RWE

Awel y Môr Offshore Wind Farm

Category 6: Environmental Statement

Volume 2, Chapter 7: Marine Mammals

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Offshore Wind Farm

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Glossary of terms

TERM	DEFINITION
Permanent Threshold Shift (PTS)	A total or partial permanent loss of hearing at a particular frequency caused by some kind of acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity at that frequency.
Sound Exposure Level (SEL)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Sound Pressure Level (SPL)	The sound pressure level or SPL is an expression of the sound pressure using the decibel (dB) scale and the standard reference pressures of 1 µPa for water.
Temporary Threshold Shift (TTS)	Temporary loss of hearing at a particular frequency as a result of exposure to sound over time. The mechanisms underlying TTS are not well understood, but there may be some temporary damage to the sensory cells. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time.
Threshold	The threshold generally represents the lowest signal level an animal will detect in some statistically predetermined percent of presentations of a signal.

TERM	DEFINITION
Unweighted sound level	Sound levels which are 'raw' or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a 'weighting envelope' in the frequency domain, typically to make an unweighted level relevant to a particular species. The overall sound level has been adjusted to account for the hearing ability of marine mammals.

Abbreviations and acronyms

TERM	DEFINITION
ADD	Acoustic Deterrent Device
AyM	Awel y Môr
BEIS	Department for Business, Energy and Industrial Strategy
CEA	Cumulative Effects Assessment
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
EDR	Effective Deterrence Range
EEA	European Economic Area
EIA	Environmental Impact Assessment
ES	Environmental Statement
GyM	Gwynt y Môr
HF	High Frequency
HRGS	High-resolution Geophysical site Surveys
IAMMWG	Inter-Agency Marine Mammal Working Group

TERM	DEFINITION
IPC	Infrastructure Planning Commission (note: the IPC was abolished in April 2012 and was replaced by the Secretary of State for Business, Energy and Industrial Strategy)
iPCoD	Interim Population Consequences of Disturbance
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MCZ	Marine Conservation Zone
MMMP	Marine Mammal Mitigation Protocol
MPA	Marine Protected Area
MU	Management Unit
MWDW	Manx Whale and Dolphin Watch
NPS	National Policy Statement
NRW	Natural Resources Wales
O&M	Operation and Maintenance
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PEMP	Project Environment Management Plan
PINS	Planning Inspectorate
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation

TERM	DEFINITION
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SNCB	Statutory Nature Conservation Body
SoS	Secretary of State
SOV	Service Operation Vessel
SPA	Special Protection Area
SPL	Sound Pressure Level
SSSI	Site of Special Scientific Interest
SWF	Sea Watch Foundation
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance
VHF	Very High Frequency
WNMP	Welsh National Marine Plan

Units

UNIT	DEFINITION
dB	Decibel (sound pressure)
Hz	Hertz (frequency)
kHz	Kilohertz (frequency)
kJ	Kilojoule (energy)

UNIT	DEFINITION
km	Kilometres (distance)
km^2	Kilometres squared (area)
m	Metres (distance)
m/s	Metres per second (speed)
µPa	Micropascal (pressure)

7 Marine mammals

7.1 Introduction

1 This chapter of the Environmental Statement (ES) has been prepared by SMRU Consulting and assesses the potential effects on marine mammal ecology from the offshore works (including construction, operation and maintenance (O&M) and decommissioning) associated with Awel y Môr Offshore Wind Farm (hereafter referred to as AyM).

2 This chapter has been informed by the following ES chapters:

- Volume 2, Chapter 1: Offshore Project Description (application ref: 6.2.1);
- Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes (application ref: 6.2.2);
- Volume 2, Chapter 3: Marine Water and Sediment Quality (application ref: 6.2.3);
- Volume 2, Chapter 6: Fish and Shellfish Ecology (application ref: 6.2.6);
- Volume 4, Annex 7.1: Marine Mammal Baseline Characterisation Report (application ref: 6.4.7.1);
- Volume 4, Annex 7.2: Outline Marine Mammal Mitigation Protocol (application ref: 6.4.7.2);
- Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties (application ref: 6.4.7.3);
- Volume 4, Annex 6.2: Underwater Noise Technical Report (application ref: 6.4.6.2);
- Volume 5 Annex 5.1: Report to Inform Appropriate Assessment (application ref: 5.2).

7.2 Statutory and policy context

3 This section identifies legislation and national and local policy of relevance to marine mammal ecology. The Planning Act 2008, Marine Works (Environmental Impact Assessment; EIA) Regulations 2007 (as amended), the Infrastructure Planning (EIA) Regulations 2017 (collectively referred to as 'the EIA Regulations'), and the Environment Act 1995 are considered along with the legislation relevant to marine mammal ecology.

4 The following section provides information regarding the legislative context surrounding the assessment of potential effects in relation to marine mammal ecology. In undertaking the assessment, the following policy and legislation has been considered:

- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017;
- The Conservation of Habitats and Species Regulations 2017;
- The Environment (Wales) Act 2016;
- Marine and Coastal Access Act 2009;
- The Marine Works (Environmental Impact Assessment) Regulations 2007;
- The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) 1994;
- EU Council Directive 92/ 43/ EEC on the conservation of natural habitats and of wild flora and fauna (the 'Habitats Directive');
- OSPAR Convention 1992;
- The Wildlife and Countryside Act 1981;
- Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979);
- The Convention on the Conservation of Migratory Species of Wild Animals 1979;(the Bonn Convention);
- Convention of International Trade in Endangered Species (CITES) 1975; and
- The Conservation of Seals Act 1970.

5 Guidance on the issues to be assessed for offshore renewable energy developments has been obtained through reference to:

- The Overarching National Policy Statement (NPS) for Energy (NPS EN-1; Department for Energy and Climate Change (DECC 2011b);
- The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3; DECC 2011a);
- The UK Marine Policy Statement (HM Government 2011);
- The Welsh National Marine Plan (WNMP; Welsh Government 2019); and
- Future Wales – the National Plan 2040.

6 The sections of National Policy Statement for Energy (EN-1) and for Renewable Energy Infrastructure (EN-3) relevant to marine mammals are listed in Table 1. In addition to the current NPS, draft NPSs have been consulted upon. The draft NPSs have been reviewed to determine the emerging expectations and changes from previous iterations of the NPSs. This includes the Draft Overarching NPS EN-1 (DECC, 2021a) and EN-3 (DECC, 2021b).

Table 1: Summary of NPS EN-1 and EN-3 and Draft Overarching NPS EN-1 and EN-3 policy relevant to marine mammals and AyM.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
NPS EN-1	"Where the development is subject to EIA the applicant should ensure that the Environmental Statement (ES) clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the IPC consider thoroughly the potential effects of a proposed project." (paragraph 5.3.3 in NPS EN-1)	The potential effects of AyM have been assessed in regard to international, national and local sites designated for ecological or geological features of conservation importance (see sections 7.10,7.11 and 7.12). Direct or indirect effects on features of relevant Special Area of Conservation (SAC) and Special Protection Area (SPA) sites are also considered in the Habitats Regulations Assessment Screening Report and where relevant will be included in the Report to Inform Appropriate Assessment (RIAA). Important protected areas for marine mammals within their respective Management Units (MUs) are detailed in Volume 4: Annex 7.1: Marine Mammal Baseline.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	"Many Sites of Special Scientific Interest (SSSI) are also designated as sites of international importance and will be protected accordingly. Those that are not, or those features of SSSIs not covered by an international designation, should be given a high degree of protection." (paragraph 5.3.10 in NPS EN-1) "All National Nature Reserves are notified as SSSIs." (paragraph 5.3.10 in NPS EN-1)	There are no marine mammal SSSIs which are considered to be at risk of effect from the construction, operation or decommissioning of AyM and as such, no further consideration of SSSIs has been given
	"Marine Conservation Zones (MCZs) introduced under the Marine and Coastal Access Act 2009 are areas that have been designated for the purpose of conserving marine flora and fauna, marine habitat or features of geological or geomorphological interest. The Secretary of State is bound by the duties in relation to MCZs imposed by Sections 125 and 126 of the Marine and Coastal Access Act 2009." (paragraph 5.3.12 in NPS EN-1)	There are no marine mammal MCZs which are considered to be at risk of effect from the construction, operation or decommissioning of AyM and as such, no further consideration of MCZs has been given.
	"Development proposals provide many opportunities for building-in beneficial biodiversity or geological features as part of good design. When considering	Designated measures to be adopted as part of the AyM project are presented in Section 7.9.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	proposals, the IPC should maximise such opportunities in and around developments, using requirements or planning obligations where appropriate." (paragraph 5.3.15 in NPS EN-1)	
	"Many individual wildlife species receive statutory protection under a range of legislative provisions" (paragraph 5.3.16 in NPS EN-1)	Relevant marine mammal policy and legislation listed in section 7.2.
	"Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in England and Wales and thereby requiring conservation action. The Secretary of State should ensure that these species and habitats are protected from the adverse effects of development by using requirements or planning obligations." (paragraph 5.3.17 in NPS EN-1)	All species receptors, including those of principal importance for the conservation of biodiversity in Wales are summarised in section 7.7. Full details are provided in Volume 4: Annex 7.1: Marine Mammal Baseline.
	"The applicant should include appropriate mitigation measures as an integral part of the proposed development. In particular, the applicant should demonstrate that:	Embedded mitigation relevant for marine mammals to be adopted as part of the AyM project are detailed in Section 7.9.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	- During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works; - 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." (paragraph 5.3.18 in NPS EN-1)	
Draft NPS EN-1	"Where the development is subject to EIA the applicant should ensure that the Environmental Statement (ES) clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the IPC consider thoroughly the potential effects of a proposed project." (paragraph 5.4.3 of the Draft NPS EN-1)	The potential effects of AyM have been assessed in regard to international, national and local sites designated for ecological or geological features of conservation importance (see sections 7.10,7.11 and 7.12). Direct or indirect effects on features of relevant Special Area of Conservation (SAC) and Special Protection Area (SPA) sites are also considered in the Habitats Regulations Assessment Screening Report and

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
		where relevant will be included in the Report to Inform Appropriate Assessment (RIAA). Important protected areas for marine mammals within their respective Management Units (MUs) are detailed in Volume 4: Annex 7.1: Marine Mammal Baseline.
	"Many Sites of Special Scientific Interest (SSSI) are also designated as sites of international importance and will be protected accordingly. Those that are not, or those features of SSSIs not covered by an international designation, should be given a high degree of protection." (paragraph 5.4.9 of the Draft NPS EN-1) "Most National Nature Reserves are notified as SSSIs." (paragraph 5.4.9 of the Draft NPS EN-1)	There are no marine mammal SSSIs which are considered to be at risk of effect from the construction, operation or decommissioning of AyM and as such, no further consideration of SSSIs has been given
	"Marine Conservation Zones (MCZs) introduced under the Marine and Coastal Access Act 2009 are areas that have been designated for the purpose of conserving marine flora and fauna, marine habitat or features of geological or geomorphological interest. The Secretary	There are no marine mammal MCZs which are considered to be at risk of effect from the construction, operation or decommissioning of AyM and as

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	of State is bound by the duties in relation to MCZs imposed by Sections 125 and 126 of the Marine and Coastal Access Act 2009." (paragraph 5.4.11 of the Draft NPS EN-1)	such, no further consideration of MCZs has been given.
	"Development proposals provide many opportunities for building-in beneficial biodiversity or geological features as part of good design. When considering proposals, the IPC should maximise such opportunities in and around developments, using requirements or planning obligations where appropriate." (paragraph 5.4.14 of the Draft NPS EN-1)	Designated measures to be adopted as part of the AyM project are presented in Section 7.9.
	"Many individual wildlife species receive statutory protection under a range of legislative provisions" (paragraph 5.4.15 of the Draft NPS EN-1)	Relevant marine mammal policy and legislation listed in section 7.2.
	"Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in England and Wales and thereby requiring conservation action. The Secretary of State should ensure that these species and habitats are protected from the adverse effects of development by using	All species receptors, including those of principal importance for the conservation of biodiversity in Wales are summarised in section 7.7. Full details are provided in Volume 4: Annex 7.1: Marine Mammal Baseline.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	requirements or planning obligations." (paragraph 5.4.16 of the Draft NPS EN-1)	
	"The applicant should include appropriate mitigation 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; - 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." (paragraph 5.4.18 of the Draft NPS EN-1)	Mitigation relevant for marine mammals to be adopted as part of the AyM project are detailed in Section 7.9.
NPS EN-3	"Assessment of offshore ecology and biodiversity should be undertaken by the applicant for all stages of the lifespan of the proposed Offshore Wind Farm (OWF) and in accordance with the appropriate policy for OWF EIAs." (NPS EN-3 Paragraph 2.6.64)	Construction, operation, maintenance and decommissioning phases of AyM have been assessed in sections 7.10, 7.11 and 7.12.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	"Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate." (NPS EN-3 Paragraph 2.6.65)	Consultations with relevant statutory and non-statutory stakeholders have been conducted throughout AyM (see Table 3 for a summary of consultation with regards to marine mammals).
	"Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational OWFs should be referred to where appropriate." (NPS EN-3 Paragraph 2.6.66)	Relevant data collected during post construction monitoring from other OWF projects as well as relevant scientific research and literature have informed the assessment of AyM in sections 7.10, 7.11 and 7.12.
	"The assessment should include the potential of the scheme to have both positive and negative effects on marine ecology and biodiversity." (NPS EN-3 Paragraph 2.6.67)	Both potential positive and negative effects of AyM on marine mammals have been assessed in section 7.16.236
	"The Secretary of State should consider the effects of a proposal on marine ecology and biodiversity taking into account all relevant information made available to it." (paragraph 2.6.68 of NPS EN-3)	The potential effects on marine mammal ecology are presented within this chapter, with the assessment of effects presented within sections 7.10, 7.11 and 7.12.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	"Mitigation may be possible in the form of careful design of the development itself and the construction techniques employed (paragraph 2.6.70 of NPS EN-3)	Embedded mitigation relevant for marine mammals is detailed in Section 7.9.
	"Ecological monitoring is likely to be appropriate during the construction and operational phases to identify the actual impact so that, where appropriate, adverse effects can then be mitigated and to enable further useful information to be published relevant to future projects." (paragraph 2.6.71 of NPS EN-3)	The requirement for marine mammal monitoring has been assessed in sections 7.10, 7.11 and 7.12.
	Where necessary, assessment of the effects on marine mammals should include details of: - likely feeding areas; - known birthing areas/haul out sites; - nursery grounds; - known migration or commuting routes; - duration of the potentially disturbing activity including cumulative/in-combination - effects with other plans or projects; - baseline noise levels; - predicted noise levels in relation to mortality, permanent threshold shift	The effects on marine mammals have been assessed in sections 7.10, 7.11, 7.12 and 7.13.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	- (PTS) and temporary threshold shift (TTS); - soft-start noise levels according to proposed hammer and pile design; and - operational noise." (paragraph 2.6.92 of NPS EN-3)	
	"The applicant should discuss any proposed piling activities with the relevant body. Where assessment shows that noise from offshore piling may reach noise levels likely to lead to an offence as described in 2.6.91 above, the applicant should look at possible alternatives or appropriate mitigation before applying for a license." (paragraph 2.6.93 of NPS EN-3)	The proposed piling activity is discussed in section 7.1. Appropriate embedded general mitigation measures to minimise the potential for an offence, along with those specific to construction, operation and maintenance and decommissioning, are discussed in Sections 7.10,7.11 and 7.12.
	"The Infrastructure Planning Commission (IPC) should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed so as to reasonably minimise significant disturbance effects on marine mammals. Unless	The maximum potential impact associated with construction, operating and decommissioning at AyM are assessed in section 7.8. Mitigation measures to minimise this potential disturbance are discussed in Sections 7.10,7.11 and 7.12.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	suitable noise mitigation measures can be imposed by requirements to any development consent the IPC may refuse the application." (paragraph 2.6.94 of NPS EN-3)	
	"Fixed submerged structures such as foundations are likely to pose little collision risk for marine mammals and the IPC is not likely to have to refuse to grant consent for a development on the grounds that offshore wind farm foundations pose a collision risk to marine mammals." (paragraph 2.6.96 of NPS EN-3)	The potential for collision risk is assessed in sections 7.10,7.11 and 7.12.
	"Monitoring of the surrounding area before and during the piling procedure can be undertaken." (paragraph 2.6.97 of NPS EN-3)	Monitoring conducted prior to development is discussed in section 7.7 and in further detail in Volume 4: Annex 7.1: Marine Mammal Baseline. Monitoring to be conducted during piling procedures is described in Section 7.9 with further detail provided in Volume 4: Annex 4.7.2: Draft Outline MMMP.
	"During construction, 24-hour working practices may be employed so that the overall construction programme and the potential for impacts to marine mammal	AyM can confirm that 24 hour working practices will be employed for offshore construction works (Volume 2, Chapter

