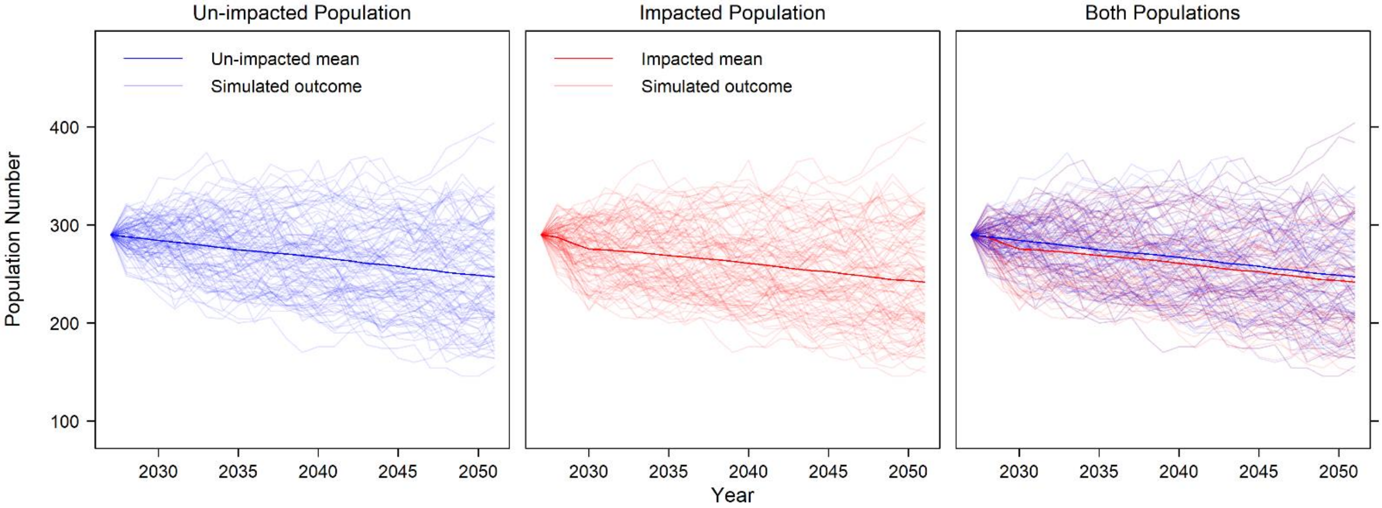

Figure A. 9: Simulated bottlenose dolphin population trajectories (fertility rate = 0.22) in an un-impacted versus impacted population, for cumulative scenario BND-C1a (Tier 1 projects only).

A.4.2.2.8 The median counterfactual of population size for scenario BND-C1a was 1.0000 throughout the 26-year simulation, while the mean counterfactual ratio at time point 26 was 0.9781. A lower counterfactual of 0.9758 was calculated at time point 7, however given that the differences in impacted to un-impacted populations at all time points approaches a ratio of 1 there is expected to be no potential for a long-term effect from cumulative piling scenario BND-C1a upon the IS MU bottlenose dolphin population.

Scenario BND-C1b: Tier 1 projects, 0.30 fertility rate

A.4.2.2.9 For scenario BND-C1b, which is equivalent to scenario BND-C1a with the exception of the model being parameterised with a fertility rate of 0.30, these results indicate a difference of eight fewer animals in the impacted population at time point 26, compared to the un-impacted population (Table A. 22).

A.4.2.2.10 At time point 7, which corresponds to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is eight animals (2.73% of the reference population). When compared to the equivalent impacted population estimate from scenario BND-02b (Table A. 20, n = 299), this is a difference of one animal.

A.4.2.2.11 This suggests that after an initial effect of disturbance upon the bottlenose dolphin population from the cumulative projects, peaking approximately seven years after the start of piling (i.e. time point 8), this effect is expected to stabilise across the duration of the modelled time series (i.e. the counterfactual of population size is not expected to reduce after the lowest estimate at six years after the start of piling).

Table A. 22: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum spatial scenario BND-C1b, with fertility rate of 0.30.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	254	**291**	318	254	**291**	318	0.9994	1.0000
3	248	**293**	330	238	**287**	328	0.9799	1.0000
7	230	**299**	364	222	**291**	360	0.9742	1.0000
8	226	**301**	372	224	**293**	368	0.9764	1.0000
9	228	**303**	378	222	**296**	376	0.9780	1.0000
11	222	**305**	392	220	**298**	388	0.9785	1.0000
13	218	**309**	406	210	**302**	398	0.9768	1.0000
21	204	**325**	462	200	**317**	454	0.9764	1.0000
26	196	**335**	490	190	**327**	484	0.9764	1.0000

A.4.2.2.12 The median counterfactual of population size for scenario BND-C1b was 1.0000 throughout the 26-year simulation, while the mean counterfactual at time point 26 was 0.9764. A lower mean counterfactual of 0.9742 was calculated at time point 7, however given that the differences in impacted to un-impacted populations at all time points approach a ratio of 1 there is expected to be no potential for a long-term effect from cumulative piling scenario BND-C1b upon the IS MU bottlenose dolphin population.

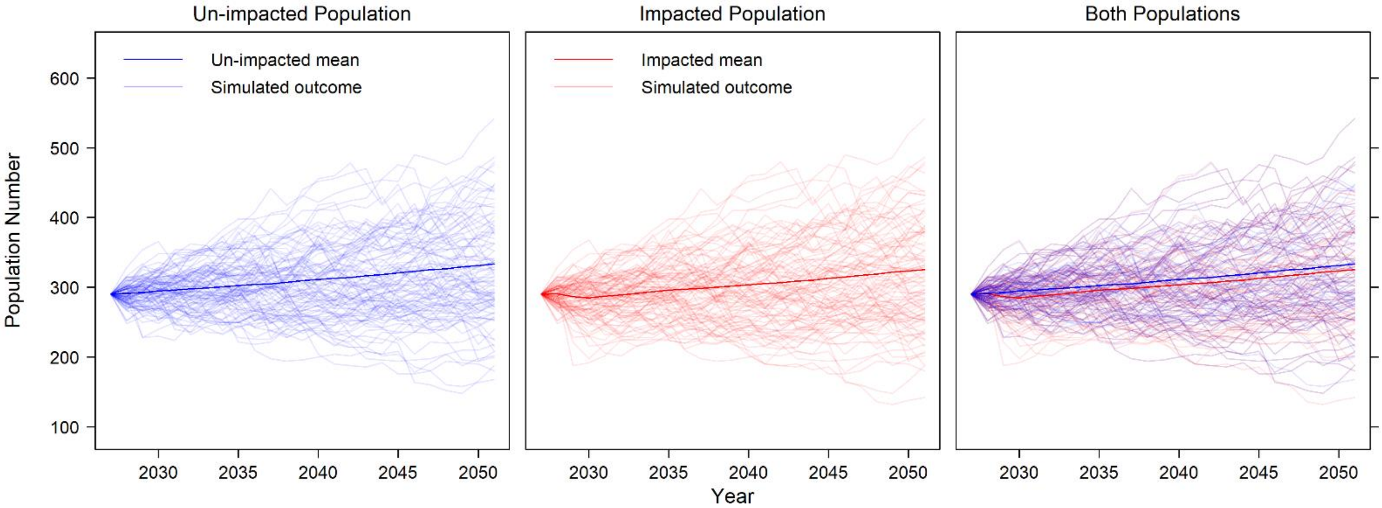

Figure A. 10: Simulated bottlenose dolphin population trajectories (fertility rate = 0.30) in an un-impacted versus impacted population, for cumulative scenario BND-C1b (Tier 1 projects only).

Scenario BND-C2a: Tier 1 and Tier 2 projects, 0.22 fertility rate

A.4.2.2.13 For scenario BND-C2a, in which a total of 90 days of piling occur at the Mona Offshore Wind Project alongside a total of 284 piling days at Tier 1 and Tier 2 cumulative projects, these results indicate a difference of six fewer animals in the impacted population at time point 26, compared to the un-impacted population (Table A. 23).

A.4.2.2.14 At time point 7, which corresponds to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is eight animals (2.73% of the reference population). When compared to the equivalent impacted population estimate from scenario BND-02a (i.e. the maximum spatial scenario for the Mona Offshore Wind Project alone: n = 278), this is a difference of seven animals, and when compared to scenario BND-C1a (i.e. Tier 1 projects only: n = 272), this is a difference of one animal.

A.4.2.2.15 This suggests that after an initial effect of disturbance upon the bottlenose dolphin population from the cumulative projects, peaking approximately six years after the start of piling (i.e. time point 7), this effect is expected to stabilise across the duration of the modelled time series (i.e. the counterfactual of population size is not expected to reduce after six years, see Figure A. 11).

Table A. 23: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum spatial scenario BND-C2a, with fertility rate of 0.22.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	256	**288**	312	254	**288**	312	0.9974	1.0000
3	246	**287**	322	234	**280**	320	0.9772	1.0000
7	218	**279**	336	206	**271**	332	0.9720	1.0000
8	212	**278**	340	204	**271**	330	0.9738	1.0000
9	208	**276**	340	200	**269**	336	0.9756	1.0000
11	196	**271**	344	192	**265**	338	0.9770	1.0000
13	188	**268**	350	182	**262**	346	0.9760	1.0000
21	164	**253**	358	158	**247**	354	0.9757	1.0000
26	154	**245**	348	150	**239**	346	0.9757	1.0000

A.4.2.2.16 The median counterfactual of population size for scenario BND-C2a was 1.0000 throughout the 26-year simulation, while the mean counterfactual at time point 26 was 0.9757. A lower mean counterfactual of 0.9720 was calculated at time point 7, however given that the differences in impacted to un-impacted populations at all time points approach a ratio of 1 there is expected to be no potential for a long-term effect from cumulative piling scenario BND-C2a upon the IS MU bottlenose dolphin population.