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	communities is reduced in time." (paragraph 2.6.98 of NPS EN-3)	1: Offshore Project Description). The predicted project time frame is discussed in section 7.1.
	"Soft start procedures during pile driving may be implemented. This enables marine mammals in the area disturbed by the sound levels to move away from the piling before significant adverse impacts are caused." (paragraph 2.6.98 of NPS EN-3)	Soft start procedures for monopiles and multi-leg pin-pile jackets are detailed in section 7.1.
Draft NPS EN-3	"Consultation on the assessment methodologies, baseline data collection, and potential mitigation and compensation options should be undertaken at early stages with the statutory consultees as appropriate." (paragraph 2.24.6 of the Draft NPS EN-3)	Consultations with relevant statutory and non-statutory stakeholders have been conducted throughout AyM (see Table 3 for a summary of consultation with regards to marine mammals).
	"Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational OWFs should be referred to where appropriate." (paragraph 2.24.7 of the Draft NPS EN-3)	Relevant data collected during post construction monitoring from other OWF projects as well as relevant scientific research and literature have informed the assessment of AyM in sections 7.10, 7.11 and 7.12.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	"Reference must be made to relevant scientific research and literature." (paragraph 2.24.7 of the Draft NPS EN-3)	
	"The assessment should include the potential of the scheme to have both positive and negative effects on marine ecology and biodiversity." (paragraph 2.24.8 of the Draft NPS EN-3)	Both potential positive and negative effects of AyM on marine mammals have been assessed in section 7.16.236
	"Mitigation may be possible in the form of careful design of the development itself and the construction techniques employed (paragraph 2.24.10 of the Draft NPS EN-3)	Mitigation relevant for marine mammals is detailed in Section 7.9.
	"Ecological monitoring will be appropriate during the pre-construction, construction and operational phases to identify the actual impacts caused by the project and compare them to what was predicted in the EIA/HRA... Monitoring should be of sufficient standard to inform future decision making." (paragraph 2.24.11 of the Draft NPS EN-3)	The requirement for marine mammal monitoring has been assessed in sections 7.10, 7.11 and 7.12.
	Where necessary, assessment of the effects on marine mammals should include details of:	The effects on marine mammals have been assessed in sections 7.10, 7.11, 7.12 and 7.13.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	- likely feeding areas and impacts on prey species and prey habitat - known birthing areas / haul out sites for breeding and pupping - migration routes - protected areas (e.g. HRA sites and SSSIs) - 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" (paragraph 2.28.3 of the Draft NPS EN-3)	
	"The applicant should discuss any proposed noisy activities with the relevant body and must reference the JNCC underwater noise guidance in relation to	The proposed piling activity is discussed in section 7.1. Appropriate embedded general mitigation

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	noisy activities (alone and in-combination with other plans or projects) within HRA sites. Where assessment shows that noise from construction and 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 2.28.1 above, the applicant should look at possible alternatives or appropriate mitigation (detailed below)." (paragraph 2.28.5 of the Draft NPS EN-3)	measures to minimise the potential for an offence, along with those specific to construction, operation and maintenance and decommissioning, are discussed in Sections 7.10,7.11 and 7.12.
	"The Infrastructure Planning Commission (IPC) should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed so as to reasonably minimise significant disturbance effects on marine mammals. Unless suitable noise mitigation measures can be imposed by requirements to any development consent the IPC may refuse the application." (paragraph 2.28.9 of the Draft NPS EN-3)	The maximum potential impact associated with construction, operating and decommissioning at AyM are assessed in section 7.8. Mitigation measures to minimise this potential disturbance are discussed in Sections 7.10,7.11 and 7.12.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	"Monitoring of the surrounding area before and during the piling procedure can be undertaken by various methods including marine mammal observers and passive acoustic monitoring. Active displacement of marine mammals outside potential injury zones can be undertaken using equipment such as acoustic deterrent devices." (paragraph 2.28.6 of the Draft NPS EN-3)	Monitoring conducted prior to development is discussed in section 7.7 and in further detail in Volume 4: Annex 7.1: Marine Mammal Baseline. Monitoring to be conducted during piling procedures is described in Section 7.9 with further detail provided in Volume 4: Annex 4.7.2: Draft Outline MMMP.
	"Soft start procedures during pile driving may be implemented. This enables marine mammals in the area disturbed by the sound levels to move away from the piling before significant adverse impacts are caused." (paragraph 2.28.7 of the Draft NPS EN-3)	Soft start procedures for monopiles and multi-leg pin-pile jackets are detailed in section 7.1.

7.2.1 Overview of Welsh Planning Policy

7 Planning Policy Wales sets out the land use planning policies of the Welsh Government, forming a strategic framework to guide development. The Planning Policy Wales documentation does not explicitly include a topic on marine mammals with other relevant policy and guidance identified below.

Welsh National Marine Plan

8 The WNMP was published on 12 November 2019 and contains policy across a range of considerations (including nature conservation, sustainable use, seascape, and coastal communities and economic growth). The WNMP includes sector objectives for renewable energy to support decarbonisation of the Welsh economy and the use of marine renewable energy generation (including OWFs), with specific reference to marine mammals in relation to underwater noise production. Table 2 provides a summary of the key provisions of the WNMP of relevance to this assessment.

Table 2: WNMP policies of relevance to marine mammals.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
Welsh National Marine Plan	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.	The potential impacts on marine mammal ecology have been assessed in sections 7.10, 7.11, 7.12 and 7.13. Consideration of the avoid, minimise and mitigate approach is given within the assessments as appropriate. Mitigation measures are detailed within Section 7.9.
	ENV_02: Marine Protected Areas. Proposals should demonstrate how they:	Designated sites within the region have been identified as appropriate, and any potential impacts to features

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	- avoid adverse impacts on individual Marine Protected Areas (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.	and the network of sites have been assessed in the RIAA.
	ENV_02: Invasive non-native species. Proposals should demonstrate how they avoid or minimise the risk of introducing and spreading invasive non-native species. Where appropriate, proposals should include biosecurity measures to reduce the risk of introducing and spreading of invasive non-native species.	The introduction of non-native species is not of relevance to marine mammals and as such, no further consideration has been given.
	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;	The effects of underwater noise on marine mammals have been assessed in sections 7.10, 7.11, 7.12 and 7.13.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	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.	
	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.	The potential effects on fish species and their habitats have been assessed in sections 7.10.10, 7.11.5 and 7.12.5 in the context of how marine mammal prey species may be impacted. The potential effects of AyM on fish and shellfish have been fully assessed in Chapter 6: Fish and Shellfish Ecology.

LEGISLATION/ POLICY	KEY PROVISIONS	SECTION WHERE COMMENT ADDRESSED
	If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	

Future Wales – The National Plan

9 Future Wales – the National Plan 2040 is Wales' national development framework, setting the direction for development in Wales to 2040. Whilst it does not specifically relate to marine mammals, it is a development plan with a strategy for addressing key national priorities through the planning system, including sustaining and developing a vibrant economy, achieving decarbonisation and climate-resilience, developing strong ecosystems and improving the health and well-being of Wales' communities.

7.3 Consultation and scoping

10 As part of the EIA for AyM, consultation has been undertaken with various statutory and non-statutory bodies, through the agreed Evidence Plan process. A formal Scoping Opinion was sought from the Secretary of State (SoS) following submission of the Scoping Report (innogy, 2020). The Scoping Opinion (the Planning Inspectorate (PINS), 2020) was issued in July 2020 by PINS. A record of key areas of consultation undertaken during the Scoping Opinion and Evidence Plan phases is summarised within Table 3 and will be presented in full within the project consultation report, to be published with the final DCO application.

Table 3: Summary of consultation relating to marine mammals.

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
Email correspondence 27/03/2020, re AyM Marine Mammal Density Estimates	Natural Resources Wales (NRW) agreed that the aerial survey data are not sufficient to inform the impact assessment and agreed with the approach to use both the SCANS III and the Joint Cetacean Protocol (JCP) III density estimates in the quantitative impact assessment.	Both SCANS III and JCP III density estimates have been used in the impact assessment (Table 16).
Email correspondence 27/03/2020, re AyM Marine Mammal Density Estimates	NRW recommends data from the Sea Watch Foundation is sourced for bottlenose and Risso's dolphins.	Sea Watch Foundation data has been purchased for the north coast of Wales area. This is included in Volume 4: Annex 7.1: Marine mammal baseline.
Email correspondence 27/03/2020, re AyM Marine Mammal Density Estimates	NRW agreed that the latest grey seal telemetry data should be used to inform seal density estimates.	Assessment uses the Carter et al. (2020) habitat preference maps for grey seal at-sea densities, which incorporates the latest telemetry data (Table 16).

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
July 2020 Scoping Opinion	Density estimates used need a clear justification and the approach should be agreed with relevant statutory nature conservation bodies (SNCBs).	Density estimates selected for impact assessment are outlined in Volume 4: Annex 7.1: Marine mammal baseline.
July 2020 Scoping Opinion	ES should provide TTS ranges used for the purpose of assessing disturbance.	TTS-onset impact ranges have been presented (section 0 TTS from piling)
July 2020 Scoping Opinion	Physical barrier effects on marine mammals should be included.	Potential barrier effects are considered in section 7.11.1.
July 2020 Scoping Opinion	ES should use updated abundance estimates for the Celtic and Irish Seas MU.	ES uses updated MU abundance estimates in the impact assessment (Table 16).
July 2020 Scoping Opinion	ES should consider the Pen Llyn a'r Sarnau SAC for bottlenose dolphins.	Baseline characterisation considers connectivity with the SAC. Predicted impacts to the SAC are assessed in the RIAA.

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
July 2020 Scoping Opinion	ES should assess impact of disturbance on North Anglesey Marine SAC.	North-west (NW) underwater noise modelling location was selected for proximity to SAC. Predicted impacts to the SAC are assessed in the RIAA.
Sep 2020 Marine ecology and marine mammal ETG	Disturbance assessment will utilise the Graham et al. (2017a)dose response curve for cetaceans. The seal assessment will use the Whyte et al. (2020)dose-response curve. Approach agreed with NRW.	Dose-response curves are used to assess disturbance from piling – described further in paragraph 27 et seq.
Email correspondence 17-22/02/2021, re AyM ADD note	NRW agreed with the proposed approach to incorporation of ADDs into the MMMP.	Described further in Volume 4, Annex 7.2: Outline Marine Mammal Mitigation Protocol.
Mar 2021 Marine ecology and marine mammal ETG	Lack of data on bottlenose dolphin density in North Wales. In the absence of Sea Watch data, NRW agreed with the proposed approach: use the wider Cardigan Bay density estimate and assume that bottlenose dolphins are restricted to 6 km from the coast.	Described further in Volume 4: Annex 7.1: Marine mammal baseline.

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
Oct 2021 s42 comments from NRW	NRW do not agree with the PTS sensitivity score for grey seals and cetaceans.	Definition of sensitivity has been updated to take into consideration the significance of the effect (Table 10). Additional justification is provided in section 7.5.1 Sensitivity to PTS.
Oct 2021 s42 comments from NRW	NRW do not support the use of EDRs.	A range of disturbance thresholds are presented in 7.10.6 Disturbance from UXO (EDRs alongside TTS-onset as a proxy for disturbance).
Oct 2021 s42 comments from NRW	NRW do not agree with the density surface for bottlenose dolphins. Coastal dolphins should be limited to the 20 m depth contour. Offshore dolphins should be considered.	The density surface has been revised as suggested. Described further in Volume 4: Annex 7.1: Marine mammal baseline.
Oct 2021 s42 comments from NRW	NRW do not agree with scoping out common dolphins.	Common dolphins are now scoped in - see Volume 4:

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
		Annex 7.1: Marine mammal baseline.
Oct 2021 s42 comments from NRW	NRW noted that the number of piling days offer no contingency for delays or practical limitations in achieving the maximum piling capacity per day. Any delays would alter the duration and frequency of impacts.	For the assessment of disturbance, it has been assumed that at a worst case, it could take up to three days to install one monopile, and two days to install a jacket foundation.
Oct 2021 s42 comments from NRW	NRW commented that it was unclear if or how the accumulation of impacts from piling events over time has been considered when estimating the number of animals potentially exposed to PTS.	Assessment text specifies that the numbers presented are the number of animals that are expected to experience PTS-onset on each day of pile driving activities (see section 7.10.1)
Oct 2021 s42 comments from NRW	NRW recommended that if a dose-response methodology is being applied this should be explained in much greater detail to demonstrate	Additional information on dose response curves and applicability to other species is

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
	the suitability of the approach to the specifics of this application.	provided in 7.4.3 Underwater noise modelling (specifically paragraph 27 et seq.).
Oct 2021 s42 comments from NRW	The outline MMMP currently offers no observer coverage during weather of visibility conditions lower than 'good', within which marine mammal observers can operate. It also does not assess the amount of cover the MMMP can provide within the PTS ranges.	The use of PAM has been included in the MMMP. Described further in Volume 4, Annex 7.2: Outline Marine Mammal Mitigation Protocol.
Oct 2021 s42 comments from NRW	It is unclear if or how the temporal extent of sheet piling activities for the cofferdam has been taken into account.	As stated in Table 18 it is expected to take 81 piling days to install the cofferdam.
Oct 2021 s42 comments from NRW	NRW consider that the combination of piling operations at the NW and SE modelling locations may not represent the worst-case scenario for the maximum impact range of simultaneous piling.	The Project Description no longer includes simultaneous piling (with the exception of two pins at the same location).

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
Oct 2021 s42 comments from NRW	No evidence is presented to support the numbers of seismic surveys assumed to occur in the cumulative assessment.	As stated in paragraph 294 "The potential number of seismic surveys that could be undertaken is unknown". Therefore, the inclusion of seismic surveys is illustrative only.
Oct 2021 s42 comments from NRW	Swimming speed data should be clearly presented and evaluated.	Additional information on swimming speed is presented in paragraph 22.
Oct 2021 s42 comments from TWT	For 49% of aerial sightings it was unknown whether the sighting was of a porpoise or dolphin and none of the dolphin sightings were identified to species level. This does not provide us with enough evidence as to the marine mammal abundance in the Awel y Môr region.	This is acknowledged in Volume 4: Annex 7.1: Marine mammal baseline. Other data sources have been used to supplement the baseline characterization.
Oct 2021 s42 comments from TWT	Seasonality and the associated presence/absence of marine mammal species throughout the year will be key in determining	Seasonality information has been added to Volume 4:

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
	both the degree of impact and the timing of any future construction and mitigation measures. Therefore, it is important that this information is placed upfront where it can be considered.	Annex 7.1: Marine mammal baseline.
Oct 2021 s42 comments from TWT	The cumulative impact assessment should include projects other than offshore wind farms.	Details on the screening of projects for the cumulative impact assessment is described in section 7.13 Environmental assessment: cumulative effects.
Oct 2021 s42 comments from TWT	Baseline data on grey seal haul-outs should be obtained from Cofnod (North Wales Records Centre).	Data obtained and presented in Volume 4: Annex 7.1: Marine mammal baseline.
Oct 2021 s42 comments from Angel Bay Seal Volunteer Group	Baseline report and impact assessment lacks reference to the Angel Bay seal haul-out.	This is now included in Volume 4: Annex 7.1: Marine mammal baseline.
Oct 2021 s42 comments from Isle of Man Govt	Isle of Man Marine Nature Reserves for marine mammals need to be considered.	This is now included in Volume 4: Annex 7.1: Marine mammal baseline.

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
Jan 2022 NRW comments on baseline	Justification is required for not using the higher, and potentially more precautionary Sea Watch Foundation density estimate for harbour porpoise.	Further detail on the Sea Watch Foundation density estimate is provided in Volume 4: Annex 7.1: Marine mammal baseline. A density estimate of 1 porpoise/km^2 (averaged across the coastal and offshore areas from the SWF report) has been presented in the impact assessment for context, however the caveats associated with this estimate are large.
Jan 2022 JNCC comments on baseline	The Sea Watch density estimate (0.5-1.5/km^2) is a magnitude higher than that estimated by either SCANS (0.086/km^2) or the JCP (0.13/km^2) however SMRU consulting still propose to take the SCANS/JCP estimates forward to the impact assessment. Justification is needed as to why the more precautionary density is not being taken forward.	
Jan 2022 NRW comments on baseline	NRW welcome the inclusion of common dolphin in the baseline. We note that to fully resolve NRW's concerns regarding common dolphin, they should also be scoped into assessments.	Common dolphins have been fully considered in the impact assessment.
Jan 2022 NRW comments on baseline	JNCC welcome the inclusion of common dolphins to the baseline and consider sufficient information	

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
	is provided to describe the likely occurrence of this species in the development area	
Jan 2022 NRW comments on cumulative PTS note	Without a suitable alternative, use of SELcum remains the appropriate means to assess this impact, particularly given its use in the RIAA and PEIR.	The limitations of the calculations for cumulative PTS are further detailed in Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties. The impact assessment presents the SELcum impact ranges but the illustration provided in Volume 4, Annex 7.3 highlights the precaution in these estimates.
Jan 2022 JNCC comments on cumulative PTS note	While we agree that SEL cumulative calculations provide likely over-precautionary injury ranges for the reasons provided, currently there is no agreed alternative method of considering these factors when predicting injury and no alternative is provided in this document. Therefore, using both the peak SPL and cumulative metrics is still the most precautionary approach in impact assessments.	
Jan 2022 NRW comments on PTS sensitivity note	We are content with the revised sensitivity definitions. We still consider the appropriate PTS sensitivity score for grey seal to be 'low'. We still	The definitions of sensitivity have been revised (Table 10). All marine mammals have

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
	consider the appropriate PTS sensitivity score for bottlenose dolphin to be 'medium.'	been assessed as having a Low sensitivity to PTS, except dolphin species which have been increased to Medium (Table 15).
Jan 2022 JNCC comments on PTS sensitivity note	JNCC are content with the sensitivity assessment for harbour porpoise as low, however we agree with NRW's recommendation that the sensitivity for seals be increased from negligible to low. Given the changes to how sensitivity is defined (Table 8), we also suggest the sensitivity for bottlenose dolphins is increased to medium as their coastal behaviour limits their ability to adapt behaviour in response to anthropogenic noise and a significant effect on individual vital rates cannot be ruled out at this stage.	
Jan 2022 NRW comments on UXO disturbance note	A broader review should be undertaken and options either demonstrated to be unsuitable or taken forward into the assessment. other options for assessing disturbance should be considered and presented to complete the intended approach, such as the Lucke *et al.* (2009) 145 SEL	The potential thresholds for the UXO disturbance assessment are now detailed in Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions,

DATE ANDCONSULTATION PHASE/ TYPE	CONSULTATION AND KEY ISSUES RAISED	SECTION WHERE COMMENT ADDRESSED
	disturbance, alongside the Soloway & Dahl (2014) method.	Limitations and Uncertainties. This includes assessment of the following thresholds: EDR, TTS, Lucke et al (2009), Level B harassment; as well as information on noise propagation models (e.g. Soloway & Dahl 2014). Section 7.10.6 Disturbance from UXO assesses disturbance using a 26 km EDR (high order), a 5 km EDR (low order) and TTS-onset thresholds.
Jan 2022 JNCC comments on UXO disturbance note	The current EDR for UXO clearance is 26km.	

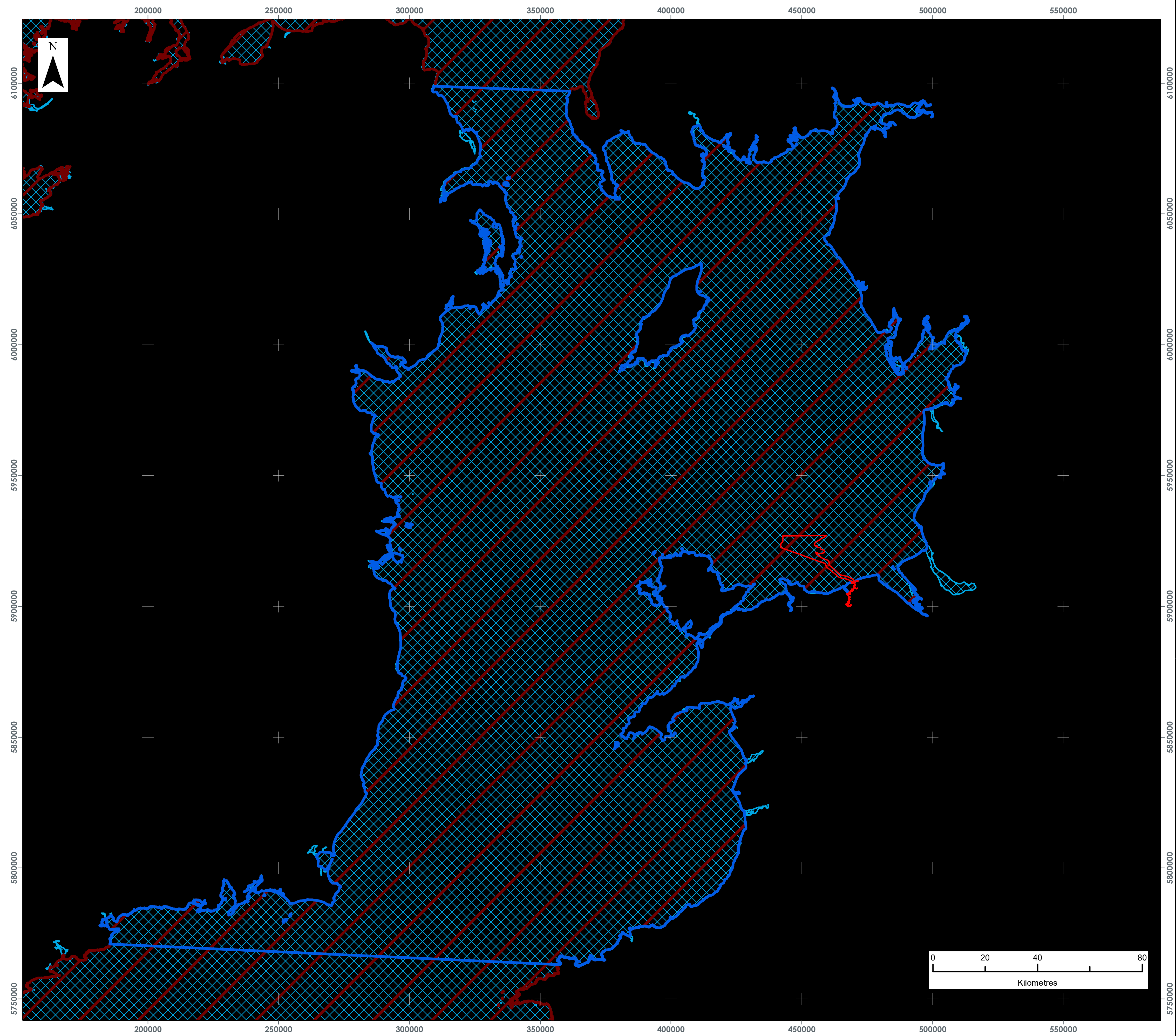
7.4 Scope and methodology

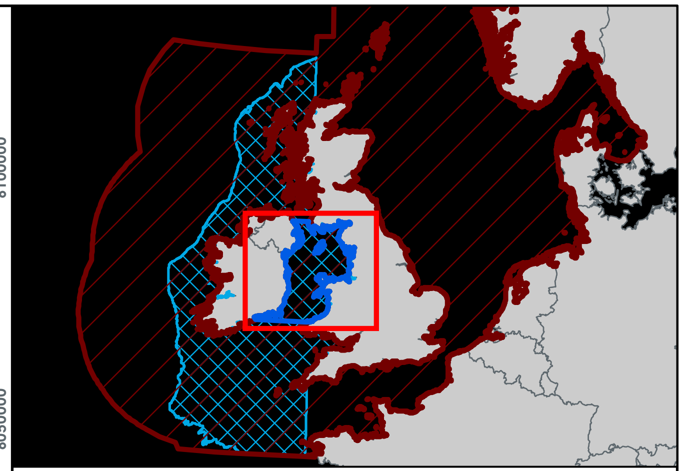
7.4.1 Study area

11 The AyM marine mammal study area varies depending on the species, considering individual species ecology and behaviour. The marine mammal species likely to be present in the AyM marine mammal study area include harbour porpoise (*Phocoena phocoena*), grey seal (*Halichoerus grypus*), bottlenose dolphin (*Tursiops truncatus*), common dolphins (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), and minke whale (*Balaenoptera acutorostrata*).

12 The marine mammal study area has been defined at two spatial scales:

- Regional scale study area: Provides a wider geographic context in terms of the species present and their estimated densities and abundance, at the appropriate scale for each marine mammal population (Management Unit, MU) Figure 1. The regional study area for harbour porpoise is the Celtic and Irish Sea Management Unit (MU), for grey seals it is the OSPAR region III MU, for bottlenose dolphins it is the Irish Sea MU, and for common dolphins, Risso's dolphins and minke whales it is the Celtic and Greater North Seas MU. This scale defines the appropriate reference population for each species for the assessment.
- Awel y Môr Study Area: includes the area covered by site-specific marine mammal surveys which are currently underway for AyM. These provide fine scale spatial and temporal data for marine mammals present in the array area (Figure 2).





LEGEND

- Order Limits
- Irish Sea MU
- Celtic and Irish Seas MU
- Ospar Region III
- Celtic and Greater North Seas MU

Data Source:
IAMMWG (2015)

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE: Marine Mammal Regional Scale Study Area

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 1

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:1,500,000	A3	WGS84	UTM30N

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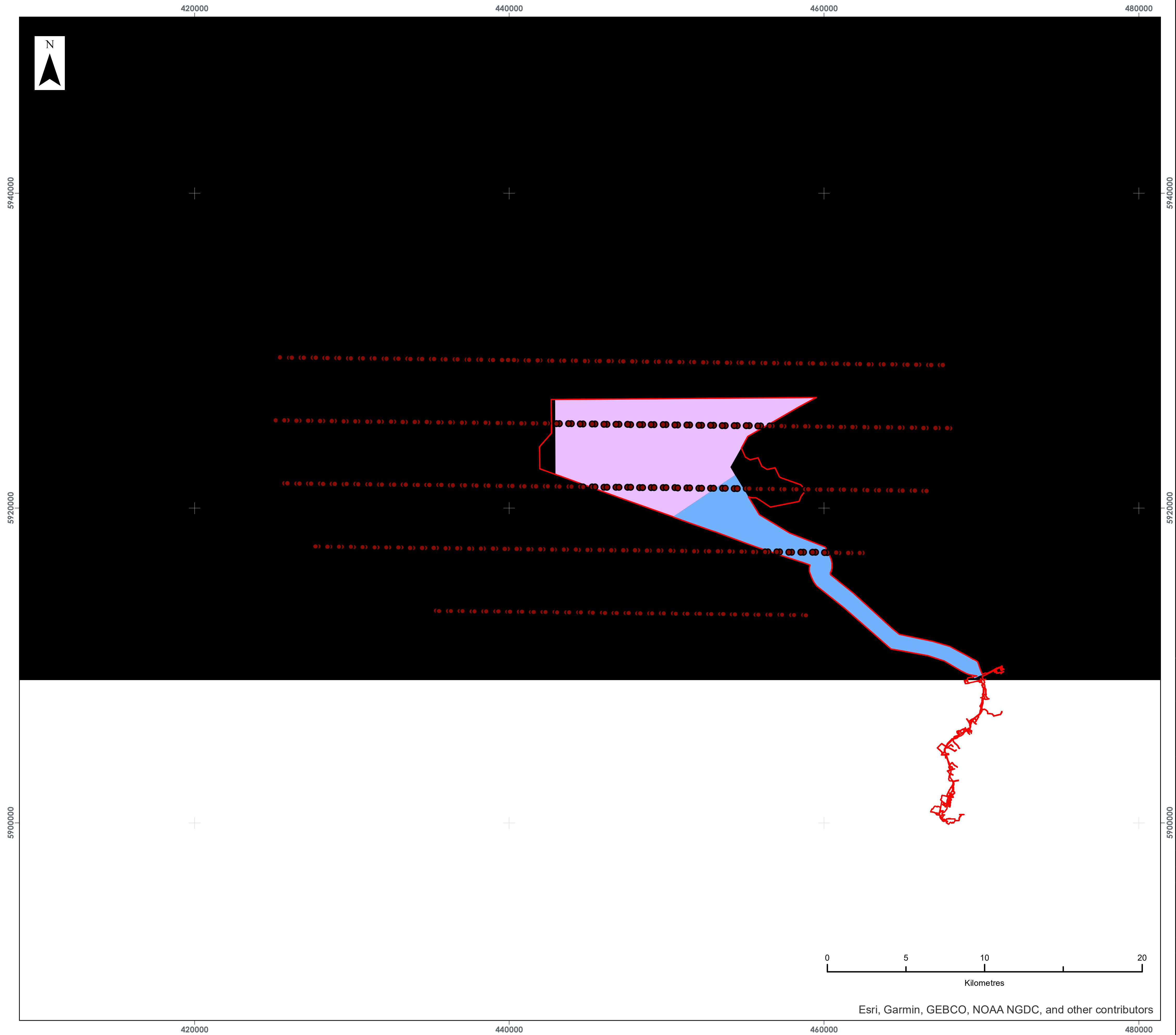

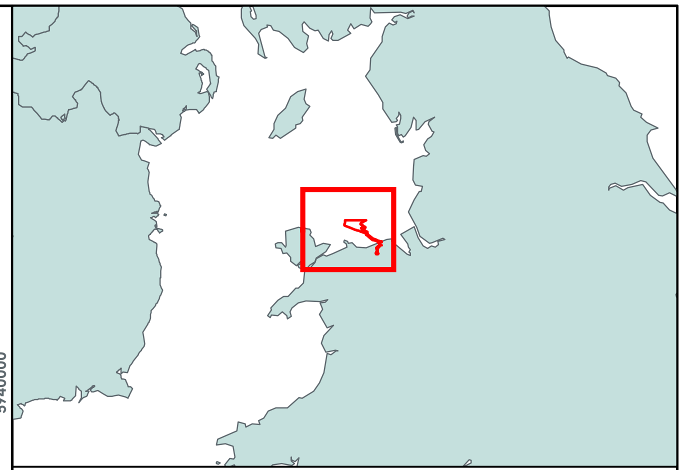

LEGEND

- Order Limits
- Array Area
- Offshore Export Cable Corridor
- Site Specific Surey Area - GPS Positions

Data Source:
APEM

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Marine Mammal Site Specific Survey Area

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 2

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:250,000	A3	WGS84	UTM30N

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7.4.2 Baseline data sources

13 The baseline characterisation for marine mammals is described in detail in Volume 4, Annex 7.1: Marine Mammal Baseline Characterisation. The baseline has been identified from the following sources:

- AyM site-specific surveys (APEM);
- Gwynt y Môr (GyM) baseline, mitigation and post-construction surveys (CMACS Ltd 2005, 2011, 2013, Goddard et al. 2017, Goddard et al. 2018, Goulding et al. 2019);
- SCANS surveys (Burt et al. 2006, Hammond et al. 2006, Hammond et al. 2017);
- Welsh Marine Atlas (Baines and Evans 2012);
- ObSERVE surveys (Rogan et al. 2018);
- JCP data (Heinänen and Skov 2015, Paxton et al. 2016);
- Local surveys around Anglesey (Shucksmith et al. 2009, Gordon et al. 2011);
- Wylfa Newydd surveys (Jacobs 2018);
- Morlais MDZ surveys (Royal Haskoning DHV 2019);
- Bottlenose dolphin photo-ID surveys (Pesante et al. 2008, Baines and Evans 2012, Veneruso and Evans 2012, Feingold and Evans 2014, Evans et al. 2015, Duckett 2018, Lohrengel et al. 2018);
- Sea Watch Foundation surveys in the north coast of Wales (Evans et al. 2021);
- COFNOD – North Wales environmental Information Service sightings database;
- Manx Whale and Dolphin Watch (MWDW) surveys (Felce 2014, 2015, Adams 2017, Howe 2018);
- Seal haul-out and pupping counts (Strong and Morris 2010, Stringell et al. 2014, Langley et al. 2018, Morgan et al. 2018, Angel Bay Seal Volunteer Group 2021, SCOS 2021);
- Seal telemetry (data provided by SMRU); and
- Seal at-sea densities (Carter et al. 2020).

7.4.3 Underwater noise modelling

14 The noise levels likely to occur as a result of the construction of AyM were predicted by Subacoustech Environmental Ltd using their INSPIRE (Impulse Noise Sound Propagation and Impact Range Estimator) model. A detailed description of the modelling approach is presented in the Volume 4, Annex 6.2: Subsea Noise Technical Report.

Piling parameters - WTGs

15 Two modelling locations were selected: North-west (NW) and South-east (SE) which represent opposite corners of the array area. These modelling locations were selected as the represented locations closest to important marine mammal areas, including the North Anglesey Marine SAC for porpoise and the Dee Estuary for grey seals. Table 4 and Table 5 present the worst-case piling parameters modelled for monopiles and multi-leg pin-piled jackets respectively.

16 For the calculation of cumulative PTS and TTS-onset from monopiles, the assumption has been made that two monopiles can be installed in a 24-hour period. Given that the capacity of AyM is for up to 50 turbines (50x monopiles), one met mast (1x monopile) and two OSPs (16x monopiles), this results in a total of 67 monopiles. For the assessment of PTS and TTS-onset the worst case is to assume two monopiles are installed in one day; this results in 34 piling days. For the assessment of disturbance additional contingency has been assumed such that it could take up to three days of pile driving to install a monopile, and therefore the worst-case total number of piling days is 201.

17 For the calculation of cumulative PTS and TTS-onset from multi-leg pin-piled jackets, the assumption has been made that four pin-piles can be installed at one location in a 24-hour period. Given that the capacity of AyM is for up to 50 turbines (200x pin piles) and other piled offshore infrastructure (24x pin piles), this results in a total of 224 pin piles. For the assessment of PTS and TTS-onset, the worst case is to assume that four pin piles are installed in one day; this results in 56 piling days. For the assessment of disturbance additional contingency has been assumed such that it could take up to two days of pile driving to a jacket, and therefore the worst-case total number of piling days is 112.

18 In the case of monopiles, piling will only occur at one location at a time – there is no possibility of simultaneous or concurrent piling. In the case of pin-piled multi-leg jacket foundations, pin-piles may be installed concurrently, but only on adjacent legs of the same jacket foundation – there is no possibility of simultaneous or concurrent piling at two separate foundation locations.

Table 4: Piling parameters for monopiles.

MONOPILE	SOFT-START	RAMP-UP				MAX
Hammer Energy (kJ)	750	1,000	2,000	3,000	4,000	5,000
# Strikes	100	100	340	680	1020	6528
Duration (min)	10	10	10	20	30	195
Strike rate (strikes/min)	10	10	34	34	34	34

Table 5: Piling parameters for multi-leg pin-piled jackets.

MULTI-LEG	SOFT-START	RAMP-UP				MAX
Hammer Energy (kJ)	450	600	1,200	1,800	2,400	3,000
# Strikes	100	100	340	680	1020	5100
Duration (min)	10	10	10	20	30	150
Strike rate (strikes/min)	10	10	34	34	34	34

Piling parameters – OSPs and Met mast

19 Other structures within the array area that may require impact pile driving for installation are the foundations for the OSPs and the met mast. The met mast is expected to be installed using a monopile. The OSPs are expected to be installed using either monopiles or pin-piles. The piling parameters are expected to be the same as those described above for WTG foundation installation (Table 4 and Table 5). For the met mast 1 piling day is required. For the OPS, a maximum of 8 piling days is required (if installing 16 smaller monopiles and assuming 2 piles per day).

Piling parameters – Cofferdam sheet piles

20 The Project Description includes the potential for impact pile driving to install sheet piles for the cofferdam as part of the landfall. The sheet piles are expected to be a maximum of 750 mm in width and a total of 650 sheet piles will be installed. Table 6 presents the worst-case piling parameters modelled for sheet piling. It is assumed that eight sheet piles can be installed in one day, resulting in a total of 81 days piling for the cofferdam.

Table 6: Piling parameters for cofferdam sheet piling.

SHEET PILES	SOFT-START	RAMP-UP	MAX
Hammer Energy (kJ)	60	Gradual ramp up	300
# Strikes	1,550	175	875
Duration (min)	30	5	25
Strike rate (strikes/min)	35		

PTS assessment

21 For marine mammals, the main impact from AyM will be as a result of underwater noise produced during construction. Therefore, a detailed assessment has been provided for this impact pathway. Exposure to loud sounds can lead to a reduction in hearing sensitivity (a shift in hearing threshold), which is generally restricted to particular frequencies. This threshold shift results from physical injury to the auditory system and may be temporary (TTS) or permanent (PTS). The PTS- and TTS-onset thresholds used in this assessment are those presented in Southall et al. (2019) (Table 7). The method used to calculate PTS-onset impact ranges for both 'instantaneous' PTS (SPL_{peak}), and 'cumulative' PTS (SEL_{cum}, over 24 hours) are detailed in Volume 4, Annex 6.2: Subsea Noise Technical Report.