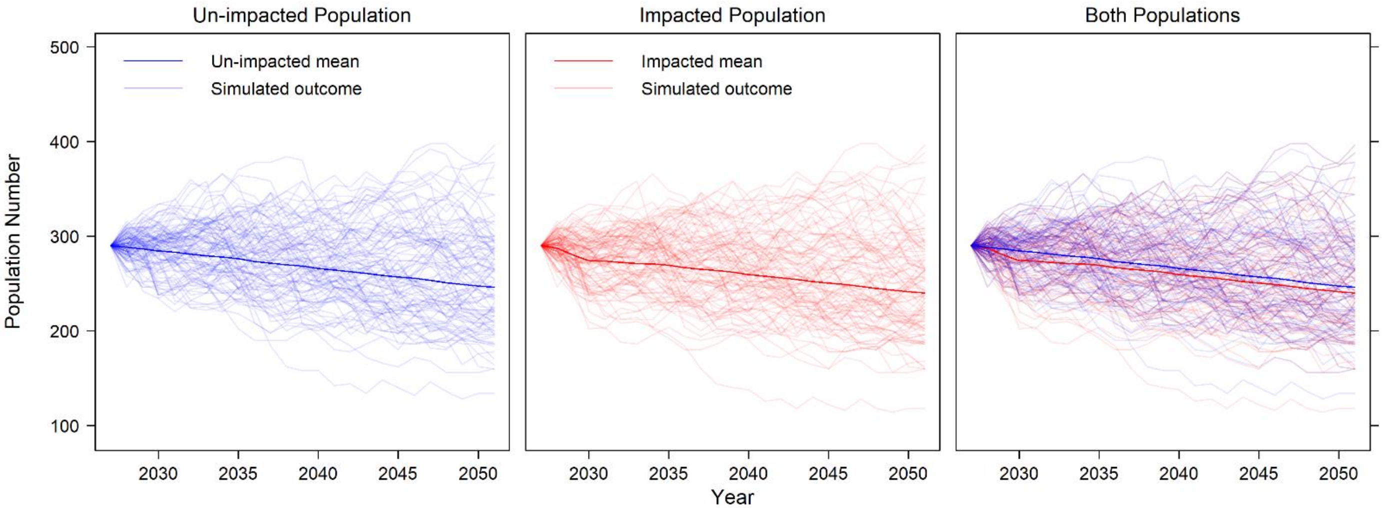

Figure A. 11: Simulated bottlenose dolphin population trajectories (fertility rate = 0.22) in un-impacted versus impacted populations, for cumulative scenario BND-C2a (Tier 1 and Tier 2 projects).

Scenario BND-C2b: Tier 1 and Tier 2 projects, 0.30 fertility rate

A.4.2.2.17 For scenario BND-C2b, which is equivalent to scenario BND-C2a with the exception of the model being parameterised with a fertility rate of 0.30, these results indicate a difference of eight fewer animals in the impacted population at time point 26, compared to the un-impacted population (Table A. 24).

Table A. 24: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for bottlenose dolphin under the maximum spatial scenario BND-C2b, with fertility rate of 0.30.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	290	**290**	290	290	**290**	290	1.0000	1.0000
2	254	**291**	318	254	**290**	316	0.9977	1.0000
3	248	**293**	334	234	**286**	332	0.9759	1.0000
7	230	**300**	366	218	**292**	364	0.9715	1.0000
8	226	**302**	370	216	**294**	368	0.9737	1.0000
9	222	**304**	382	214	**296**	380	0.9758	1.0000
11	216	**307**	396	210	**300**	388	0.9768	1.0000
13	218	**310**	408	206	**302**	406	0.9751	1.0000
21	208	**325**	476	200	**317**	458	0.9751	1.0000
26	200	**334**	506	192	**326**	494	0.9749	1.0000

A.4.2.2.18 At time point 7, which corresponds to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is eight animals (2.73% of the reference population). When compared to the equivalent impacted population estimate at time point 7 in scenario BND-02b (i.e.

the maximum spatial scenario for the Mona Offshore Wind Project alone: n = 299), this is a difference of seven animals, and when compared to scenario BND-C1b (i.e. Tier 1 projects only: n = 291), this is a difference of one animal.

A.4.2.2.19 This suggests that after an initial effect of disturbance upon the bottlenose dolphin population from the cumulative projects, peaking approximately eight years after the start of piling (i.e. time point 9), this effect is expected to stabilise across the duration of the modelled time series (i.e. the counterfactual of population size is not expected to reduce after eight years, see Figure A. 12).

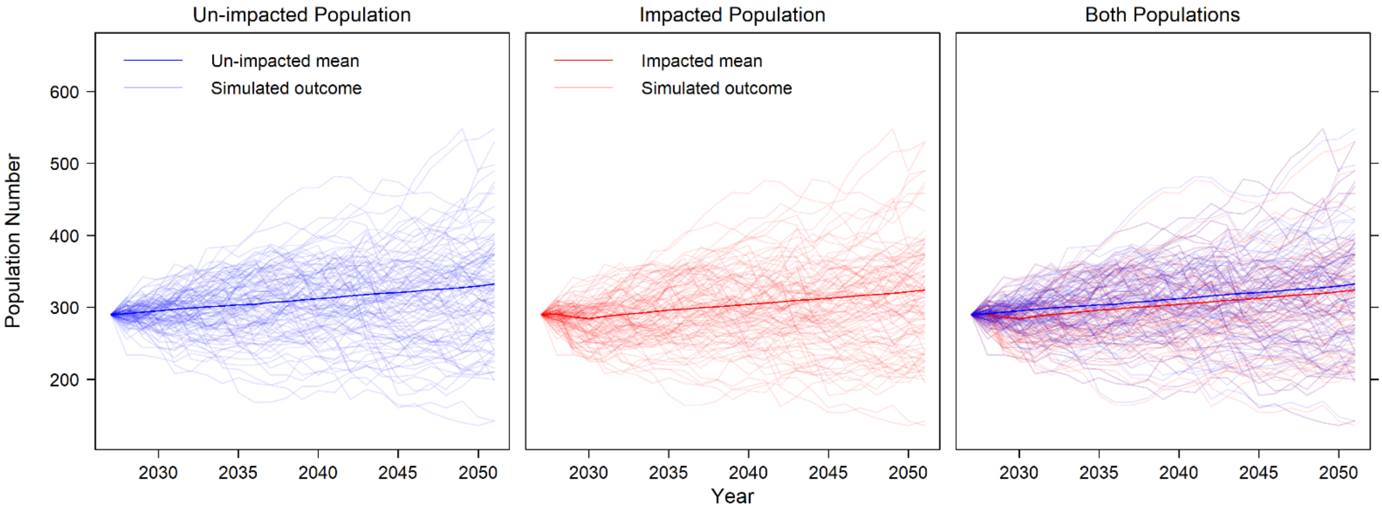

Figure A. 12: Simulated bottlenose dolphin population trajectories (fertility rate = 0.30) in un-impacted versus impacted populations, for cumulative scenario BND-C2a (Tier 1 and Tier 2 projects).

A.4.2.2.20 The median counterfactual of population size for scenario BND-C2b was 1.0000 throughout the 26-year simulation, while the mean counterfactual at time point 26 was 0.9749. A lower mean counterfactual of 0.9715 was calculated at time point 7, however given that the differences in impacted to un-impacted populations at all time points approach a ratio of 1 there is expected to be no potential for a long-term effect from cumulative piling scenario BND-C2b upon the IS MU bottlenose dolphin population.

A.4.3 Minke whale

A.4.3.1 Project alone

A.4.3.1.1 Results of the iPCoD modelling for minke whale, at the time points described in Table A. 7, under the maximum temporal and maximum spatial scenarios for the Mona Offshore Wind Project alone, are presented in Table A. 25 and Table A. 26. Simulated trajectories of both un-impacted and impacted populations of minke whale appear to be broadly stable in size and are illustrated in Figure A. 13 and Figure A. 14, respectively.

Scenario MW-01: maximum temporal scenario

A.4.3.1.2 For the maximum temporal scenario the results of iPCoD simulations indicate a very small difference in the trajectory of minke whale between the un-impacted population and impacted population (Table A. 25). At all time points there was very little difference in the mean size of the impacted and un-impacted populations (Figure A. 13).

A.4.3.1.3 At time point 3, which represents the end of the two-year piling phase, the impacted population was predicted to be 17 animals smaller than the un-impacted population. At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations was 60 animals.

Table A. 25: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for minke whale under the maximum temporal scenario.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	20,120	**20,120**	20,120	20,120	**20,120**	20,120	1.0000	1.0000
2	17,821	**20,108**	21,788	17,804	**20,104**	21,788	0.9998	1.0000
3	17,360	**20,109**	22,548	17,334	**20,092**	22,542	0.9992	0.9995
7	16,631	**19,986**	23,884	16,582	**19,926**	23,807	0.9970	0.9976
9	16,474	**19,976**	24,298	16,341	**19,905**	24,276	0.9964	0.9972
11	16,128	**19,919**	24,611	16,090	**19,839**	24,459	0.9960	0.9968
13	15,623	**19,913**	25,052	15,578	**19,826**	24,892	0.9957	0.9965
21	14,900	**19,916**	26,425	14,835	**19,820**	26,300	0.9952	0.9959
26	14,368	**19,918**	27,102	14,296	**19,822**	26,966	0.9952	0.9959

A.4.3.1.4 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of piling (and 23 years after the cessation of piling), this difference has increased to 96 animals, corresponding to approximately 0.48% of the reference population (Table A. 13). This suggests that there would not be a long-term increase in any potential effect from piling upon the minke whale population within the CGNS MU.