Table 7: PTS-onset thresholds for impulsive noise (from Southall et al 2019).

HEARING GROUP	SPECIES	CUMULATIVE PTS (SEL_{CUM} DB RE 1 μPA^2S WEIGHTED)	INSTANTANEOUS PTS (SPL_{PEAK} DB RE 1 µPA UNWEIGHTED)
Very High Frequency (VHF) Cetacean	Harbour porpoise	155	202
High Frequency (HF) Cetacean	Bottlenose, Common & Risso's dolphin	185	230
Low Frequency (LF) Cetacean	Minke whale	183	219
Phocid	Grey seal	185	218

Swimming speed

22 In calculating the received noise level that animals are likely to receive during the whole piling sequence, all animals were assumed to start fleeing at a swim speed of 1.5 m/s once the piling has started (based on reported sustained swimming speeds for harbour porpoises) (Otani et al. 2000), except for minke whales which are assumed to flee at a speed of 3.25 m/s (Blix and Folkow 1995). The calculated PTS and TTS-onset impact ranges therefore represent the minimum starting distances from the piling location for animals to escape and prevent them from receiving a dose higher than the threshold.

23 Other marine mammal fleeing swimming speeds have previously been recommended by Scottish Natural Heritage (2016). They recommend that 1.4 m/s is used for harbour porpoise, however this is based on an *average* descent and ascent speed from tagged porpoise (Westgate et al. 1995), not a fleeing speed. Kastelein et al. (2018) found that swimming speeds of ~7 km/h (1.94 m/s) are sustainable for harbour porpoise (throughout a 30 min test period), thus, the modelling is conservative as it used fleeing speeds lower than this. Scottish Natural Heritage (2016) also recommend a fleeing speed of 2.1 m/s for minke whales based on Williams (2009), however this reference states that the *routine* speeds for mysticete whales is 2.1 to 2.6 m/s and is thus not representative of fleeing speeds. Scottish Natural Heritage (2016) recommend a swimming speed of 1.8 m/s for grey seals, based on Thompson (2015) which estimated that *typical* swimming speeds were in the range of 1.8-2.0 m/s. This typical swimming speed is faster than the 1.5 m/s used in the modelling and thus the modelled fleeing speed for grey seals is highly conservative.

24 The swimming speeds assumed in this impact assessment are standard swimming speeds that have been assumed in several other recent offshore wind farm impact assessments (including: Hornsea Three, Hornsea Four, Erebus, Rampion 2, Norfolk Boreas, East Anglia Two etc.).

TTS Assessment

25 It is recognised that TTS is a temporary impairment of an animal's hearing ability with potential consequences for the animal's ability to escape predation, forage and/or communicate, supporting the statement of Kastelein et al. (2012c) that "*the magnitude of the consequence is likely to be related to the duration and magnitude of the TTS*". An assessment of the impact based on the TTS thresholds as currently given in Southall et al. (2019) (or the former NMFS (2016) guidelines and Southall et al. (2007) guidance) would lead to a substantial overestimate of the potential impact of TTS. Furthermore, the prediction of TTS impact ranges, based on the sound exposure level (SEL) thresholds, are subject to the same inherent uncertainties as those for PTS, and in fact the uncertainties may be considered to have a proportionately larger effect on the prediction of TTS. These concepts are explained in detail in Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties.

26 The ranges that indicate TTS-onset were modelled and are presented in this impact assessment (Table 8). However, as TTS-onset is defined primarily as a means of predicting PTS-onset, there is currently no threshold for TTS-onset that would indicate a biologically significant amount of TTS; therefore it was not possible to carry out a quantitative assessment of the magnitude or significance of the impact of TTS on marine mammals. This approach has been agreed with Natural England, the MMO and CEFAS and, as such, recent projects have not presented an assessment of magnitude, sensitivity or resulting significance for TTS-onset (for example, Hornsea Three EIA, Hornsea Four PEIR, Rampion 2 PEIR). In addition to this, the Scottish SNCBs do not require the assessment of TTS-onset in marine mammal EIAs.

Table 8: TTS-onset thresholds for impulsive noise (from Southall et al 2019).

HEARING GROUP	SPECIES	CUMULATIVE TTS (SEL_{CUM} DB RE 1 µPA^{2}S WEIGHTED)	INSTANTANEOUS TTS (SPL_{PEAK} DB RE 1 µPA UNWEIGHTED)
VHF Cetacean	Harbour porpoise	140	196

HEARING GROUP	SPECIES	CUMULATIVE TTS (SEL$_{CUM}$ DB RE 1 µPA^{2}S WEIGHTED)	INSTANTANEOUS TTS (SPL$_{PEAK}$ DB RE 1 µPA UNWEIGHTED)
HF Cetacean	Bottlenose, common & Risso's dolphin	170	224
LF Cetacean	Minke whale	168	213
Phocid	Grey seal	170	212

Disturbance assessment – piling

27 The assessment of disturbance from pile driven foundations was based on the current best practice methodology, making use of the best available scientific evidence. This incorporates the application of a species-specific dose-response approach rather than a fixed behavioural threshold approach. Noise contours at 5 dB intervals were generated by noise modelling and were overlain on species density surfaces to predict the number of animals potentially disturbed. This allowed for the quantification of the number of animals that will potentially respond.

28 Compared with the EDR and fixed noise threshold approaches, the application of a dose-response curve allows for more realistic assumptions about animal response varying with dose, which is supported by a growing number of studies. A dose-response curve is used to quantify the probability of a response from an animal to a dose of a certain stimulus or stressor (Dunlop et al. 2017) and is based on the assumption that not all animals in an impact zone will respond. The dose can either be determined using the distance from the sound source or the received weighted or unweighted sound level at the receiver (Sinclair et al. 2021).

29 Using a species-specific dose-response approach rather than a fixed behavioural threshold to assess disturbance is currently considered to be the best practice methodology and the latest guidance provided in Southall et al. (2019) is that *"Apparent patterns in response as a function of received noise level (sound pressure level) highlighted a number of potential errors in using all-or-nothing "thresholds" to predict whether animals will respond. Tyack and Thomas (2019) subsequently and substantially expanded upon these observations. The clearly evident variability in response is likely attributable to a host of contextual factors, which emphasizes the importance of estimating not only a dose-response function but also characterizing response variability at any dosage".*

30 To estimate the number of porpoise predicted to experience behavioural disturbance as a result of pile driving, this impact assessment uses the porpoise dose-response curve presented in Graham et al. (2017a) (Figure 3).

31 The Graham et al. (2017a) dose-response curve was developed using data on harbour porpoise collected during the first six weeks of piling during Phase 1 of the Beatrice Offshore Wind Farm monitoring program. Changes in porpoise occurrence (detection positive hours per day) were estimated using 47 CPODs[i] placed around the wind farm site during piling and compared with baseline data from 12 sites outside of the wind farm area prior to the commencement of operations, to characterise this variation in occurrence. Porpoise were considered to have exhibited a behavioural response to piling when the proportional decrease in occurrence was greater than 0.5. The probability that porpoise occurrence did or did not show a response to piling was modelled along with the received single-pulse sound exposure levels piling source levels based on the received noise levels (Graham et al. 2017a).

[i] CPODs monitor the presence and activity of toothed cetaceans by the detection within the CPOD app of the trains of echo-location clicks that they make. See [redacted]

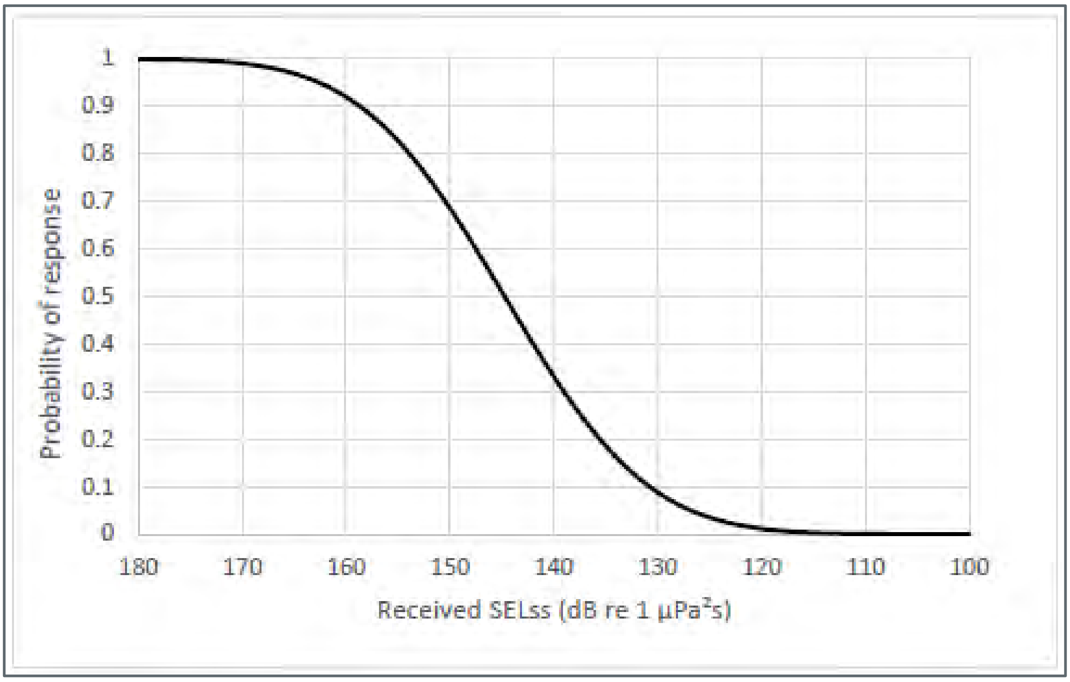


Figure 3: Relationship between the proportion of porpoise responding and the received single strike SEL (SEL_{SS}) (Graham et al. 2017a).

32 Since the initial development of the dose-response curve in 2017, additional data from the remaining pile driving events at Beatrice Offshore Windfarm have been processed, and are presented in Graham et al. (2019). The passive acoustic monitoring showed a 50% probability of porpoise response (a significant reduction in detection relative to baseline) within 7.4 km at the first location piled, with decreasing response levels over the construction period to a 50% probability of response within 1.3 km by the final piling location (Figure 4)(Graham *et al.*, 2019). Therefore, using the dose-response curve derived from the initial piling events for all piling events in the impact assessment is precautionary, as evidence shows that porpoise response is likely to diminish over the construction period.

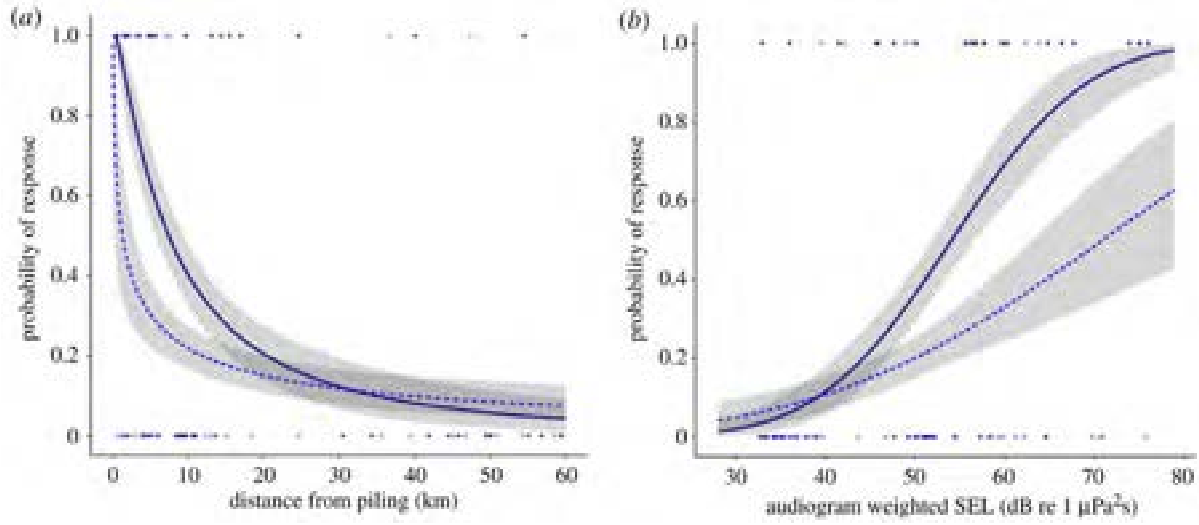


Figure 4 The probability of a harbour porpoise response (24 h) in relation to the partial contribution of (a) distance from piling and (b) audiogram-weighted received single-pulse SEL for the first location piled (solid navy line) and the final location piled (dashed blue line). Obtained from Graham et al. (2019).

Predicted assuming the number of AIS vessel locations within 1 km ¼ 0; confidence intervals (shaded areas) estimated for uncertainty in fixed effects only. Harbour porpoise occurrence was considered to have responded to piling when the proportional decrease in occurrence (DPH) exceeded a threshold of 0.5. Points show actual response data for the first location piled (filled navy circles) and the final location piled (open blue circles).

33 In the absence of species-specific data on bottlenose dolphins, common dolphins, Risso's dolphins or minke whales, this dose-response curve has been adopted for all cetaceans, however it is considered that the application of the porpoise dose-response curve to other cetacean species is highly over precautionary. Porpoise are considered to be particularly responsive to anthropogenic disturbance, with playback experiments showing avoidance reactions to very low levels of sound (Tyack 2009) and multiple studies showing that porpoise respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g., Brandt et al. 2013, Thompson et al. 2013, Tougaard et al. 2013, Brandt et al. 2018, Sarnocinska et al. 2019, Thompson et al. 2020, Benhemma-Le Gall et al. 2021).

34 Various studies have shown that other cetacean species show comparatively less of a disturbance response from underwater noise compared with harbour porpoise. For example, through an analysis of 16 years of marine mammal observer data from seismic survey vessels, Stone et al. (2017) found a significant reduction in porpoise detection rates when large seismic airgun arrays were actively firing, but not for bottlenose dolphins. While the strength and significance of responses varied between porpoise and other dolphin species for different measures of effect, the study emphasised the sensitivity of the harbour porpoise (Stone et al. 2017). In the Moray Firth, bottlenose dolphins have been shown to remain in the impacted area during both seismic activities and pile installation activities (Fernandez-Betelu et al. 2021) which highlights a lack of complete displacement response. Likewise, other high-frequency cetacean species, such as striped and common dolphins, have been shown to display less of a response to underwater noise signals and construction-related activities compared with harbour porpoise (e.g. Kastelein et al. 2006, Culloch et al. 2016).

35 There is no disturbance threshold (effective disturbance range or dose-response curve) for any other cetacean species included in this assessment. Therefore, in the complete absence of an alternative, the assessment for all cetacean species has used the porpoise dose-response curve. This is considered highly precautionary and as such the number of animals predicted to experience behavioural disturbance is considered to be an over-estimate and should be interpreted with a large degree of caution.

36 For grey seals, the dose-response curve adopted was based on the data presented in Whyte et al. (2020) (Figure 5). The Whyte et al. (2020) study updates the initial dose-response information presented in Russell et al. (2016b) and Russell and Hastie (2017), where the percentage change in harbour seal density was predicted at the Lincs offshore windfarm. The original study used telemetry data from 25 harbour seals tagged in the Wash between 2003 and 2006, in addition to a further 24 harbour seals tagged in 2012, to estimate levels of seal usage in the area in order to assess how seal usage changed in relation to the pile driving activities at the Lincs Offshore Wind farm in 2011-2012.

37 In the Whyte et al. (2020) dose-response curve it has been assumed that all seals are displaced at sound exposure levels above 180 dB re 1 μPa²s. This is a conservative assumption since there were no data presented in the study for harbour seal responses at this level. It is also important to note that the percentage decrease in response in the categories 170≤175 and 175≤180 dB re 1 μPa²s is slightly anomalous (higher response at a lower sound exposure level) due to the small number of spatial cells included in the analysis for these categories (n= 2 and 3 respectively). Given the large confidence intervals on the data, this assessment presents the mean number of seals predicted to be disturbed alongside the 95% Confidence intervals, for context.

38 There are no corresponding data for grey seals and, as such, the harbour seal curve is applied to the grey seal disturbance assessment. This is considered to be an appropriate proxy for grey seals, since both species are categorised within the same functional hearing group. However, it is likely that this over estimates the grey seal response, since grey seals are considered to be less sensitive to behavioural disturbance than harbour seals and could tolerate more days of disturbance before there is likely to be an effect on vital rates (Booth et al. 2019). Recent studies of tagged grey seals have shown that there is vast individual variation is responses to pile driving, with some animals not showing any evidence of a behavioural response (Aarts et al. 2018). Likewise, if the impacted area is considered to be a high quality foraging patch, it is likely that some grey seals may show no behavioural response at all, given their motivation to remain in the area for foraging (Hastie et al. 2021). Therefore, the adoption of the harbour seal dose-response curve for grey seals is considered to be precautionary as it will likely over-estimate the potential for impact on grey seals.

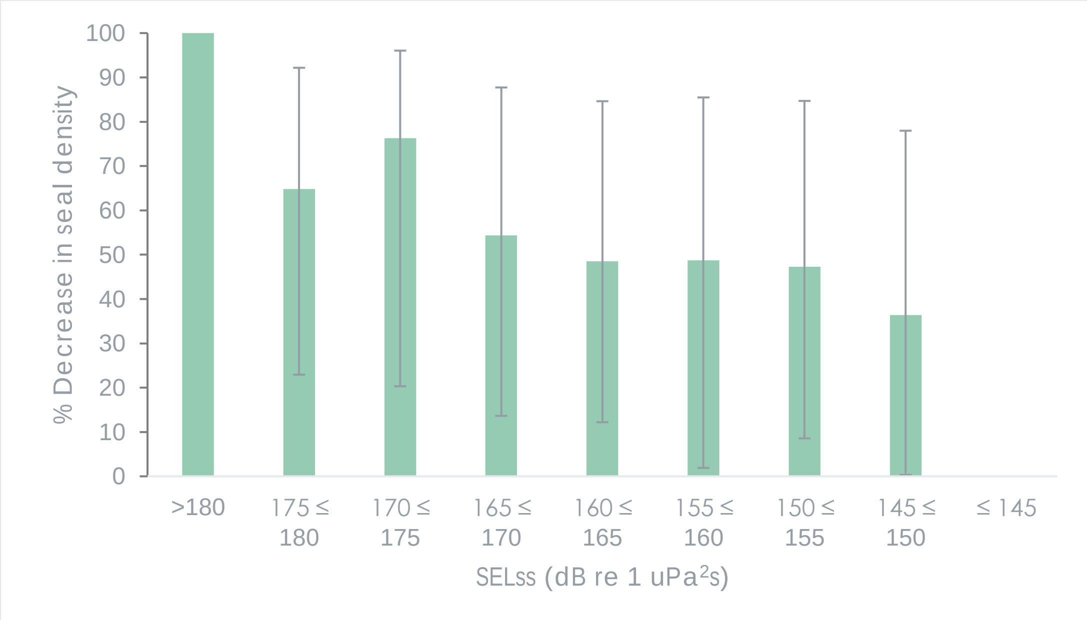


Figure 5: Predicted decrease in seal density as a function of estimated sound exposure level, error bars show 95% CI (from Whyte et al 2020).

Disturbance assessment - UXO

39 While there are empirically-derived dose-response relationships for pile driving; these are not directly applicable to the assessment of UXO detonation due to the very different nature of the sound emission. While both sound sources (piling and explosives) are categorised as "impulsive" sound sources, they differ drastically in the number of pulses and the overall duration of the noise emission, both of which will ultimately drive the behavioural response. While one UXO-detonation is anticipated to result in a one-off startle-response or aversive behaviour, the series of pulses emitted during pile driving will more or less continuously drive animals out of the impacted area, giving rise to a measurable and quantifiable dose-response relationship. For UXO clearance, there are no dose-response functions available that describe the magnitude and transient nature of the behavioural impact of UXO detonation on marine mammals.

40 Since there is no dose-response function available that appropriately reflects the behavioural disturbance from UXO detonation, other behavioural disturbance thresholds have been considered instead. These alternatives are summarised in the sections below.

EDR - 26 km for high order UXO clearance

41 There is guidance available on the EDR that should be applied to assess the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs in England, Wales & Northern Ireland (JNCC et al. 2020). This guidance advises that an effective deterrence range of 26 km around the source location is used to determine the impact area from high order UXO detonation with respect to disturbance of harbour porpoise in SACs.

42 However, the guidance itself acknowledges that this EDR is based on the EDR recommended for pile driving of monopiles (without noise abatement measures), since there is no equivalent data for explosives.

"The 26 km EDR is also to be used for the high order detonation of unexploded ordnance (UXOs) despite there being no empirical evidence of harbour porpoise avoidance." (JNCC et al. 2020)

43 The guidance also acknowledges that the disturbance resulting from a single explosive detonation would likely not cause the more wide-spread prolonged displacement that has been observed in response to pile driving activities:

"… a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement…" (JNCC et al. 2020).

44 While NRW have expressed concerns regarding the use of the EDR approach to assess disturbance, they do remain the only published threshold currently advised by a regulator in UK waters to assess behavioral disturbance from high-order UXO detonations. While the Applicant acknowledges that NRW do not agree with the 26 km EDR for UXO detonation, the Applicant will present the 26 km EDR for comparison to the alternative fixed noise threshold described below.

EDR - 5 km for low order UXO clearance

45 There is no guidance available on which thresholds should be used to assess disturbance from low-order UXO clearance. Current risk assessments conducted to support UXO Marine Licence Applications that are including deflagration as the preferred method, are assuming an EDR of 5 km (e.g. Sofia offshore wind farm[ii]). As a consequence, due to the absence of formal guidance, this approach has been adopted here for the assessment of disturbance from low-order detonation of UXOs at the Project.

Fixed noise threshold – TTS-onset

46 Some recent assessments of UXO clearance activities have used the TTS-onset threshold to indicate the level at which a 'fleeing' response may be expected to occur in marine mammals (e.g. Seagreen and Neart na Goithe). This is a result of discussion in Southall et al. (2007) which states that in the absence of empirical data on responses, the use of the TTS-onset threshold may be appropriate for single pulses (like UXO detonation):

"Even strong behavioral responses to single pulses, other than those that may secondarily result in injury or death (e.g., stampeding), are expected to dissipate rapidly enough as to have limited long-term consequence. Consequently, upon exposure to a single pulse, the onset of significant behavioral disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e., TTS-onset). We recognize that this is not a behavioral effect per se, but we use this auditory effect as a de facto behavioral threshold until better measures are identified. Lesser exposures to a single pulse are not expected to cause significant disturbance, whereas any compromise, even temporarily, to hearing functions has the potential to affect vital rates through altered behavior." (Southall et al., 2007)."

"Due to the transient nature of a single pulse, the most severe behavioral reactions will usually be temporary responses, such as startle, rather than prolonged effects, such as modified habitat utilization. A transient behavioral response to a single pulse is unlikely to result in demonstrable

[ii] Sofia Offshore Wind Farm UXO Clearance Marine License Application (GoBe 2021)MLA/2020/00489

effects on individual growth, survival, or reproduction. Consequently, for the unique condition of a single pulse, an auditory effect is used as a de facto disturbance criterion. It is assumed that significant behavioral disturbance might occur if noise exposure is sufficient to have a measurable transient effect on hearing (i.e., TTS-onset). Although TTS is not a behavioral effect per se, this approach is used because any compromise, even temporarily, to hearing functions has the potential to affect vital rates by interfering with essential communication and/or detection capabilities. 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." (Southall et al., 2007).

47 Therefore, an estimation of the extent of behavioural disturbance can be based on the sound levels at which the onset of TTS is predicted to occur from impulsive sounds. Marine Scotland and NatureScot currently recommend that TTS-onset as a proxy for disturbance from UXO detonation is the most appropriate threshold to use given the lack of empirical data. TTS-onset thresholds are taken as those proposed for different functional hearing groups by Southall et al. (2019).

Summary

48 In the absence of agreed thresholds to assess the potential for behaviour disturbance in marine mammals from UXO detonations, the AyM impact assessment presents results for each of the following behavioural disturbance thresholds:

- 26 km EDR for high-order detonations;
- 5 km EDR for low-order detonations; and
- TTS-onset thresholds for high-order detonations.

49 While the Applicant acknowledges that there is no empirical data to validate these thresholds as appropriate for behavioural disturbance from UXO detonations, these thresholds do cover our understanding of the range of potential behavioural responses from impulsive sound sources, and as such, provide the best indication as to the potential level of impact.

50 It is important for the impact assessment to acknowledge that our understanding of the effect of disturbance from UXO detonation is very limited, and as such the assessment can only provide an indication of the number of animals potentially at risk of disturbance given the limited evidence available.

Disturbance assessment – other construction activities

51 There is currently no guidance on the thresholds to be used to assess disturbance of marine mammals from drilling, dredging or vessel activity. Therefore, this impact assessment provides a qualitative assessment for these impacts. The assessment is based on the limited evidence that is available in the existing literature for that impact pathway and species combination, where available.

7.5 Assessment criteria and assignment of significance

52 Determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts (see Volume 1, Chapter 3: Environmental Impact Assessment Methodology).

53 Information about the project and the project activities for all stages of the project life cycle (construction, O&M and decommissioning) have been combined with information about the environmental baseline to identify the potential interactions between the project and the environment. These potential interactions are known as potential impacts, the potential impacts are then assessed to give a level of significance of effect upon the receiving environment/ receptors.

54 The outcome of the assessment is to determine the significance of these effects against predetermined criteria.

55 The magnitude of potential impacts is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in the assessment as shown in Table 9.

56 The sensitivities of marine mammal receptors are defined by both their potential vulnerability to an impact from the proposed development, their recoverability, and the value or importance of the receptor. The definitions of terms relating to the sensitivity of marine mammal ecology chapters are detailed in Table 10.

Table 9: Impact magnitude definitions.

MAGNITUDE	DEFINITION
High	The impact would affect the behaviour and distribution of sufficient numbers of individuals, with sufficient severity, to affect the favourable conservation status and/or the long-term viability of the population at a generational scale adverse.
	Long-term, large-scale increase in the population trajectory at a generational scale (beneficial).
Medium	Temporary changes in behaviour and/or distribution of individuals at a scale that would result in potential reductions to lifetime reproductive success to some individuals although not enough to affect the population trajectory over a generational scale. Permanent effects on individuals that may influence individual survival but not 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	Short-term and/or intermittent and temporary behavioural effects in a small proportion of the population. Reproductive rates of individuals may be impacted in the short term (over a limited number of breeding cycles). Survival and reproductive rates very unlikely to be impacted to the extent that the population trajectory would be altered adverse.

MAGNITUDE	DEFINITION
	Short term (over a limited number of breeding cycles) benefit to the habitat influencing foraging efficiency resulting in increased reproductive potential (beneficial).
Negligible	Very short term, recoverable effect on the behaviour and/or distribution in a very small proportion of the population. No potential for the any changes in the individual reproductive success or survival therefore no changes to the population size or trajectory adverse.
	Very minor benefit to the habitat influencing foraging efficiency of a limited number of individuals (beneficial).

Table 10: Sensitivity/importance of the environment.

RECEPTOR SENSITIVITY/ IMPORTANCE	DESCRIPTION/ REASON
High	No ability to adapt behaviour so that individual vital rates (survival and reproduction) are highly likely to be significantly affected. No tolerance – effect will cause a significant change in individual vital rates (survival and reproduction). No ability for the animal to recover from any impact on vital rates (reproduction and survival rates).
Medium	Limited ability to adapt behaviour so that individual vital rates (survival and reproduction) may be significantly affected. Limited tolerance – effect may cause a significant change in individual vital rates (survival and reproduction). Limited ability for the animal to recover from any impact on vital rates (reproduction and survival rates).

RECEPTOR SENSITIVITY/ IMPORTANCE	DESCRIPTION/ REASON
Low	Ability to adapt behaviour so that individual vital rates (survival and reproduction) may be affected, but not at a significant level. Some tolerance – no significant change in individual vital rates (survival and reproduction). Ability for the animal to recover from any impact on vital rates (reproduction and survival rates).
Negligible	Receptor is able to adapt behaviour so that individual vital rates (survival and reproduction) are not affected. Receptor is able to tolerate the effect without any impact on individual vital rates (survival and reproduction). Receptor is able to return to previous behavioural states/activities once the impact has ceased.

57 The matrix used for the assessment of the significance of potential effects is described in Table 11. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance.

58 For the purpose of this assessment any effect that is moderate or major is considered to be significant in EIA terms. Any effect that is minor or below is not significant with respect to the EIA Regulations.

Table 11: Matrix to determine effect significance.

		SENSITIVITY			
		HIGH	MEDIUM	LOW	NEGLIGIBLE
ADVERSE MAGNITUDE	HIGH	Major	Major	Moderate	Minor
	MEDIUM	Major	Moderate	Minor	Negligible
	LOW	Moderate	Minor	Minor	Negligible
	NEGLIGIBLE	Minor	Minor	Negligible	Negligible
BENEFICIAL MAGNITUDE	NEGLIGIBLE	Minor	Minor	Negligible	Negligible
	LOW	Moderate	Minor	Minor	Negligible
	MEDIUM	Major	Moderate	Minor	Negligible
	HIGH	Major	Major	Moderate	Minor

Note: Effects of 'moderate' significance or greater are defined as significant with regards to the EIA Regulations.

7.5.1 Sensitivity to PTS

Expert elicitation on PTS sensitivity

59 The ecological consequences of PTS for marine mammals are uncertain. At a Department for Business, Energy & Industrial Strategy (BEIS) funded expert elicitation workshop held at the University of St Andrews (March 2018), experts in marine mammal hearing discussed the nature, extent and potential consequence of PTS to UK marine mammal species (Booth and Heinis 2018). This workshop outlined and collated the best and most recent empirical data available on the effects of PTS on marine mammals. A number of general points came out in discussions as part of the elicitation. These included that PTS did not mean animals were deaf, that the limitations of the ambient noise environment should be considered and that the magnitude and frequency band in which PTS occurs are critical to assessing the effect on vital rates.

60 Southall et al. (2007) defined the onset of TTS as *"being a temporary elevation of a hearing threshold by 6 dB"* (in which the reference pressure for the dB is 1µPa). Although 6 dB of TTS is a somewhat arbitrary definition of onset, it has been adopted largely because 6 dB is a measurable quantity that is typically outside the variability of repeated thresholds measurements. The onset of PTS was defined as a non-recoverable elevation of the hearing threshold of 6 dB, for similar reasons. Based upon TTS growth rates obtained from the scientific literature, it has been assumed that the onset of PTS occurs after TTS has grown to 40 dB. The growth rate of TTS is dependent on the frequency of exposure, but is nevertheless assumed to occur as a function of an exposure that results in 40 dB of TTS, i.e. 40 dB of TTS is assumed to equate to 6 dB of PTS.

61 For piling noise, most energy is between ~30 - 500 Hz, with a peak usually between 100 – 300 Hz and energy extending above 2 kHz (Kastelein et al. 2015, Kastelein et al. 2016). Studies have shown that exposure to impulsive pile driving noise induces TTS in a relatively narrow frequency band in harbour porpoise and harbour seals (reviewed in Finneran 2015), with statistically significant TTS occurring at 4 and 8 kHz (Kastelein et al. 2016) and centred at 4 kHz (Kastelein et al. 2012a, Kastelein et al. 2012b, Kastelein et al. 2013, Kastelein et al. 2017). Therefore, during the expert elicitation, the experts agreed that any threshold shifts as a result of pile driving would manifest themselves in the 2 - 10 kHz range (Kastelein et al. 2017) and that a PTS 'notch' of 6 – 18 dB in a narrow frequency band in the 2 - 10 kHz region is unlikely to significantly affect the fitness of individuals (ability to survive and reproduce). The expert elicitation concluded that:

… the effects of a 6 dB PTS in the 2-10 kHz band was unlikely to have a large effect on survival or fertility of the species of interest.

… for all species experts indicated that the most likely predicted effect on survival or fertility as a result of 6 dB PTS was likely to be very small (i.e. <5 % reduction in survival or fertility).

… the defined PTS was likely to have a slightly larger effect on calves/pups and juveniles than on mature females survival or fertility.

62 For harbour porpoise, the predicted decline in vital rates from the impact of a 6 dB PTS in the 2-10 kHz band for different percentiles of the elicited probability distribution are provided in Table 12. The data provided in Table 12 should be interpreted as:

- Experts estimated that the median decline in an individual mature female harbour porpoise's survival was 0.01% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual mature female harbour porpoise's fertility was 0.09% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual harbour porpoise juvenile or dependent calf survival was 0.18% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).

Table 12: Predicted decline in harbour porpoise vital rates for different percentiles of the elicited probability distribution.