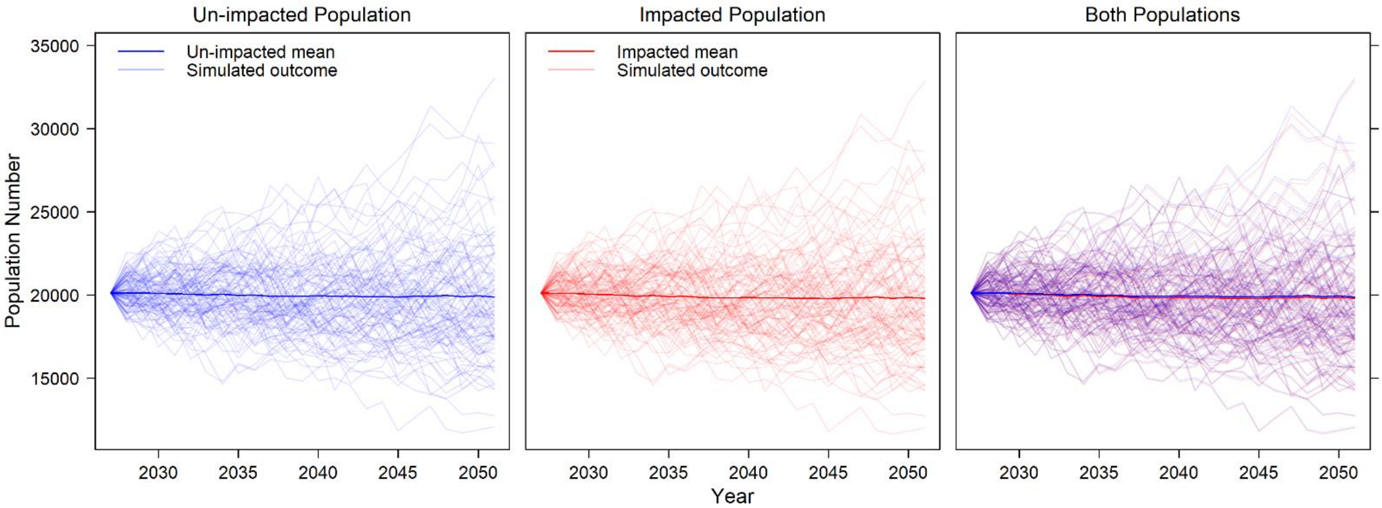

Figure A. 13: Simulated minke whale population trajectories in an un-impacted versus impacted population, for the maximum temporal scenario.

A.4.3.1.5 The median counterfactual for scenario MW-01 reduced from 1.0000 to 0.9959 through the 26-year simulation, whereas the mean counterfactual reduced to 0.9952. Therefore, given that the differences in disturbed to un-disturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term effect from this piling scenario upon minke whale.

Scenario MW-02: maximum spatial scenario

A.4.3.1.6 For the maximum spatial scenario the results indicate a very small difference in the population trajectory of minke whale between the un-impacted population and impacted population (Table A. 26 and Figure A. 14).

A.4.3.1.7 At all time points there was very little difference in the mean size of the impacted and un-impacted populations. At time point 3, corresponding to the end of the two-year piling phase, the impacted population was predicted to be 13 fewer than the un-impacted population, corresponding to approximately 0.065% of the reference population. At time point 7, representing six years following the start of piling, and corresponding to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations was 47 animals.

A.4.3.1.8 At time point 26, which represents the population at the end point of the iPCoD modelling, 25 years after the start of piling (and 23 years after the cessation of piling), this difference was 74 animals (Table A. 26). This suggests that there would not be a long-term increase in any potential effect from piling upon the minke whale population within the CGNS MU.

Table A. 26: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for minke whale under the maximum spatial scenario.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	20,120	**20,120**	20,120	20,120	**20,120**	20,120	1.0000	1.0000
2	17,822	**20,142**	21,832	17,822	**20,139**	21,832	0.9998	1.0000
3	17,386	**20,137**	22,654	17,372	**20,124**	22,634	0.9993	0.9996
7	16,871	**20,125**	23,837	16,867	**20,078**	23,813	0.9976	0.9983
9	16,695	**20,158**	24,537	16,624	**20,102**	24,376	0.9972	0.9979
11	16,178	**20,072**	24,573	16,152	**20,009**	24,488	0.9969	0.9975
13	15,721	**20,008**	25,089	15,670	**19,940**	25,005	0.9966	0.9973
21	15,000	**20,006**	27,115	14,884	**19,931**	27,063	0.9962	0.9969
26	14,680	**20,011**	27,564	14,582	**19,937**	27,423	0.9963	0.9969

A.4.3.1.9 The median counterfactual of population size for scenario MW-02 was 0.9969 at the end of the 26-year simulation, whereas the mean counterfactual ratio at time point 26 had reduced from 1.0000 to 0.9963. Therefore, given that the differences in disturbed to undisturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term effect from this piling scenario upon mike whale.

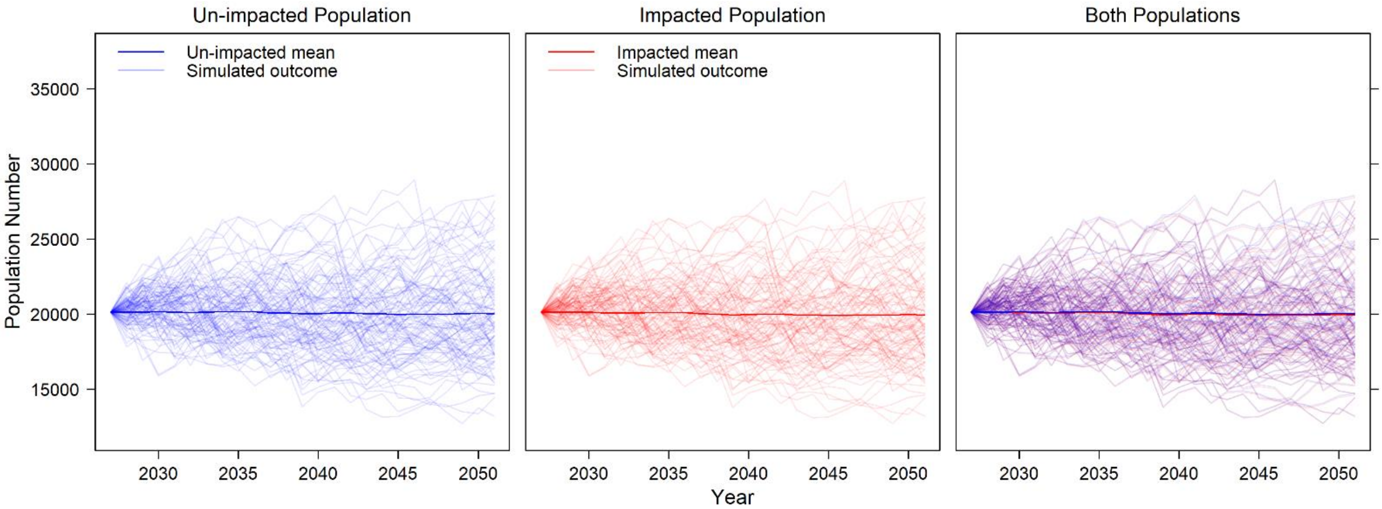

Figure A. 14: Simulated minke whale population trajectories in an un-impacted versus impacted population, for the maximum temporal scenario.

A.4.3.2 Cumulative projects

A.4.3.2.1 Results of the iPCoD modelling at the time points described in Table A. 10 for minke whale using the maximum spatial cumulative scenarios are presented in Table A. 27 and Table A. 28 and illustrated in Figure A. 15 and Figure A. 16, respectively.

Scenario MW-C1: Tier 1 projects

A.4.3.2.2 For scenario MW-C1, in which a total of 90 days of piling occur at the Mona Offshore Wind Project alongside a total of 225 piling days across Tier 1 cumulative projects (18 days at Project Erebus, six days at White Cross Offshore Windfarm and 201 days at Awel y Môr), these results indicate a difference of 75 fewer animals in the impacted population at time point 26, compared to the un-impacted population (Table A. 15).

A.4.3.2.3 At time point 7, which corresponds to the six-year reporting period formerly required under the Habitats Directive, the difference between impacted and un-impacted populations is 33 animals (0.16% of the reference population). When compared to the equivalent population estimate from scenario MW-02 (n = 47), this is a difference of 14 animals.

A.4.3.2.4 The median counterfactual of population size for scenario MW-C1 was 0.9967 at the end of the 26-year simulation, while the mean counterfactual was 0.9962. Therefore, given that the differences in disturbed to un-disturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term MU population-level effect from this cumulative piling scenario upon minke whale.

A.4.3.2.5 The results of the simulations, reflected in the counterfactual of population size, suggest that after an initial effect of disturbance upon the minke whale population from the Tier 1 cumulative projects, peaking approximately three years after the start of piling, this effect is expected to stabilise across the duration of the modelled time series (i.e. the counterfactual of population size is not expected to reduce substantially after four years).