	PERCENTILES OF THE ELICITED PROBABILITY DISTRIBUTION								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
Adult survival	0	0	0	0.01	0.01	0.03	0.05	0.1	0.23
Fertility	0	0	0.02	0.05	0.09	0.16	0.3	0.7	1.35
Calf/Juvenile survival	0	0	0.02	0.09	0.18	0.31	0.49	0.8	1.46

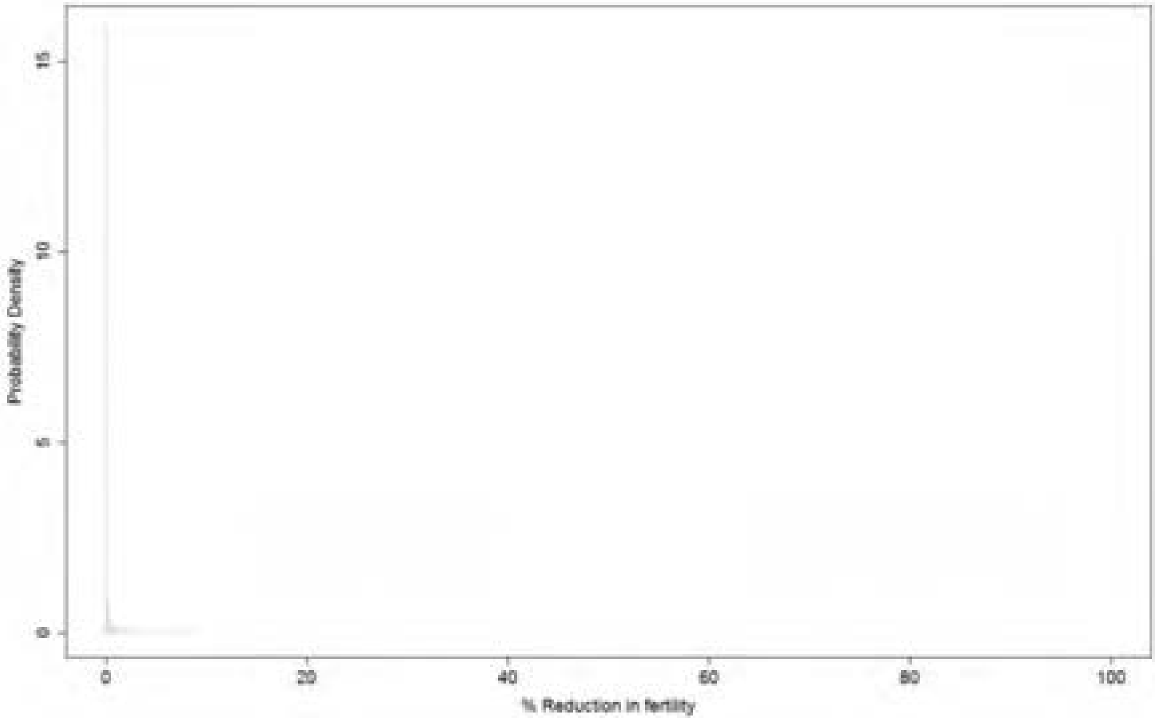


Figure 6: Probability distribution showing the consensus distribution for the effects on fertility of a mature female harbour porpoise as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

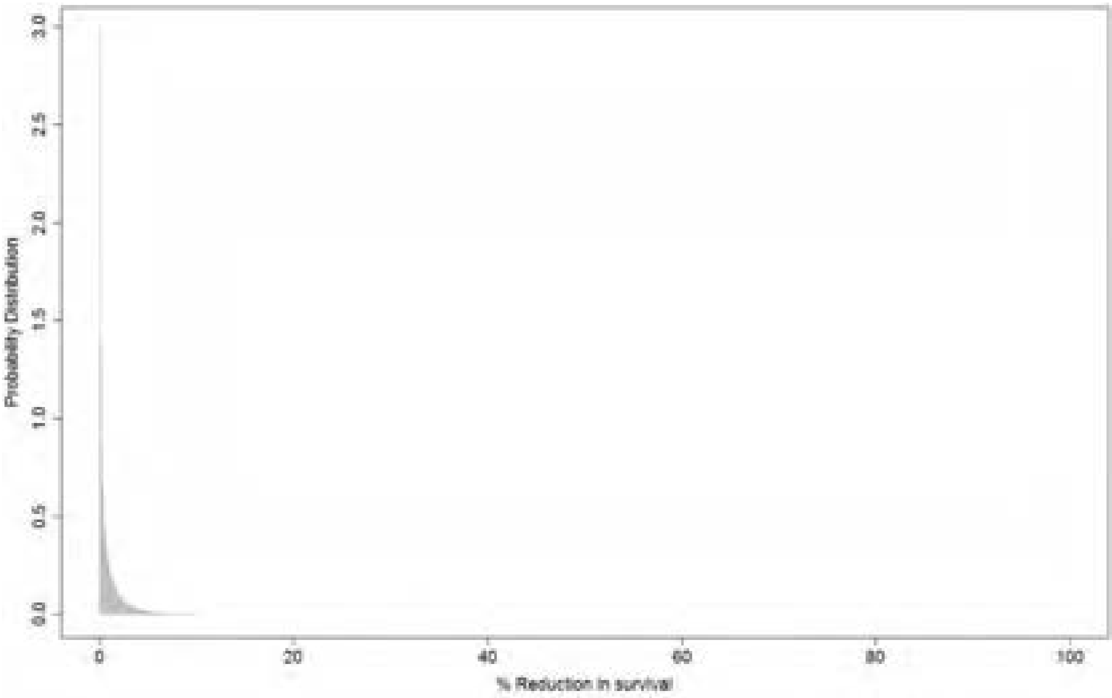


Figure 7: Probability distribution showing the consensus distribution for the effects on survival of a mature female harbour porpoise as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

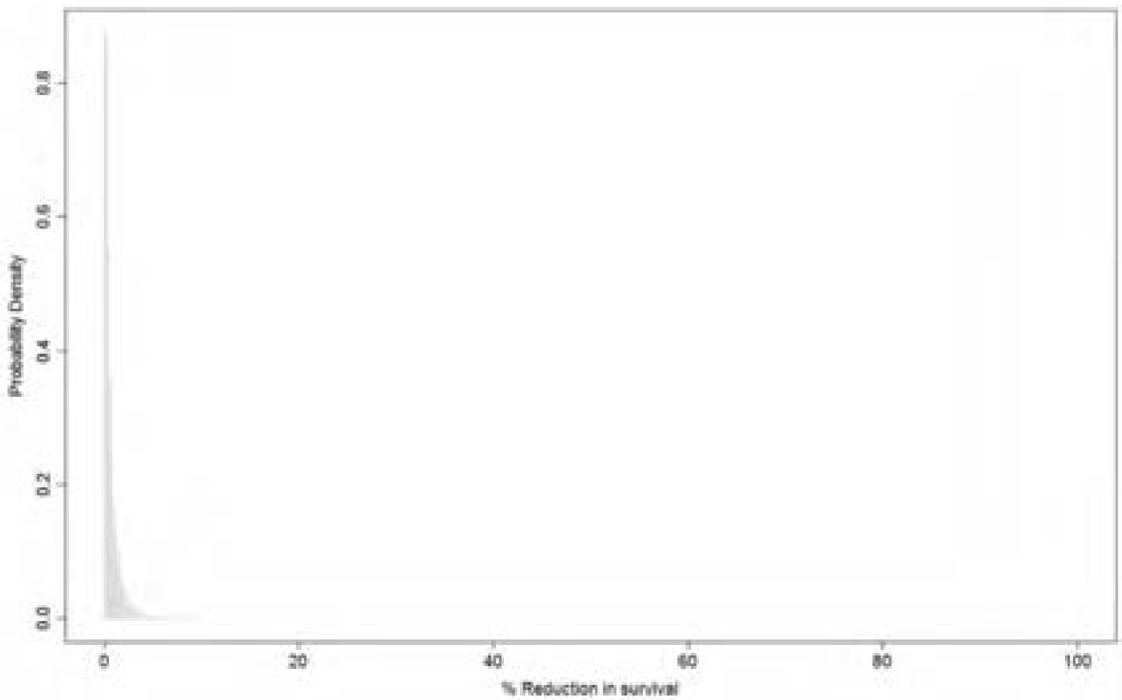


Figure 8: Probability distribution showing the consensus distribution for the effects on survival of juvenile or dependent calf harbour

porpoise as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

63 The predicted decline in bottlenose dolphin vital rates from the impact of a 6 dB PTS in the 2-10 kHz band for different percentiles of the elicited probability distribution are provided in Table 13. The data provided in Table 13 should be interpreted as:

- Experts estimated that the median decline in an individual mature female bottlenose dolphin's survival was 1.6% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual mature female bottlenose dolphin's fertility was 0.43% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual bottlenose dolphin juvenile survival was 1.32% (due to a 6 dB PTS (a notch a few kHz wide and 6dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual bottlenose dolphin dependent calf survival was 2.96% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).

Table 13: Predicted decline in bottlenose dolphin vital rates for different percentiles of the elicited probability distribution.

	PERCENTILES OF THE ELICITED PROBABILITY DISTRIBUTION								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
Adult survival	0	0.18	0.57	1.04	1.6	2.34	3.39	5.18	10.99
Fertility	0	0.04	0.13	0.26	0.43	0.85	1.66	3.49	6.22
Juvenile survival	0.01	0.11	0.35	0.75	1.32	2.14	3.3	5.19	11.24
Calf survival	0	0.29	0.93	1.77	2.96	4.96	7.81	10.69	14.79

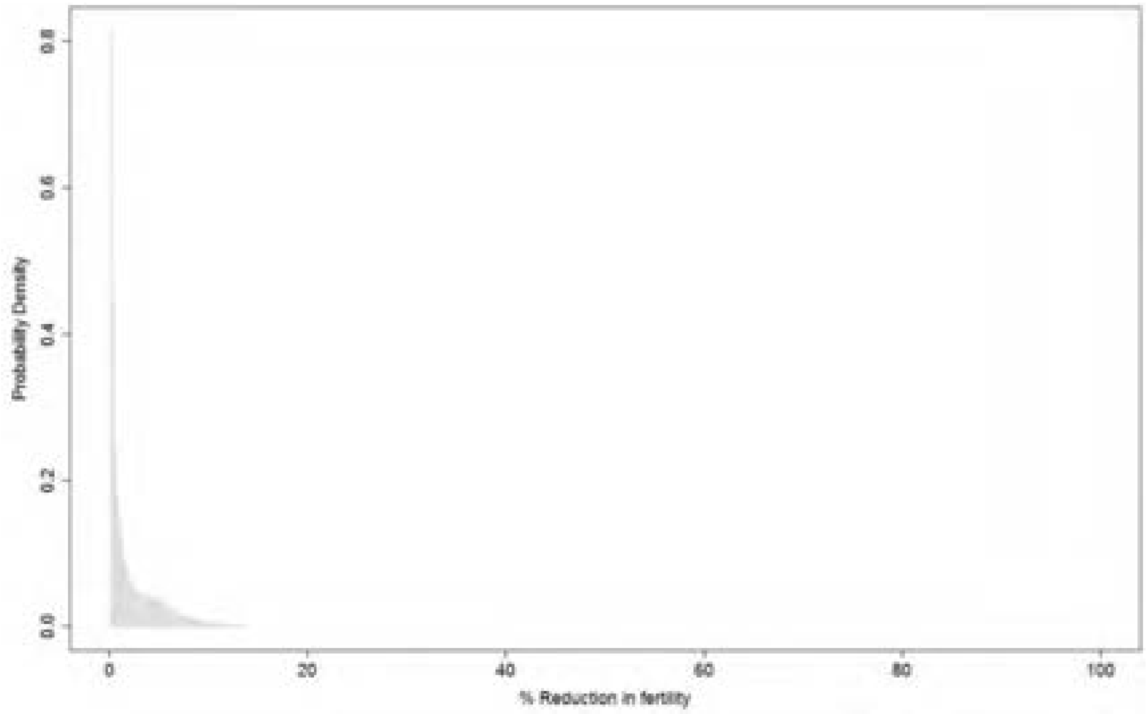


Figure 9: Probability distribution showing the consensus distribution for the effects on fertility of mature female bottlenose dolphin as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

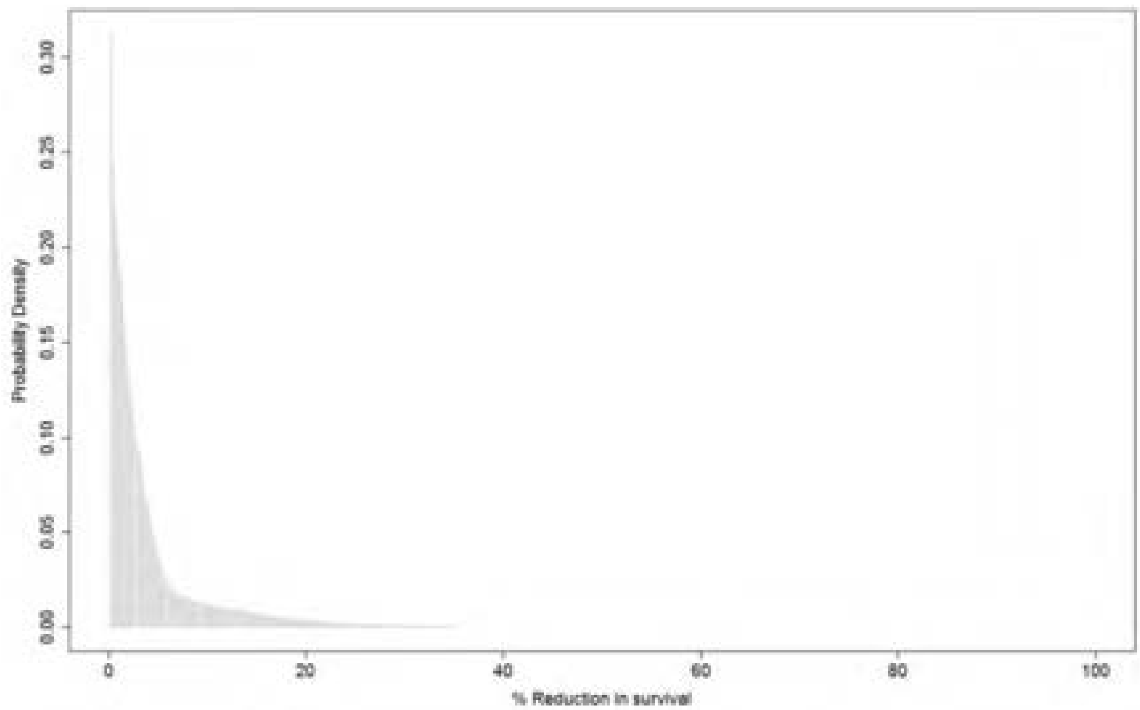


Figure 10: Probability distribution showing the consensus distribution for the effects on survival of mature female bottlenose dolphin as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

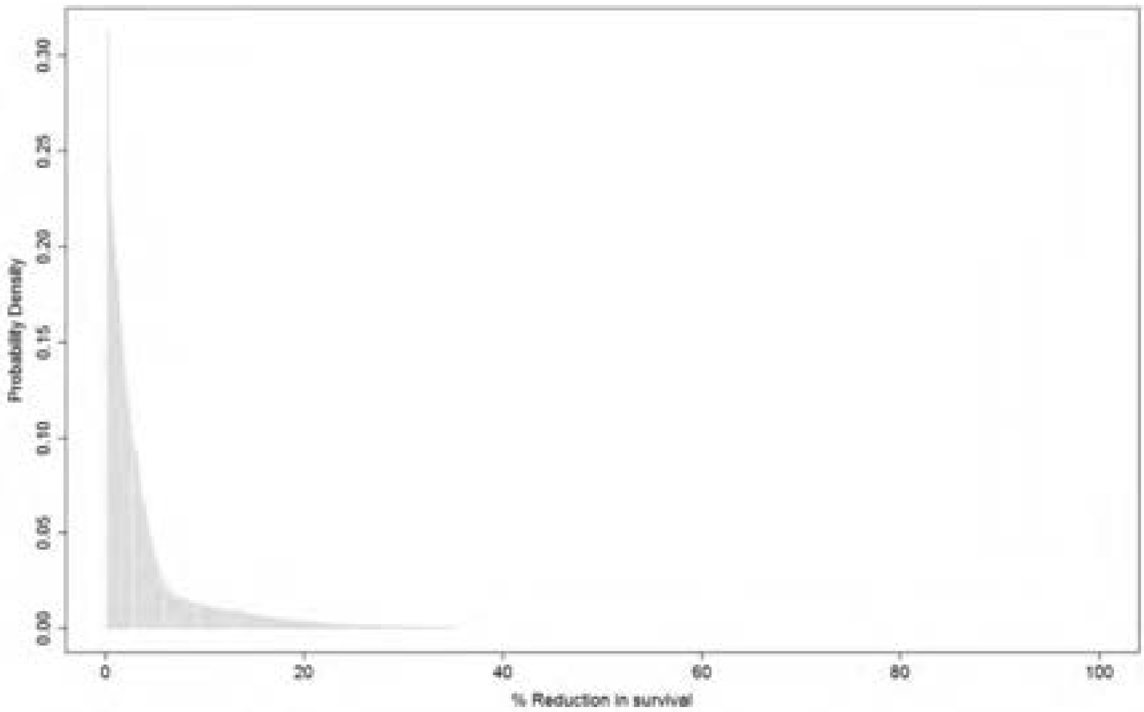


Figure 11: Probability distribution showing the consensus distribution for the effects on survival of juvenile or dependent calf bottlenose dolphin as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

64 The predicted decline in harbour and grey seals vital rates from the impact of a 6 dB PTS in the 2-10 kHz band for different percentiles of the elicited probability distribution are provided in Table 14. The data provided in Table 14 should be interpreted as:

- Experts estimated that the median decline in an individual mature female seal's survival was 0.39% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual mature female seal's fertility was 0.27% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).
- Experts estimated that the median decline in an individual seal pup/juvenile survival was 0.52% (due to a 6 dB PTS (a notch a few kHz wide and 6 dB high) occurring somewhere in the hearing between 2-10 kHz).

Table 14: Predicted decline in harbour and grey seal vital rates for different percentiles of the elicited probability distribution.

	PERCENTILES OF THE ELICITED PROBABILITY DISTRIBUTION								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
Adult survival	0.02	0.1	0.18	0.27	0.39	0.55	0.78	1.14	1.89
Fertility	0.01	0.02	0.05	0.14	0.27	0.48	0.88	1.48	4.34
Calf survival	0	0.04	0.15	0.32	0.52	0.8	1.21	1.88	3

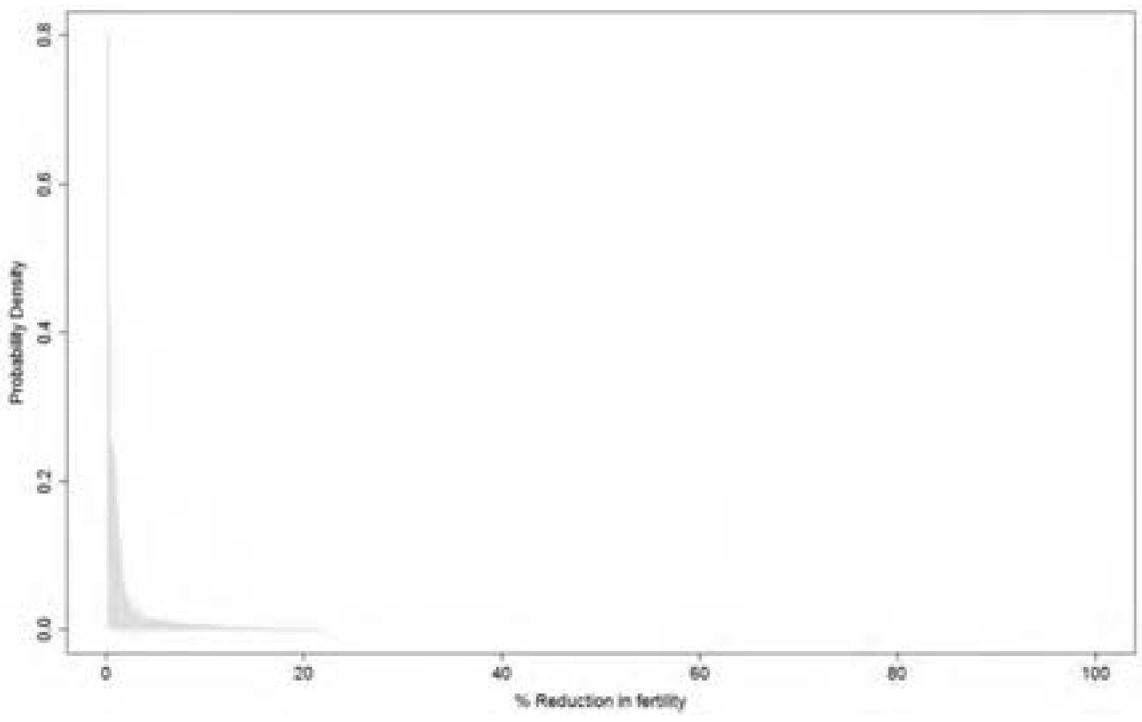


Figure 12: Probability distribution showing the consensus distribution for the effects on fertility of a mature female (harbour or grey) seal as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

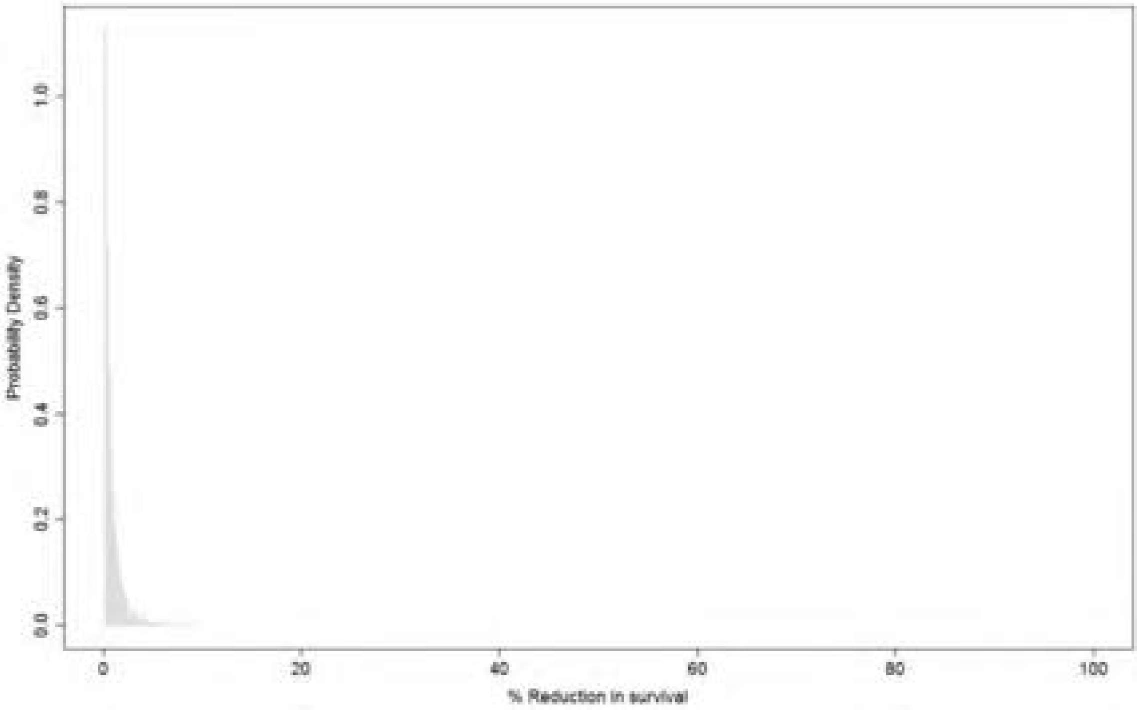


Figure 13: Probability distribution showing the consensus distribution for the effects on survival of a mature female (harbour or grey) seal as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

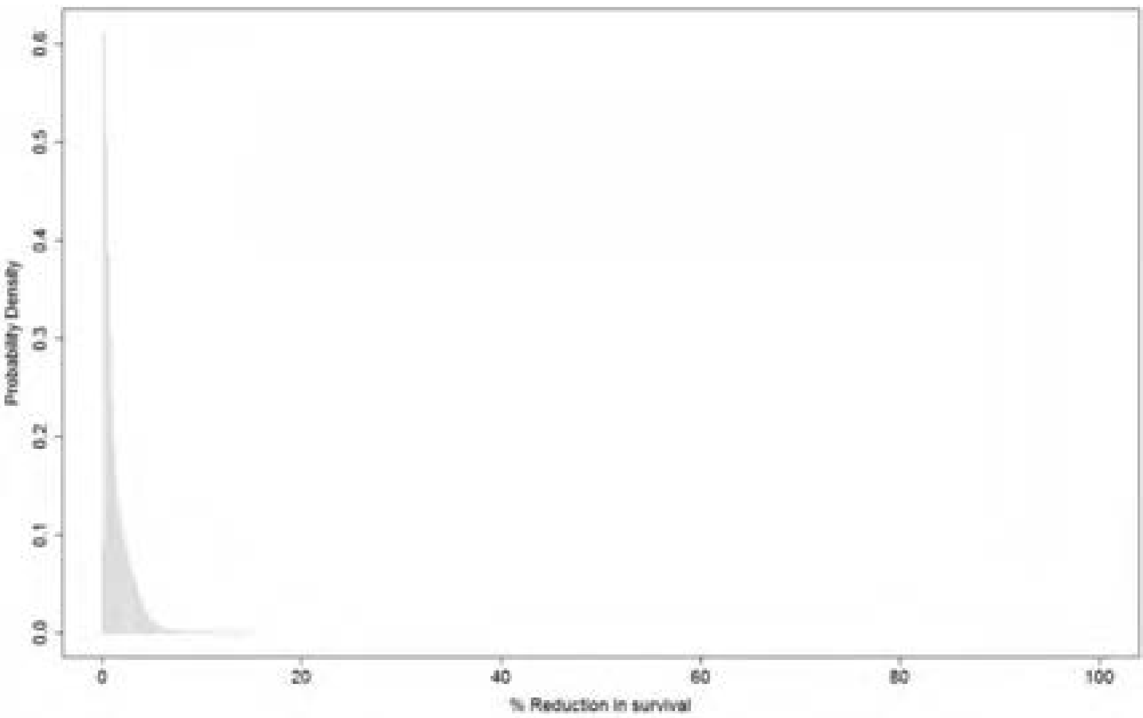


Figure 14: Probability distribution showing the consensus distribution for the effects on survival of juvenile or dependent pup (harbour or

grey) seal as a consequence of a maximum 6 dB of PTS within a 2-10 kHz band.

Other PTS-onset information

65 The low frequency noise produced during piling may be more likely to overlap with the hearing range of low frequency cetacean species such as minke whales. For minke whales, Tubelli et al. (2012) estimated the most sensitive hearing range (the region with thresholds within 40 dB of best sensitivity) to extend from 30 to 100 Hz up to 7.5 to 25 kHz, depending on the specific model used. Therefore a 2-10 kHz notch of 6 dB will only affect a small region of minke whale hearing. In addition, minke whale communication signals have been demonstrated to be below 2 kHz (Edds-Walton 2000, Mellinger et al. 2000, Gedamke et al. 2001, Risch et al. 2013, Risch et al. 2014). Like other mysticete whales, minke whales are also thought to be capable of hearing sounds through their skull bones (Cranford and Krysl 2015).

66 Data collected during wind farm construction have demonstrated that porpoise detections around the pile driving site decline several hours prior to the start of pile driving, and it is assumed that this is due to the increase in other construction related activities and vessel presence in advance of the actual pile driving (Brandt et al. 2018, Graham et al. 2019, Benhemma-Le Gall et al. 2020). Therefore, the presence of construction related vessels prior to the start of piling can act as a local scale deterrent for harbour porpoise and therefore reduce the risk of auditory injury. Assumptions that harbour porpoise are present in the vicinity of the pile driving at the start of the soft start are therefore likely to be overly conservative.

67 Seals are less dependent on hearing for foraging than cetaceans, but rely on sound for communication and predator avoidance (Deecke et al. 2002). Seals have very well developed tactile sensory systems that are used for foraging (Dehnhardt et al. 2001) and Hastie et al. (2015) reported that, based on calculations of SEL of tagged seals during the Lincs Offshore Windfarm construction, at least half of the tagged seals would have received a dose of sound greater than published thresholds for PTS.

68 A recent update of this analysis using the revised Southall et al. (2019) thresholds and weighting reduced this proportion to 25% of the seals (Russell and Hastie 2017). Based on the extent of the offshore wind farm construction in the Wash over the last ten years and the degree of overlap with the foraging ranges of harbour seals in the region (Russell et al. 2016a), it would not be unreasonable to suggest that a large number of individuals of the Wash population may have experienced levels of sound with the potential to cause hearing loss.

69 The Wash harbour seal population has been increasing over this period which may provide an indication that either: a) seals are not developing PTS despite predictions of exposure that would indicate that they should; or b) that the survival and fitness of individual seals are not affected by PTS. Point a) would indicate that methods for predicting PTS are perhaps unreliable and/ or over precautionary, and b) would suggest a lack of sensitivity to the effects of PTS.

PTS sensitivity conclusions

70 In conclusion, given the results of the expert elicitation, which combined best available knowledge on the effects of PTS-onset on marine mammals, the sensitivity of all marine mammal species (except dolphins) to PTS-onset is considered to be **Low**, whereby individual vital rates (survival and reproduction) may be affected, but not at a significant level. Given that there was greater uncertainty in the estimates for bottlenose dolphins, all dolphin species have precautionarily been assessed as having a **Medium** sensitivity to PTS, whereby there is the potential for reductions to vital rates to some individuals.

7.5.2 VHF cetacean sensitivity to pile driving disturbance

71 Previous studies have shown that harbour porpoises are displaced from the vicinity of piling events. For example, studies at wind farms in the German North Sea have recorded large declines in porpoise detections close to the piling (>90% decline at noise levels above 170 dB) with decreasing effect with increasing distance from the pile (25% decline at noise levels between 145 and 150 dB) (Brandt et al. 2016). The detection rates revealed that porpoise were only displaced from the piling area in the short term (1 to 3 days) (Brandt et al. 2011, Dähne et al. 2013, Brandt et al. 2016, Brandt et al. 2018). Harbour porpoise are small cetaceans which makes them vulnerable to heat loss and requires them to maintain a high metabolic rate with little energy remaining for fat storage (e.g. Rojano-Doñate et al. 2018). This makes them vulnerable to starvation if they are unable to obtain sufficient levels of prey intake.

72 Studies using Digital Acoustic Recording Tags (DTAGs) have shown that porpoise tagged after capture in pound nets foraged on small prey nearly continuously during both the day and the night on their release (Wisniewska et al. 2016). However, Hoekendijk et al. (2018) point out that this could be an extreme short-term response to capture in nets, and may not reflect natural harbour porpoise behaviour. Nevertheless, if the foraging efficiency of harbour porpoise is disturbed or if they are displaced from a high-quality foraging ground, and are unable to find suitable alternative feeding grounds, they could potentially be at risk of changes to their overall fitness if they are not able to compensate and obtain sufficient food intake in order to meet their metabolic demands.

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

74 Monitoring of harbour porpoise activity at the Beatrice Offshore Wind Farm during pile driving activity has indicated that porpoises were displaced from the immediate vicinity of the pile driving activity – with a 50% probability of response occurring at approximately 7 km (Graham et al. 2019). This monitoring also indicated that the response diminished over the construction period, so that eight months into the construction phase, the range at which there was a 50% probability of response was only 1.3 km. In addition, the study indicated that porpoise activity recovered between pile driving events.

75 A study of tagged harbour porpoises has shown large variability between individual responses to an airgun stimulus (van Beest et al. 2018). Of the five porpoises tagged and exposed to airgun pulses at ranges of 420–690 m (SEL 135–147 dB re 1 $\mu Pa^2 s$), one individual showed rapid and directed movements away from the source. Two individuals displayed shorter and shallower dives immediately after exposure and the remaining two animals did not show any quantifiable response. Therefore, there is expected to be a high level of variability in responses from individual harbour porpoises exposed to low frequency broadband pulsed noise (including both airguns and pile-driving).

76 At a BEIS-funded expert elicitation workshop held in Amsterdam in June 2018, experts in marine mammal physiology, behaviour and energetics discussed the nature, extent and potential consequences of disturbance to harbour porpoise from exposure to low frequency broadband pulsed noise (e.g. pile-driving, airgun pulses) (Booth et al. 2019). Experts were asked to estimate the potential consequences of a six-hour period of zero energy intake, assuming that disturbance from a pile driving event resulted in missed foraging opportunities for this duration. A Dynamic Energy Budget model for harbour porpoise (based on the DEB model in Hin et al. (2019)) was used to aid discussions regarding the potential effects of missed foraging opportunities on survival and reproduction. The model described the way in which the life history processes (growth, reproduction and survival) of a female and her calf depend on the way in which assimilated energy is allocated between different processes and was used during the elicitation to model the effects of energy intake and reserves following simulated disturbance.

77 The experts agreed that first year calf survival (post-weaning) and fertility were the most likely vital rates to be affected by disturbance, but that juvenile and adult survival were unlikely to be significantly affected as these life-stages were considered to be more robust. Experts agreed that the final third of the year was the most critical for harbour porpoises as they reach the end of the current lactation period and the start of new pregnancies, therefore it was thought that significant impacts on fertility would only occur when animals received repeated exposure throughout the whole year. Experts agreed it would likely take high levels of repeated disturbance to an individual before there was any effect on that individual's fertility (Figure 15 left), and that it was very unlikely an animal would terminate a pregnancy early. The experts agreed that calf survival could be reduced by only a few days of repeated disturbance to a mother/calf pair during early lactation (Figure 15 right); however, it is highly unlikely that the same mother-calf pair would repeatedly return to the area in order to receive these levels of repeated disturbance.

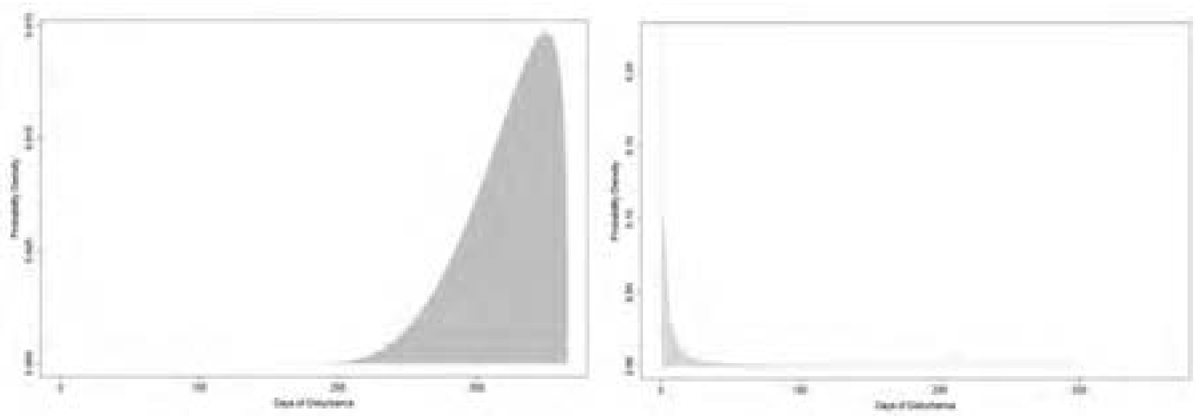


Figure 15: Probability distributions showing the consensus of the expert elicitation for harbour porpoise disturbance from piling (Booth et al., 2019).

Left: the number of days of disturbance (i.e. days on which an animal does not feed for six hours) a pregnant female could 'tolerate' before it has any effect on fertility. Right: the number of days of disturbance (of six hours zero energy intake) a mother/calf pair could 'tolerate' before it has any effect on survival.

78 A recent study by Benhemma-Le Gall et al. (2021) provided two key findings in relation to harbour porpoise response to pile driving. Porpoise were not completely displaced from the piling site: detections of clicks (echolocation) and buzzing (associated with prey capture) in the short-range (2 km) did not cease in response to pile driving, and porpoise appeared to compensate: detections of both clicks (echolocation) and buzzing (associated with prey capture) increased above baseline levels with increasing distance from the pile, which suggests that those porpoise that are displaced from the near-field, compensate by increasing foraging activities beyond the impact range (Figure 16). Therefore, porpoise that experience displacement are expected to be able to compensate for the lost foraging opportunities and increased energy expenditure of fleeing.