Table A. 27: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for minke whale for cumulative piling scenario MW-C1.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	20,120	20,120	20,120	20,120	20,120	20,120	1.0000	1.0000
3	17,313	20,045	22,500	17,313	20,045	22,500	1.0000	1.0000
4	17,071	20,074	22,866	17,071	20,071	22,868	0.9999	1.0000
5	16,973	20,067	23,168	16,975	20,054	23,151	0.9994	0.9996
7	16,758	20,068	23,506	16,753	20,035	23,471	0.9983	0.9988
9	16,408	19,992	24,140	16,346	19,946	24,089	0.9977	0.9982
10	16,387	20,034	24,291	16,349	19,983	24,161	0.9974	0.9980
11	16,227	19,952	24,716	16,148	19,897	24,663	0.9972	0.9978
13	16,157	19,988	25,110	16,071	19,926	25,040	0.9969	0.9975
15	15,493	19,919	25,639	15,431	19,852	25,533	0.9966	0.9972
23	14,634	19,807	26,364	14,587	19,732	26,320	0.9962	0.9967
26	14,381	19,782	27,058	14,294	19,707	26,951	0.9962	0.9967

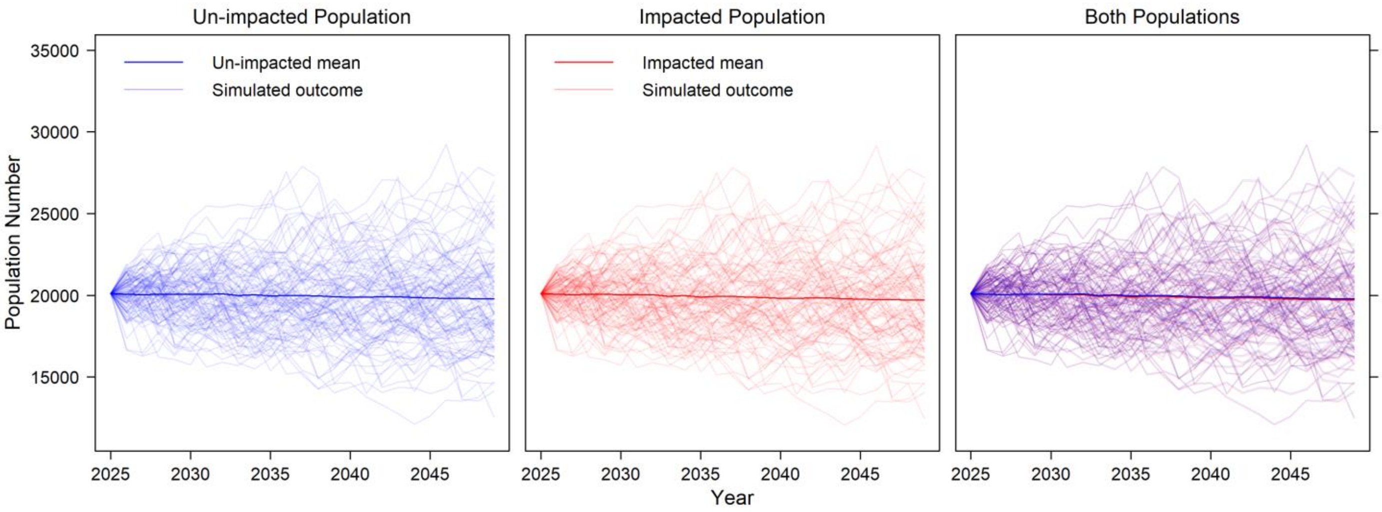

Figure A. 15: Simulated minke whale population trajectories in an un-impacted versus impacted population, for cumulative scenario MW-C1 (Tier 1 projects only).

Scenario MW-C2: Tier 1 and Tier 2 projects

A.4.3.2.6 The results for scenario MW-C2 (i.e. 90 days of piling for the Mona Offshore Wind Project alongside up to 308 piling days from Tier 1 and Tier 2 cumulative projects) indicate a similar pattern in the population trajectory as scenario MW-C1 (Table A. 28).

A.4.3.2.7 The impacted population size at time point 26 is estimated to be 77 animals fewer than the un-impacted population (0.38% of the reference population), and for time point 7, this difference reduces to 34 animals fewer than the un-impacted population. As for scenario MW-C1, an initial peak in the effect after five years appears to reduce and stabilise over the longer term (Figure A. 16).

Table A. 28: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for minke whale for cumulative piling scenario MW-C2.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	20,120	**20,120**	20,120	20,120	**20,120**	20,120	1.0000	1.0000
3	17,297	**20,060**	22,586	17,297	**20,060**	22,586	1.0000	1.0000
4	17,260	**20,040**	22,881	17,260	**20,037**	22,879	0.9999	1.0000
5	16,968	**20,058**	23,362	16,957	**20,045**	23,363	0.9993	0.9996
7	16,640	**20,053**	23,794	16,632	**20,019**	23,756	0.9983	0.9988
9	16,441	**20,047**	24,584	16,363	**20,000**	24,542	0.9976	0.9982
10	16,044	**20,038**	24,826	16,033	**19,986**	24,770	0.9974	0.9980
11	16,148	**20,063**	25,221	16,082	**20,007**	25,162	0.9972	0.9978
13	15,806	**20,106**	25,670	15,715	**20,042**	25,592	0.9968	0.9975
15	15,698	**20,089**	25,630	15,644	**20,020**	25,479	0.9965	0.9972
23	14,854	**20,043**	27,013	14,732	**19,966**	26,960	0.9961	0.9968
26	14,612	**20,067**	27,592	14,613	**19,990**	27,566	0.9961	0.9968

A.4.3.2.8 The median counterfactual of population size for scenario MW-C2 was 0.9968 at the end of the 26-year simulation, while the mean counterfactual at the same time point was 0.9961. Therefore, given that the differences in disturbed to undisturbed populations approaches a ratio of 1 there is not considered to be a potential for a long-term MU population-level effect from this cumulative piling scenario upon minke whale.

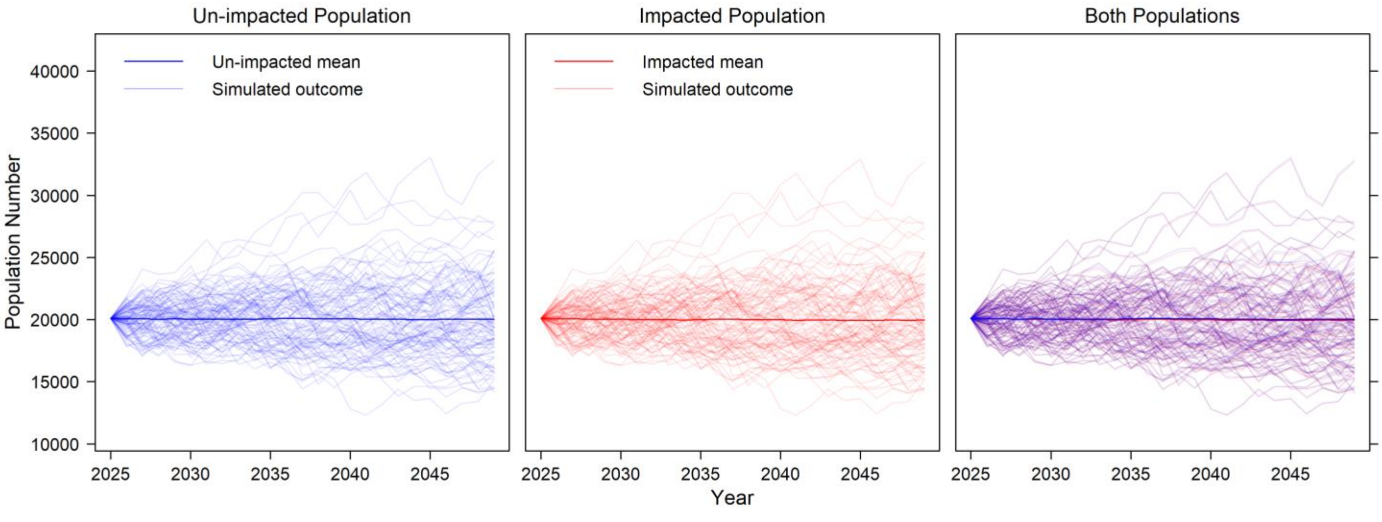

Figure A. 16: Simulated minke whale population trajectories in un-impacted versus impacted populations, for cumulative scenario MW-C2 (Tier 1 and Tier 2 projects).

A.4.4 Grey seal

A.4.4.1 Project alone

A.4.4.1.1 Results of the iPCoD modelling at the time points described in Table A. 7 for grey seal under the maximum temporal and maximum spatial piling scenarios are presented in Table A. 29 to Table A. 32. Based upon the vital rates used to parameterise these models, simulated trajectories of both GSRP and OSPAR Region III reference populations of grey seal appear to be increasing in size and are illustrated in Figure A. 17 to Figure A. 20.

A.4.4.1.2 For grey seal, iPCoD models incorporating the maximum temporal scenario and the maximum spatial scenario were based upon two reference populations: the GSRP (as described in section A.3.3 and Table A. 3) and the OSPAR Region III population.

Scenario GS-01a: maximum temporal scenario, GSRP

A.4.4.1.3 For the maximum temporal scenario for the GSRP, the results of iPCoD modelling indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 29 and Figure A. 17).

A.4.4.1.4 At all time points there was a no difference in the mean size of the impacted and un-impacted populations. This includes at time point 3 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the SMUs that comprise the GSRP.

Table A. 29: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal under the maximum temporal scenario, for the GSRP.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	12,908	**12,908**	12,908	12,908	**12,908**	12,908	1.0000	1.0000
2	11,950	**13,076**	13,914	11,950	**13,076**	13,914	1.0000	1.0000
3	11,900	**13,275**	14,448	11,900	**13,275**	14,448	1.0000	1.0000
7	11,882	**14,026**	16,143	11,882	**14,026**	16,143	1.0000	1.0000
9	11,804	**14,395**	16,945	11,804	**14,395**	16,945	1.0000	1.0000
11	11,886	**14,799**	17,939	11,886	**14,799**	17,939	1.0000	1.0000
13	11,937	**15,220**	18,797	11,937	**15,220**	18,797	1.0000	1.0000
21	12,459	**16,930**	21,974	12,459	**16,930**	21,974	1.0000	1.0000
26	12,635	**18,058**	24,402	12,635	**18,058**	24,402	1.0000	1.0000

A.4.4.1.5 Both the median and mean counterfactual of population size for scenario GS-01a were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the SMUs that comprise the GSRP.

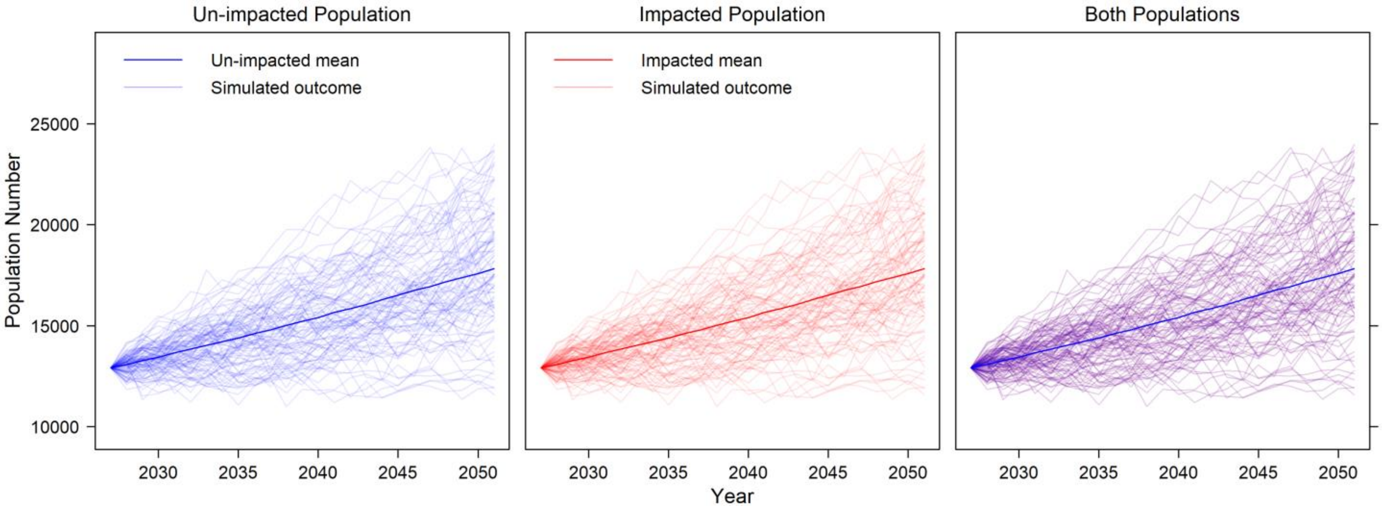

Figure A. 17: Simulated grey seal population trajectories for the GSRP in an un-impacted versus impacted population, for the maximum temporal scenario.

Scenario GS-01b: maximum temporal scenario, OSPAR Region III

A.4.4.1.6 For the maximum temporal scenario for the OSPAR Region III reference population, the results of iPCoD modelling indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 30 and Figure A. 18).

A.4.4.1.7 At all time points there was no difference in the mean size of the impacted and un-impacted populations. This includes at time point 2 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the bottlenose dolphin population within the IS management unit.

A.4.4.1.8 Both the median and mean counterfactual of population size for scenario GS-01b were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the OSPAR Region III reference population.

Table A. 30: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal under the maximum temporal scenario, for the OSPAR Region III reference population.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	60,780	**60,780**	60,780	60,780	**60,780**	60,780	1.0000	1.0000
2	56,505	**61,502**	65,178	56,505	**61,502**	65,178	1.0000	1.0000
3	55,812	**62,231**	67,597	55,812	**62,231**	67,597	1.0000	1.0000

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
7	54,325	**65,602**	76,210	54,325	**65,602**	76,210	1.0000	1.0000
9	55,599	**67,258**	79,773	55,599	**67,258**	79,773	1.0000	1.0000
11	55,179	**69,035**	84,359	55,179	**69,035**	84,359	1.0000	1.0000
13	55,870	**70,935**	88,361	55,870	**70,935**	88,361	1.0000	1.0000
21	57,097	**78,660**	103,377	57,097	**78,660**	103,377	1.0000	1.0000
26	58,622	**83,933**	114,964	58,622	**83,933**	114,964	1.0000	1.0000

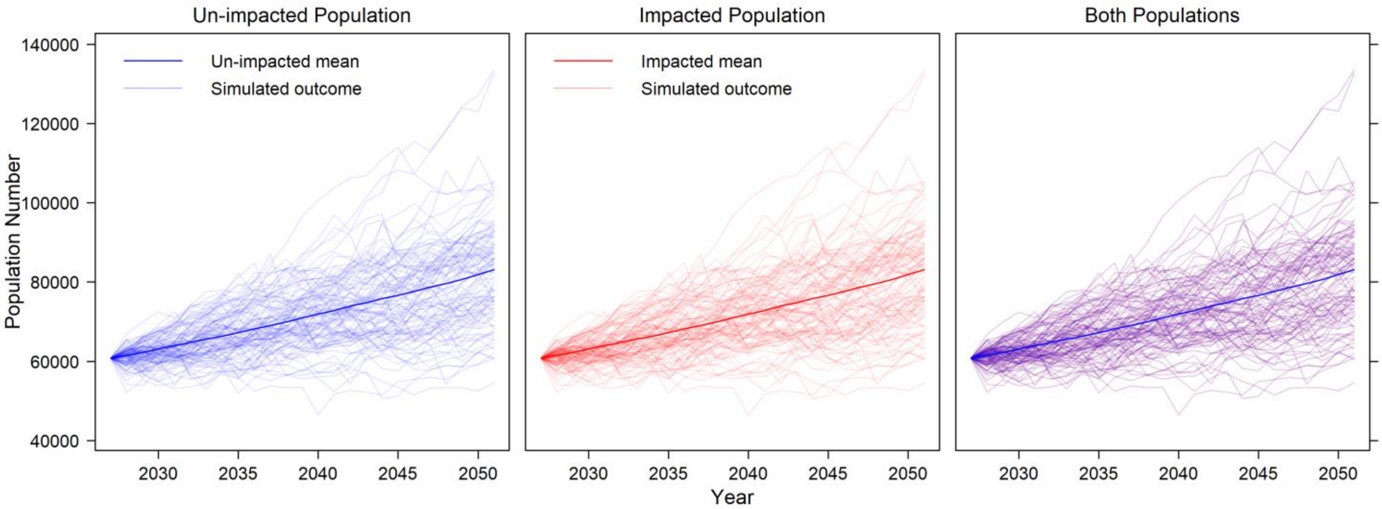

Figure A. 18: Simulated grey seal population trajectories for the OSPAR Region III reference population in an un-impacted versus impacted population, for the maximum temporal scenario.

Scenario GS-02a: maximum spatial scenario, GSRP

A.4.4.1.9 For the maximum spatial scenario for the GSRP, the results of iPCoD modelling indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 31 and Figure A. 19).

A.4.4.1.10 At all time points there was a no difference in the mean size of the impacted and un-impacted populations. This includes at time point 3 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the SMUs that comprise the GSRP.

Table A. 31: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal under the maximum spatial scenario, for the GSRP.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	12,908	**12,908**	12,908	12,908	**12,908**	12,908	1.0000	1.0000
2	11,894	**13,054**	13,894	11,894	**13,054**	13,894	1.0000	1.0000
3	11,860	**13,242**	14,330	11,860	**13,242**	14,330	1.0000	1.0000
7	11,720	**13,986**	16,060	11,720	**13,986**	16,060	1.0000	1.0000
9	11,732	**14,364**	16,918	11,732	**14,364**	16,918	1.0000	1.0000
11	11,873	**14,742**	17,732	11,873	**14,742**	17,732	1.0000	1.0000
13	12,000	**15,107**	18,555	12,000	**15,107**	18,555	1.0000	1.0000
21	12,451	**16,768**	21,669	12,451	**16,768**	21,669	1.0000	1.0000
26	12,694	**17,957**	23,807	12,694	**17,957**	23,807	1.0000	1.0000

A.4.4.1.11 Both the median and mean counterfactual of population size for scenario GS-02a were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the SMUs that comprise the GSRP.

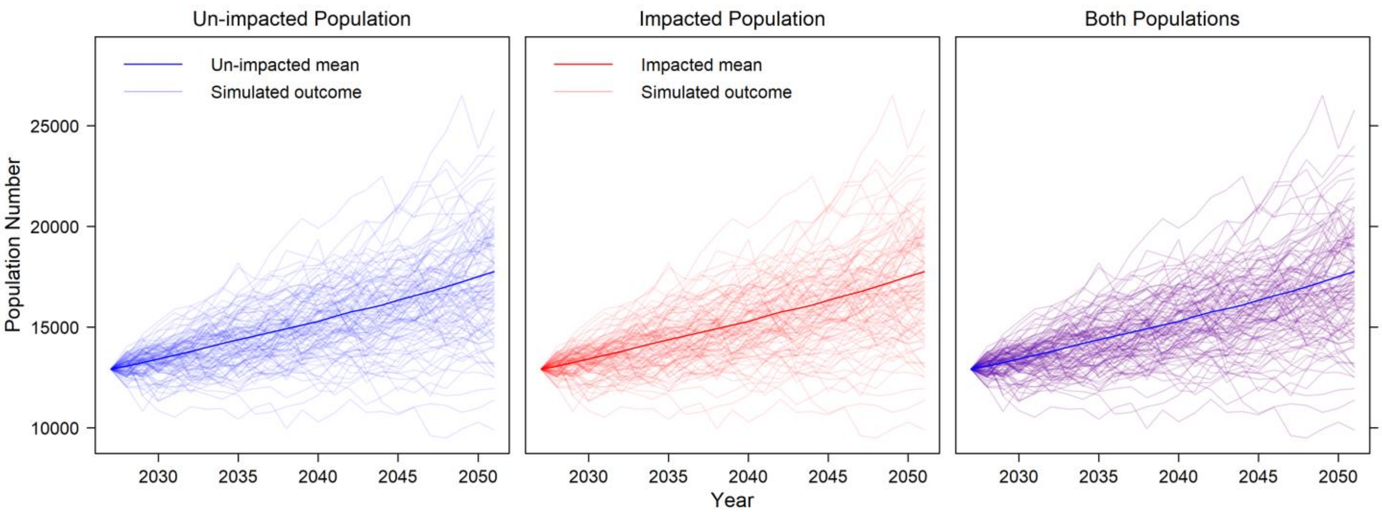

Figure A. 19: Simulated grey seal population trajectories for the GSRP in an un-impacted versus impacted population, for the maximum spatial scenario.

Scenario GS-02b: maximum spatial scenario, OSPAR Region III

A.4.4.1.12 For the maximum spatial scenario for the OSPAR Region III reference population, the results of iPCoD modelling indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 32 and Figure A. 20).

A.4.4.1.13 At all time points there was no difference in the mean size of the impacted and un-impacted populations. This includes at time point 3 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the OSPAR Region III reference population.

A.4.4.1.14 Both the median and mean counterfactual of population size for scenario GS-01b were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the OSPAR Region III reference population.

Table A. 32: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal under the maximum spatial scenario, for the OSPAR Region III reference population.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	60,780	**60,780**	60,780	60,780	**60,780**	60,780	1.0000	1.0000
2	56,697	**61,544**	65,414	56,697	**61,544**	65,414	1.0000	1.0000
3	55,905	**62,362**	67,577	55,905	**62,362**	67,577	1.0000	1.0000
7	55,619	**65,641**	75,448	55,619	**65,641**	75,448	1.0000	1.0000
9	55,389	**67,319**	79,529	55,389	**67,319**	79,529	1.0000	1.0000
11	56,249	**68,995**	84,100	56,249	**68,995**	84,100	1.0000	1.0000
13	56,319	**71,049**	88,175	56,319	**71,049**	88,175	1.0000	1.0000
21	59,105	**79,322**	105,019	59,105	**79,322**	105,019	1.0000	1.0000
26	61,040	**84,780**	113,633	61,040	**84,780**	113,633	1.0000	1.0000

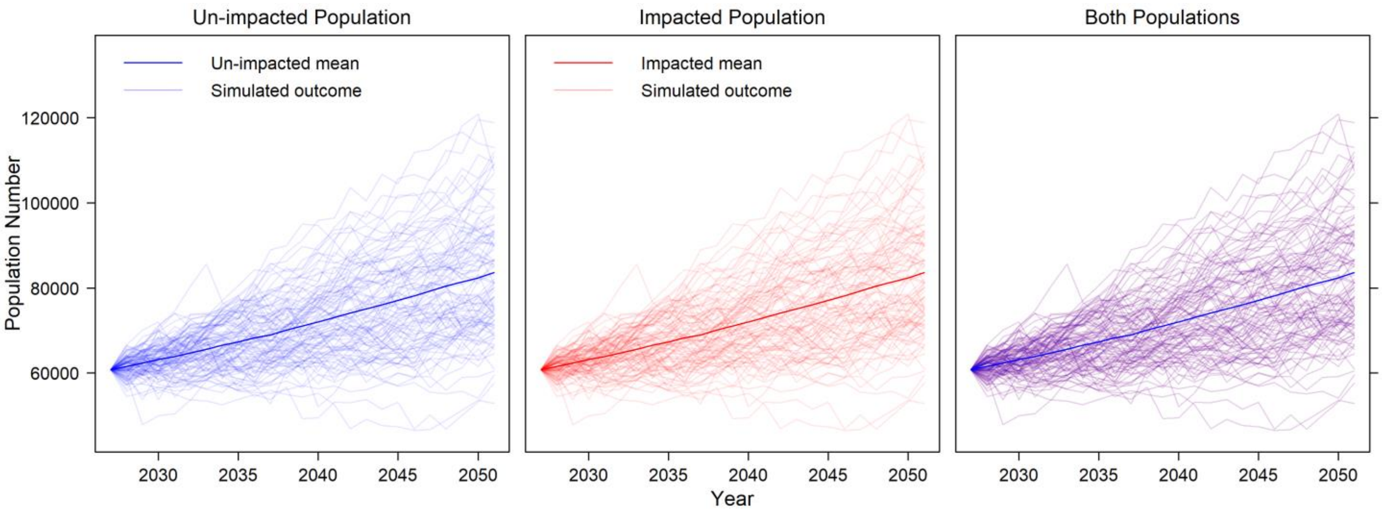

Figure A. 20: Simulated grey seal population trajectories for the OSPAR Region III reference population in an un-impacted versus impacted population, for the maximum spatial scenario.

A.4.4.2 Cumulative projects

A.4.4.2.1 Results of the iPCoD modelling at the time points described in Table A. 10 for grey seal under the maximum temporal and maximum spatial piling scenarios are presented in Table A. 33 to Table A. 36. As for the Mona Offshore Wind Project alone, simulated trajectories of both GSRP and OSPAR Region III reference populations of grey seal appear to be increasing in size and are illustrated in Figure A. 21 to Figure A. 24.

A.4.4.2.2 For grey seal, iPCoD models incorporating the maximum spatial scenario were based upon two reference populations: the GSRP (as described in section A.3.3 and Table A. 3) and the OSPAR Region III population.

Scenario GS-C1a: Tier 1 projects, GSRP

A.4.4.2.3 For scenario GS-C1a, in which a total of 90 days of piling occur at the Mona Offshore Wind Project alongside a total of 225 piling days across Tier 1 cumulative projects (18 days at Project Erebus, six days at White Cross Offshore Windfarm and 201 days at Awel y Môr), these results indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 33 and Figure A. 21) for the SMUs that comprise the GSRP.

A.4.4.2.4 At all time points there was a no difference in the mean size of the impacted and un-impacted populations. This includes at time point 3 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the SMUs that comprise the GSRP.

Table A. 33: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal for cumulative piling scenario GS-C1a, for the GSRP.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	12,908	12,908	12,908	12,908	12,908	12,908	1.0000	1.0000
3	11,803	13,271	14,344	11,803	13,271	14,344	1.0000	1.0000
4	11,813	13,461	14,764	11,813	13,461	14,764	1.0000	1.0000
5	11,642	13,615	15,206	11,642	13,615	15,206	1.0000	1.0000
7	11,722	13,952	16,066	11,722	13,952	16,066	1.0000	1.0000
9	11,694	14,344	17,143	11,694	14,344	17,143	1.0000	1.0000
10	11,744	14,525	17,445	11,744	14,525	17,445	1.0000	1.0000
11	11,850	14,702	17,841	11,850	14,702	17,841	1.0000	1.0000
13	11,855	15,112	18,367	11,855	15,112	18,367	1.0000	1.0000
15	11,828	15,482	19,354	11,828	15,482	19,354	1.0000	1.0000
23	12,388	17,259	22,931	12,388	17,259	22,931	1.0000	1.0000
26	12,785	17,946	24,246	12,785	17,946	24,246	1.0000	1.0000

A.4.4.2.5 Both the median and mean counterfactual of population size for scenario GS-C1a were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the SMUs that comprise the GSRP.

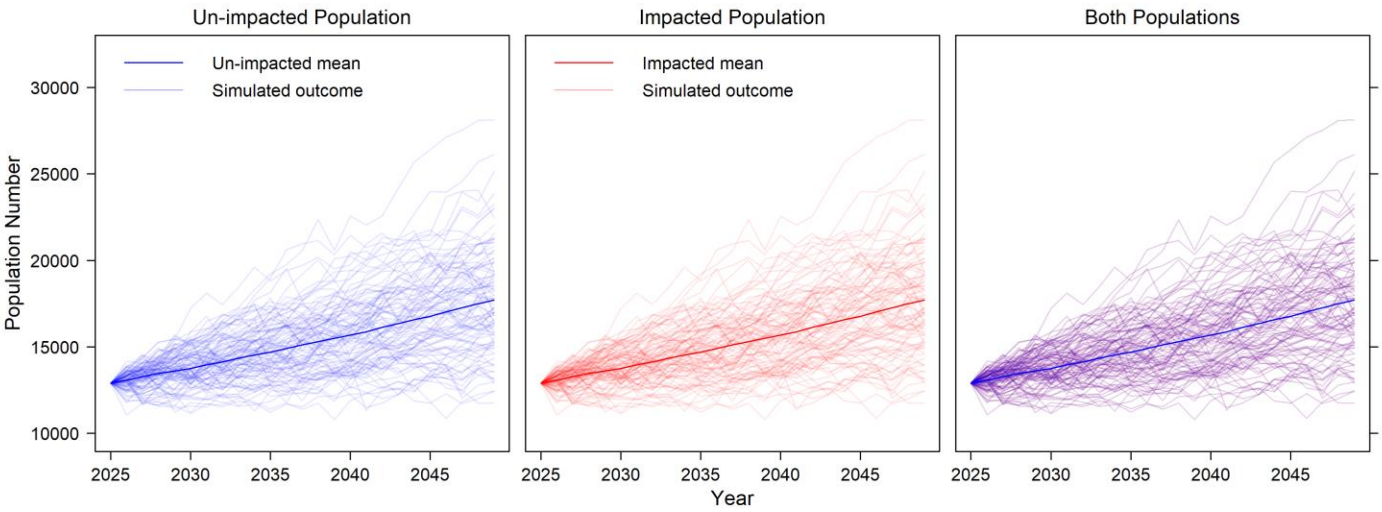

Figure A. 21: Simulated grey seal population trajectories for the GSRP in an un-impacted versus impacted population, for cumulative scenario GS-C1a (Tier 1 projects only).

Scenario GS-C1b: Tier 1 projects, OSPAR Region III

A.4.4.2.6 For scenario GS-C1b, in which a total of 90 days of piling occur at the Mona Offshore Wind Project alongside a total of 225 piling days across Tier 1 cumulative projects (18 days at Project Erebus, six days at White Cross Offshore Windfarm and 201 days at Awel y Môr), these results indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 34 and Figure A. 22) for the OSPAR Region III reference population.

Table A. 34: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal for cumulative piling scenario GS-C1b, for the OSPAR Region III reference population.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	60,780	60,780	60,780	60,780	60,780	60,780	1.0000	1.0000
3	56,031	62,402	67,662	56,031	62,402	67,662	1.0000	1.0000
4	55,537	63,167	69,566	55,537	63,167	69,566	1.0000	1.0000
5	54,908	63,938	71,611	54,908	63,938	71,611	1.0000	1.0000
7	55,384	65,596	75,656	55,384	65,596	75,656	1.0000	1.0000
9	55,191	67,269	79,427	55,191	67,269	79,427	1.0000	1.0000
10	55,333	68,191	81,608	55,333	68,191	81,608	1.0000	1.0000

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
11	55,302	69,160	82,981	55,302	69,160	82,981	1.0000	1.0000
13	55,455	70,899	87,115	55,455	70,899	87,115	1.0000	1.0000
15	56,558	72,801	90,900	56,558	72,801	90,900	1.0000	1.0000
23	58,514	80,576	108,236	58,514	80,576	108,236	1.0000	1.0000
26	58,706	83,811	114,787	58,706	83,811	114,787	1.0000	1.0000

A.4.4.2.7 At all time points there was a no difference in the mean size of the impacted and un-impacted populations. This includes at time point 3 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the OSPAR Region III reference population.

A.4.4.2.8 Both the median and mean counterfactual of population size for scenario GS-C1b were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the OSPAR Region III reference population.

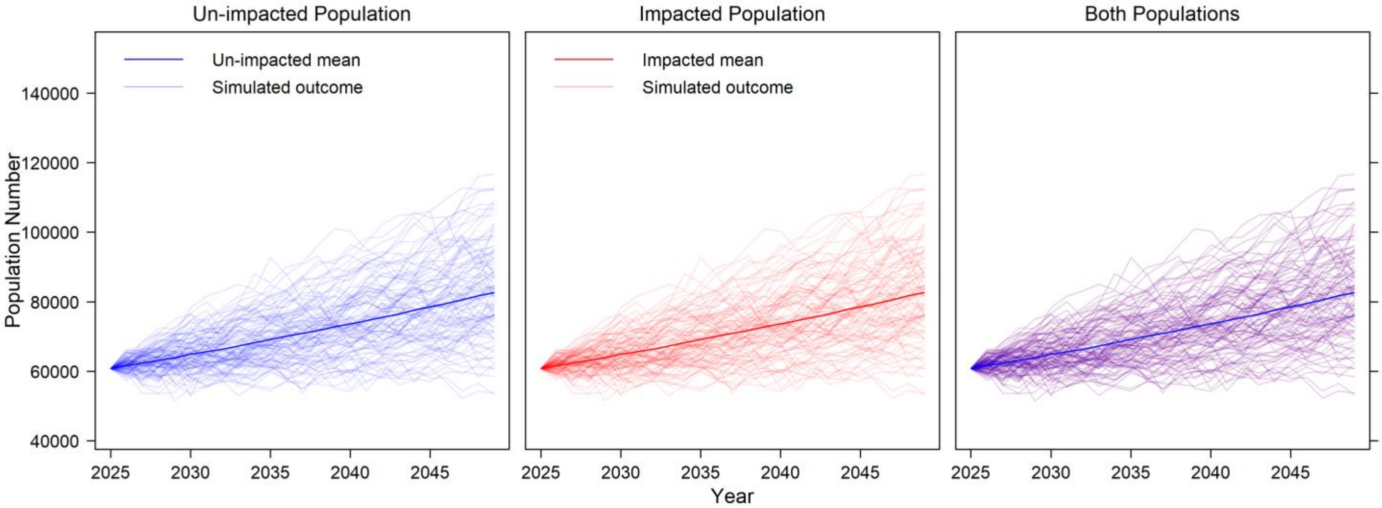

Figure A. 22: Simulated grey seal population trajectories for the OSPAR Region III reference population in an un-impacted versus impacted population, for cumulative scenario GS-C1b (Tier 1 projects only).

Scenario GS-C2a: Tier 1 and Tier 2 projects, GSRP

A.4.4.2.9 The results for scenario GS-C2a (i.e. 90 days of piling for the Mona Offshore Wind Project alongside up to 308 piling days from Tier 1 and Tier 2 cumulative projects: Table A. 9) indicate a similar pattern in the population trajectory as scenario GS-C1a which includes Tier 1 projects only. The results indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 35 and Figure A. 23) for the SMUs that comprise the GSRP.

Table A. 35: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal for cumulative piling scenario GS-C2a, for the GSRP.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	12,908	12,908	12,908	12,908	12,908	12,908	1.0000	1.0000
3	11,874	13,227	14,374	11,874	13,227	14,374	1.0000	1.0000
4	11,814	13,409	14,694	11,814	13,409	14,694	1.0000	1.0000
5	11,726	13,596	15,172	11,726	13,596	15,172	1.0000	1.0000
7	11,741	13,938	15,902	11,741	13,938	15,902	1.0000	1.0000
9	11,965	14,320	16,726	11,965	14,320	16,726	1.0000	1.0000
10	11,820	14,537	17,245	11,820	14,537	17,245	1.0000	1.0000
11	11,954	14,739	17,462	11,954	14,739	17,462	1.0000	1.0000
13	12,142	15,139	18,517	12,142	15,139	18,517	1.0000	1.0000
15	12,245	15,559	19,196	12,245	15,559	19,196	1.0000	1.0000
23	12,719	17,330	22,780	12,719	17,330	22,780	1.0000	1.0000
26	13,069	17,992	24,090	13,069	17,992	24,090	1.0000	1.0000

A.4.4.2.10 At all time points there was a no difference in the mean size of the impacted and un-impacted populations. This includes at time point 2 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the SMUs that comprise the GSRP.

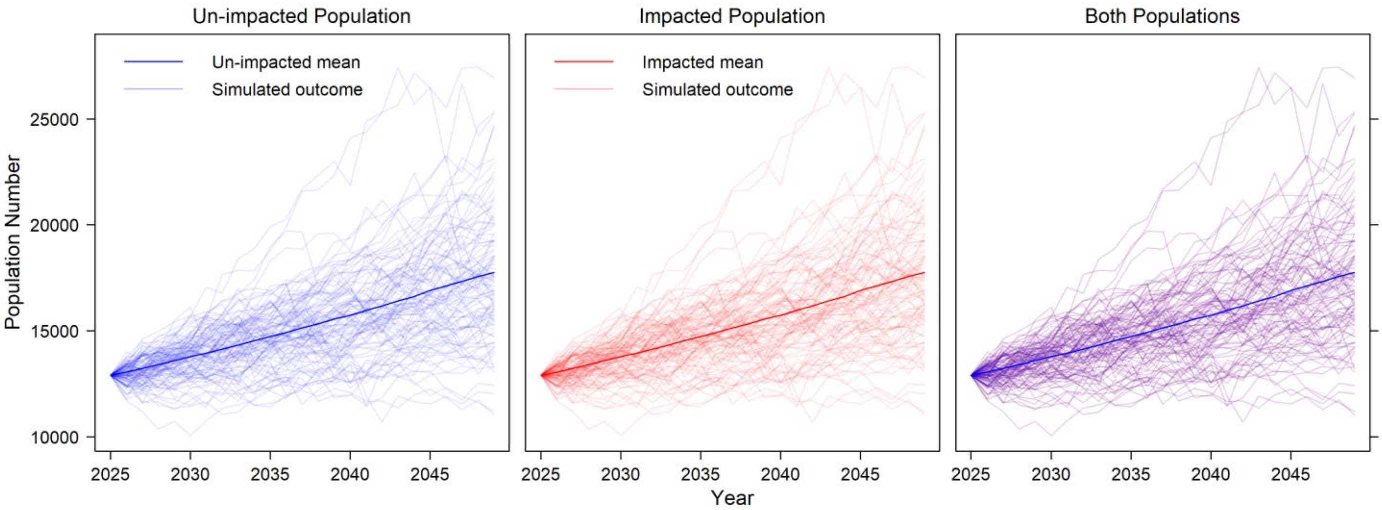

Figure A. 23: Simulated grey seal population trajectories for the GSRP in an un-impacted versus impacted population, for cumulative scenario GS-C2a (Tier 1 and Tier 2 projects).

A.4.4.2.11 Both the median and mean counterfactual of population size for scenario GS-C2a were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the SMUs that comprise the GSRP.

Scenario GS-C2b: Tier 1 and Tier 2 projects, OSPAR Region III

A.4.4.2.12 The results for scenario GS-C2b (i.e. 90 days of piling for the Mona Offshore Wind Project alongside up to 308 piling days from Tier 1 and Tier 2 cumulative projects: Table A. 9) indicate a similar pattern in the population trajectory as scenario GS-C1b which includes Tier 1 projects only. The results indicate no difference in the population trajectory of grey seal between the un-impacted population and impacted population (Table A. 35 and Figure A. 23) for the OSPAR Region III reference population.

A.4.4.2.13 At all time points there was a no difference in the mean size of the impacted and un-impacted populations. This includes at time point 3 (cessation of two-year piling phase), time point 7 (corresponding to the six-year reporting period formerly required under the Habitats Directive) and time point 26 (25 years after the start of the piling phase). This suggests that there would not be a short- or long-term effect from piling at the Mona Offshore Wind Project upon the grey seal population within the OSPAR Region III reference population.

Table A. 36: Population estimates for the un-impacted and impacted populations and counterfactuals of population size for grey seal for cumulative piling scenario GS-C2b, for the OSPAR Region III reference population.

Time point	Un-impacted population			Impacted population			Ratio of population size	
	Lower 2.5%	Mean	Upper 97.5%	Lower 2.5%	Mean	Upper 97.5%	Mean	Median
1	60,780	60,780	60,780	60,780	60,780	60,780	1.0000	1.0000
3	55,911	62,462	67,975	55,911	62,462	67,975	1.0000	1.0000
4	56,338	63,395	69,659	56,338	63,395	69,659	1.0000	1.0000
5	55,743	64,193	71,611	55,743	64,193	71,611	1.0000	1.0000
7	55,598	65,853	75,721	55,598	65,853	75,721	1.0000	1.0000
9	55,527	67,688	79,855	55,527	67,688	79,855	1.0000	1.0000
10	54,959	68,572	82,073	54,959	68,572	82,073	1.0000	1.0000
11	55,261	69,482	84,060	55,261	69,482	84,060	1.0000	1.0000
13	55,345	71,191	87,803	55,345	71,191	87,803	1.0000	1.0000
15	57,009	73,189	91,066	57,009	73,189	91,066	1.0000	1.0000
23	59,155	81,541	108,858	59,155	81,541	108,858	1.0000	1.0000
26	59,448	84,843	114,444	59,448	84,843	114,444	1.0000	1.0000

A.4.4.2.14 Both the median and mean counterfactual of population size for scenario GS-C2b were 1.0000 throughout the 26-year simulation. Therefore, given that the differences between impacted and un-impacted populations equate to a ratio of 1 there is not considered to be a potential for an effect from this piling scenario upon grey seal in the OSPAR Region III reference population.

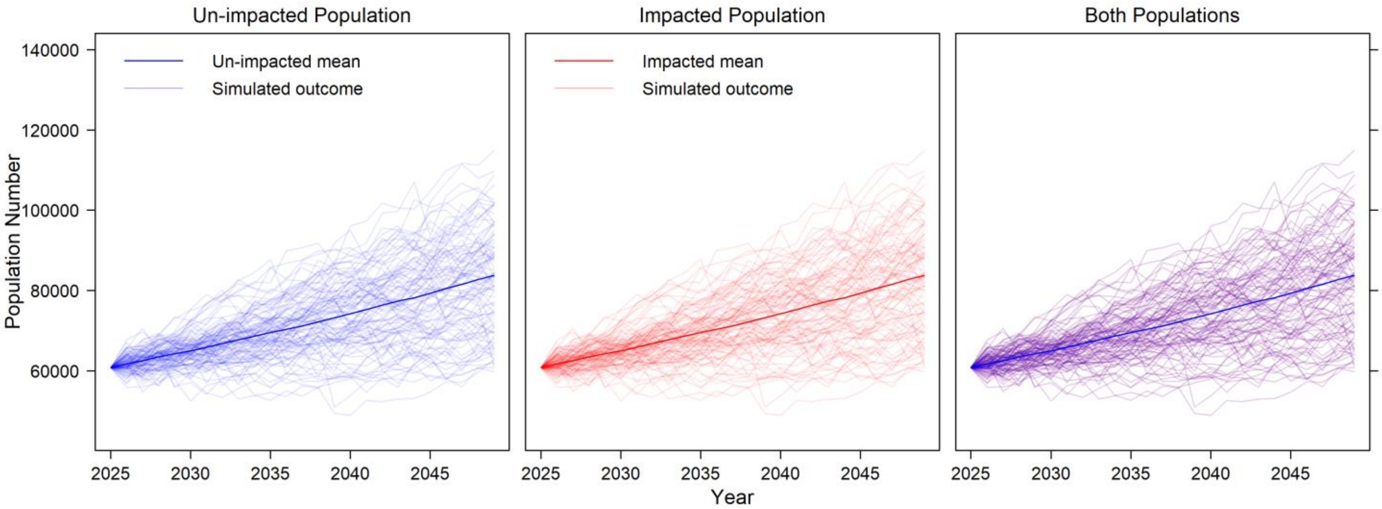

Figure A. 24: Simulated grey seal population trajectories for the OSPAR Region III reference population in an un-impacted versus impacted population, for cumulative scenario GS-C2b (Tier 1 and Tier 2 projects).

A.5. Summary

A.5.1.1.1 This appendix presents the results of the iPCoD population modelling undertaken for key marine mammal species with the potential to be affected by the Mona Offshore Wind Project and for cumulative projects that overlap with the relevant species' MUs. Overall, the iPCoD modelling results demonstrate that there would be no long-term differences between impacted and un-impacted populations of harbour porpoise, bottlenose dolphin, minke whale and grey seal.

A.5.1.1.2 The iPCoD models were run to predict potential changes in population size as a result of piling at the Mona Offshore Wind Project. Reference populations were based on the latest estimates of population size for these species' MUs, as summarised in Table A. 3.

A.5.1.1.3 The numbers of animals potentially experiencing disturbance were based on two maximum design scenarios. The maximum temporal scenario of a combination of 3,000 kJ and 4,400 kJ maximum hammer energies (depending on the foundation type) across 114 days, and the maximum spatial scenario of the same maximum hammer energies, incorporating some concurrent piling at 3,000 kJ, across a total of up to 90 days. However, these would not be the maximum hammer energies for all locations, and the realistic hammer energy would likely be lower, affecting fewer animals.

A.5.1.1.4 Conservative estimates of demographic rates were used to parameterise the models, ensuring that these aligned across scenarios to allow direct comparison. The precautionary assumption was made that animals would be disturbed both on the day of piling and for 24 hours the following day, building additional conservatism in the models.

A.5.1.1.5 The modelling demonstrated that for all species there was predicted to be no long-term decline in the population as a result of piling at the Mona Offshore Wind Project, with negligible to small differences between the impacted to un-impacted population size. Even where there were differences in the simulated population trajectories (i.e. a maximum of 2.73% of the reference population in the case of bottlenose dolphin) it is considered likely that this variation would fall within the natural stochasticity of the population and therefore would not represent a measurable (or significant) difference.

A.5.1.1.6 Similarly, for cumulative projects there were no long-term population level effects predicted for either species. The simulations were based on the MDS for each respective cumulative project (i.e. largest number of animals potentially disturbed at any one time) and therefore represents a conservative approach to the cumulative assessment.

A.5.1.1.7 Results of the cumulative models should be interpreted with caution as limited information on the actual piling schedules was available to inform the iPCoD models presented here. However, the parameters used to develop the models for the cumulative projects have been informed by the respective Environmental Statements and are considered to represent a conservative and accurate depiction of these projects.

A.5.1.1.8 Though the iPCoD models attempt to incorporate major sources of uncertainty, and have been agreed through consultation with stakeholders as the most robust and precautionary approach available, results will always vary greatly due to environmental and demographic stochasticity. Whilst the models show no evidence of population change associated with the Mona Offshore Wind Project, there are sources of uncertainty.

A.5.1.1.9 Variation in demographic rates between years may exist as a result of changes in environmental conditions, as a result of random processes or chance events which impact vital rates (e.g. survival, fertility, etc.), or other sources of heterogeneity. In two, otherwise identical populations that experience exactly the same sequence of environmental conditions, demographic stochasticity will mean populations could follow slightly different trajectories over time.

A.5.1.1.10 These models assume that the effects of environmental variation on survival and fertility are adequately reflected by the range of values obtained from the expert elicitation (and shown in the spread of trajectories around the means in Figure A. 1 to Figure A. 24). In addition, the model assumes that survival and fertility rates are not density-dependent, and are therefore not affected by population size.

A.5.1.1.11 Whilst it is understood that iPCoD is a relatively simplified population model (simulating the link between days of disturbance and changes in individual vital rates), the most obvious sources of uncertainty are considered to have been adequately captured in the development of these models. In addition, the marine mammal assessment has adopted a precautionary approach in recognition of the uncertainties in how animals respond to repeated piling over time.

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