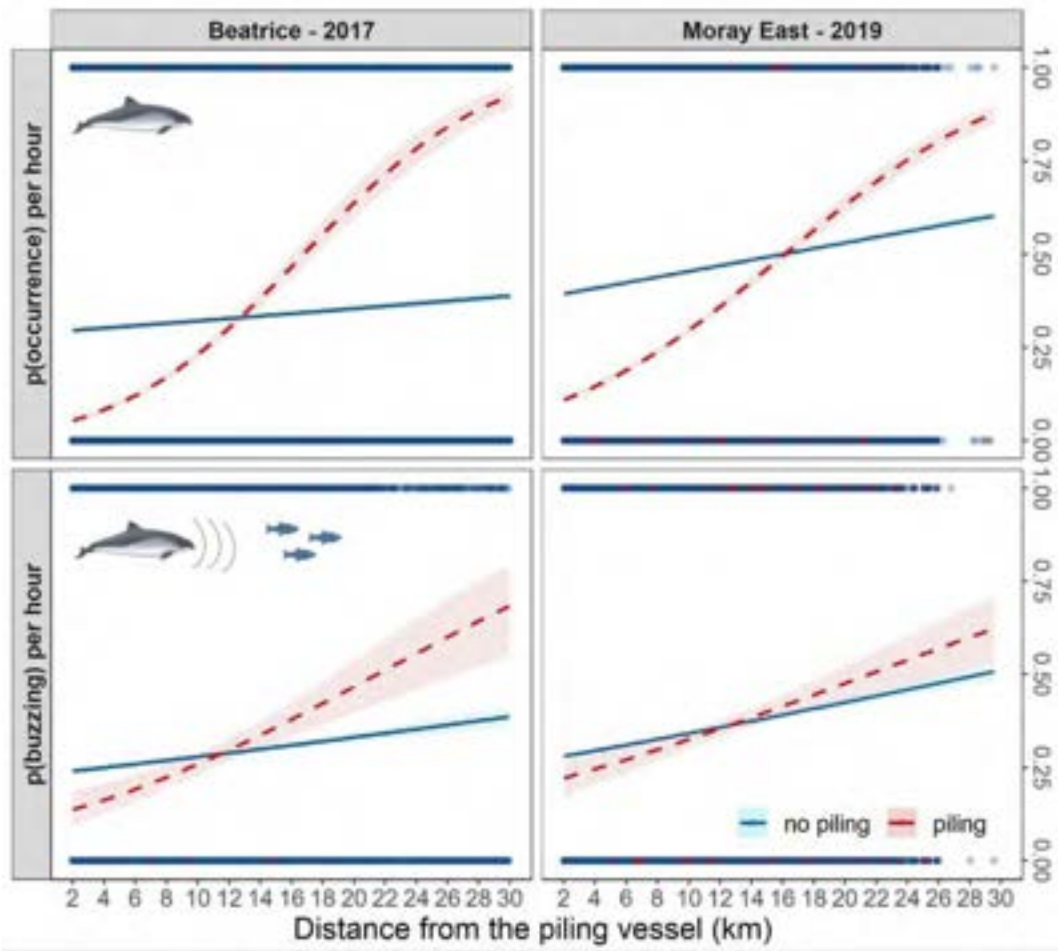


Figure 16: The probability of harbour porpoise occurrence and buzzing activity per hour during (dashed red line) and out with (blue line) pile-driving hours, in relation to distance from the pile-

driving vessel at Beatrice (left) and Moray East (right). Obtained from Benhemma-Le Gall et al. (2021).

79 While much of the evidence base included within this section is from studies of animals in the North Sea, it is expected that harbour porpoise in the Irish sea would respond in a similar way, and therefore the data are considered to be applicable.

80 Due to observed responsiveness to piling, their income breeder life history, and the low numbers of days of disturbance expected to effect calf survival, harbour porpoises have been assessed here as having a **low** sensitivity to disturbance and resulting displacement from foraging grounds.

7.5.3 HF Cetacean sensitivity to pile driving disturbance

Bottlenose dolphin

81 Bottlenose dolphins have been shown to be displaced from an area as a result of the noise produced by offshore construction activities; for example, avoidance behaviour in bottlenose dolphins has been shown in relation to dredging activities (Pirotta et al. 2013). In a recent study on bottlenose dolphins in the Moray Firth (in relation to the construction of the Nigg Energy Park in the Cromarty Firth), small effects of pile driving on dolphin presence have been observed, however, dolphins were not excluded from the vicinity of the piling activities (Graham et al. 2017b). In this study, the median peak-to-peak source levels recorded during impact piling were estimated to be 240 dB re 1μPa (range 8 dB) with a single pulse source level of 198 dB re 1 μPa^2s. The pile driving resulted in a slight reduction of the presence, detection positive hours and the encounter duration for dolphins within the Cromarty Firth, however, this response was only significant for the encounter durations. Encounter durations decreased within the Cromarty Firth (though only by a few minutes) and increased outside of the Cromarty Firth on days of piling activity. These data highlight a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities.

82 According to the opinions of the experts involved in the expert elicitation for iPCoD (the interim Population Consequences of Disturbance framework), which forms our best available knowledge on the topic, disturbance would be most likely to affect bottlenose dolphin calf survival, where: *"Experts felt that disturbance could affect calf survival if it exceeded 30-50 days, because it could result in mothers becoming separated from their calves and this could affect the amount of milk transferred from the mother to her calf"* (Harwood et al. 2014).

83 There is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs. However, it has been previously shown that bottlenose dolphins have the ability to compensate for behavioural responses as a result of increased commercial vessel activity (New et al. 2013). Therefore, while there remains the potential for disturbance and displacement to affect individual behaviour and therefore vital rates and population level changes, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. Therefore, since bottlenose dolphins are expected to be able to adapt their behaviour, with the impact most likely to result in potential changes in calf survival (but not expected to affect adult survival or future reproductive rates) bottlenose dolphins are considered to have a **low** sensitivity to behavioural disturbance from piling.

Common dolphin

84 The hearing range of common dolphins is currently estimated from their sound production, and has been labelled medium-high frequency, spanning between 150 Hz to 160 kHz (Finneran 2016, Houser et al. 2017). There are few studies investigating the effects of pile driving on common dolphins, which could relate to their occupation of deeper waters, contrasting with the shallower habitat in which offshore construction frequently occurs.

85 However, an analysis of pile driving activity in Broadhaven Bay, Ireland, found construction activity to be associated with a reduction in the presence of minke whales and harbour porpoise, but not with common dolphins (Culloch et al. 2016). Conversely, increased vessel presence during the construction period was associated with a decrease of common dolphins in the surrounding area. While there is little information on the Impacts of pile driving on common dolphins, there are a few studies documenting the impacts of seismic activity. Although the noise produced by airguns differs in its duration and cumulative acoustic energy levels, it may be similar in its frequency range to the low-frequency noise produced by pile driving. In general, there is contrasting evidence for the response of common dolphins to seismic surveys. While some research indicates no change in the occurrence or sighting density of common dolphins when exposed to seismic activity (Stone et al. 2017, Kavanagh et al. 2019), Goold (1996) found a reduction in common dolphin presence within 1 km of ongoing seismic surveys near Pembrokeshire.

86 The sparse information available for the impacts of construction, seismic activity and vessel noise on common dolphins makes it difficult to assess the risk for this species. While there is some evidence of disturbance of animals by seismic activity, and reduced presence in increasingly noisy habitat, this species may adjust its whistle characteristics to account for masking, suggesting some flexibility or tolerance.

87 Given that they are grouped as high-frequency cetaceans alongside bottlenose dolphins, and are therefore likely to have similar hearing abilities, common dolphins are also considered to have a **Low** sensitivity to behavioural disturbance from piling.

Risso's dolphin

88 In the absence of any species-specific data, given that they are both grouped as high-frequency cetaceans, and are therefore likely to have similar hearing abilities, Risso's dolphins are also considered to have a **Low** sensitivity to behavioural disturbance from piling.

7.5.4 LF cetacean sensitivity to pile driving disturbance

89 There is little information available on the behavioural responses of minke whales to underwater noise. Minke whales have been shown to change their diving patterns and behavioural state in response to disturbance from whale watching vessels; and it was suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success in this capital breeding species (Christiansen et al. 2013). There is only one study showing minke whale reactions to sonar signals (Sivle et al. 2015) with severity scores above 4 for a received SPL of 146 dB re 1 μPa (score 7) and a received SPL of 158 dB re 1 μPa (score 8). There is a study detailing minke whale responses to the Lofitech device which has a source level of 204 dB re 1 μPa @1m, which showed minke whales within 500 m and 1,000 m of the source exhibiting a behavioural response. The estimated received level at 1,000 m was 136.1 dB re 1 μPa (McGarry et al. 2017).

90 Since minke whales are known to forage in UK waters in the summer months, there is the potential for displacement to impact on reproductive rates. However, due to their large size and capacity for energy storage, it is expected that minke whales will be able to tolerate temporary displacement from foraging areas much better than harbour porpoise and individuals are expected to be able to recover from any impact on vital rates. Therefore, minke whales have been assessed as having a **Low** sensitivity to disturbance from pile driving.

7.5.5 Seal sensitivity to pile driving disturbance

91 There are still limited data on grey seal behavioural responses to pile driving. The key dataset on this topic is presented in Aarts et al. (2018) where 20 grey seals were tagged in the Wadden Sea to record their responses to pile driving at two offshore wind farms: Luchterduinen in 2014 and Gemini in 2015. The grey seals showed varying responses to the pile driving, including no response, altered surfacing and diving behaviour, and changes in swimming direction. The most common reaction was a decline in descent speed and a reduction in bottom time, which suggests a change in behaviour from foraging to horizontal movement.

92 The distances at which seals responded varied significantly; in one instance a grey seal showed responses at 45 km from the pile location, while other grey seals showed no response when within 12 km. Differences in responses could be attributed to differences in hearing sensitivity between individuals, differences in sound transmission with environmental conditions or the behaviour and motivation for the seal to be in the area. The telemetry data also showed that seals returned to the pile driving area after pile driving ceased. While this evidence base is from studies of grey seals tagged in the Wadden Sea, it is expected that grey seals in the Irish Sea would respond in a similar way, and therefore the data are considered to be applicable.

93 The expert elicitation workshop in Amsterdam in 2018 (Booth et al. 2019) concluded that grey seals were considered to have a reasonable ability to compensate for lost foraging opportunities due to their generalist diet, mobility, life history and adequate fat stores and that the survival of 'weaned of the year' animals and fertility were determined to be the most sensitive parameters to disturbance (i.e. reduced energy intake). However, in general, experts agreed that grey seals would be much more robust than harbour seals to the effects of disturbance due to their larger energy stores and more generalist and adaptable foraging strategies. It was agreed that grey seals would require moderate-high levels of repeated disturbance before there was any effect on fertility rates to reduce fertility (Figure 17 left). The 'weaned of the year' were considered to be most vulnerable following the post-weaning fast, and that during this time it might take ~60 days of repeated disturbance before there was expected to be any effect on weaned-of-the-year survival (Figure 17 right), however there was a lot of uncertainty surrounding this estimate.

94 Grey seals are capital breeders and store energy in a thick layer of blubber, which means that, in combination with their large body size, they are tolerant of periods of fasting as part of their normal life history. Grey seals are also highly adaptable to a changing environment and are capable of adjusting their metabolic rate and foraging tactics, to compensate for different periods of energy demand and supply (Beck et al. 2003, Sparling et al. 2006). Grey seals are also very wide ranging and are capable of moving large distances between different haul out and foraging regions (Russell et al. 2013). Therefore, they are unlikely to be particularly sensitive to displacement from foraging grounds during periods of active piling.

95 Hastie et al. (2021) found that grey seal avoidance rates in response to pile driving sounds were dependent on the quality of the prey patch, with grey seals continuing to forage at high density prey patches when exposed to pile driving sounds but showing reduced foraging success at low density prey patches when exposed to pile driving sounds. Additionally, the seals showed an initial aversive response to the pile driving playbacks (lower proportion of dives spent foraging) but this diminished during each trial. Therefore, the likelihood of grey seal response is expected to be linked to the quality of the prey patch. The quality of the AyM array area as a prey patch is unknown, and the importance of this area to grey seals specifically for foraging has not been quantitatively assessed. However, some inference can be made from movement and distribution data. Habitat preference data do not appear to indicate that the AyM array area itself is an important foraging location, though there are higher densities predicted to occur in the Dee estuary.

96 Due to observed responsiveness to piling, and their life-history characteristics, grey seals have been assessed as having **negligible** sensitivity to disturbance and resulting displacement from foraging grounds during pile-driving events.

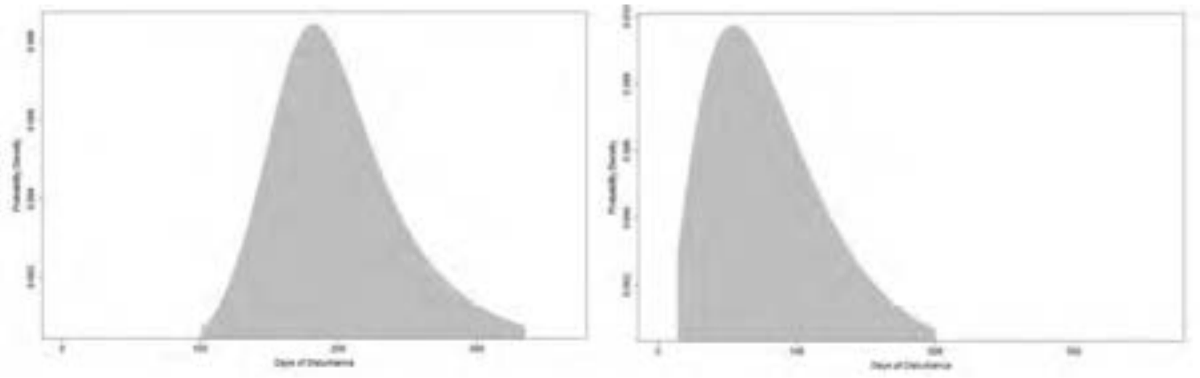


Figure 17: Probability distributions showing the consensus of the expert elicitation for grey seal disturbance from piling (Booth et al., 2019).

Left: the number of days of disturbance (i.e. days on which an animal does not feed for six hours) a pregnant female could 'tolerate' before it has any effect on fertility. Right: the number of days of disturbance (of six hours zero energy intake) a 'weaned of the year' grey seal could 'tolerate' before it has any effect on survival.

7.5.6 Harbour porpoise sensitivity to vessels

97 Given their high-frequency hearing range, it has been suggested that porpoise are more likely to be sensitive to vessels that produce medium to high frequency noise components (Hermannsen et al. 2014). However, harbour porpoise are known to avoid vessels and behavioural responses have been shown in porpoise exposed to vessel noise that contains low levels of high-frequency components (Dyndo et al. 2015). Thomsen et al. (2006) estimated that porpoise will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. Wisniewska et al. (2018) presented data that suggested that porpoises may respond to very close-range vessel passes with an interruption in foraging. However, observed responses were short lived, porpoises were observed to resume foraging ten minutes after a very close-range vessel encounter, and tagged porpoises remained in areas where shipping levels were high. Overall, despite animals remaining in heavily trafficked areas, the incidence of responses to vessels was low, indicating little fitness cost to exposure to vessel noise and any local scale responses taken to avoid vessels. It is likely that porpoise may become habituated where vessel movements are regular and predictable whereas they may be expected to show more of a local behavioural response to novel vessel activities related to construction activities.

98 Data collected during windfarm construction have demonstrated that porpoise detections around the pile driving site decline several hours prior to the start of pile driving, and it is assumed that this is due to the increase in other construction related activities and vessel presence in advance of the actual pile driving (Brandt et al. 2018, Benhemma-Le Gall et al. 2021). Therefore, because the dose-response relationships relating displacement to piling are based on data collected over periods including such vessel activity, these local responses to novel activity such as pile driving vessels have effectively already been included in the assessment of underwater noise related to pile driving above.

99 Land-based surveys in Swansea Bay, Wales, found a significant correlation between porpoise sightings and the number of vessels present, with 26% of the interactions considered to be negative (moving away or prolonged dives), occurring within distances of up to 1 km between the animal and the vessel. The type of vessel was relevant, as smaller motorised boats (jet-ski, speed boat, small fishing vessels), were associated with more negative behaviours than larger ships (Oakley et al. 2017).

100 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 ships/year (80 per day). Vessel traffic in the AyM area will be below this figure (see Volume 2, Chapter 1: Offshore Project Description and Table 18) as it is anticipated that the peak number of vessels on-site simultaneously will be 35 vessels during construction and 22 vessels during O&M. This level of activity is the anticipated peak, and therefore it is expected that average daily levels will be lower and will not lead to significant changes in porpoise density in the area. Therefore, harbour porpoise are assessed as having a **low** sensitivity to disturbance from vessels.

7.5.7 Dolphin sensitivity to vessels

101 Pirotta et al. (2015) found that transit of vessels 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 noise, resulted in disturbance. There is however likely to be rapid recovery from disturbance from vessel presence and vessel noise, as they recorded little pre-emptive disturbance or recovery time following disturbance. There is evidence of bottlenose dolphin habituation to boat traffic, particularly in relation to larger vessel types (Sini et al. 2005). Lusseau et al. (2011) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphin. They hypothesise that this was because most of the vessels were commercial ones, which have more predictable patterns of movement than the recreational vessels and are thus less likely to disrupt the feeding behaviour of dolphins than recreational or tourist activity. Therefore, bottlenose dolphins have been assumed as having a **low** sensitivity to disturbance from vessels.

102 In the absence of any species-specific data, given that they are both grouped as high-frequency cetaceans, and are therefore likely to have similar hearing abilities, Risso's dolphins are also considered to have a **low** sensitivity to behavioural disturbance from vessels.

7.5.8 Minke whale sensitivity to vessels

103 There is limited information available on the responses of minke whales to vessels. Whale watching vessels that specifically target minke whales have been shown to cause behavioural responses in minke whales and repeated exposure can result in a decrease in foraging activity (Christiansen et al. 2013). However, these are vessels which specifically target and follow minke whales, so it is unknown whether minke whales respond to more general ship traffic.

104 A conservative approach is assumed that vessel disturbance could result in temporary displacement of minke whales from the immediate area, however there is no evidence that the AyM area is an important foraging habitat for minke whales, and given their generalist and varied diet, it is not expected that any temporary displacement resulting from vessel activity in relation to the AyM will lead to any significant effect on individual energy budgets and subsequently fitness. The sensitivity of minke whales to vessel disturbance is therefore assessed as **low**.

7.5.9 Grey seal sensitivity to vessels

105 Jones et al. (2017) presents an analysis of the predicted co-occurrence of ships and seals at sea which demonstrates that UK wide there is a large degree of predicted co-occurrence, particularly within 50 km of the coast close to seal haul-outs. There is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and animals. In fact, in areas where seal populations are showing high levels of growth (e.g. southeast England) ship co-occurrences are highest (Jones et al. 2017). Thomsen et al. (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. The sensitivity of grey seals to disturbance from vessels is therefore assessed as **negligible**.

7.5.10 Sensitivity summary

106 Through the use of literature reviews on the potential impacts of underwater noise on marine mammals, the sensitivity of each species to PTS-onset and behavioural disturbance from pile driving has been assessed. While much of the evidence base included within this section is from studies of animals in the North Sea, it is expected that marine mammals in the Irish Sea would respond in a similar way, and therefore the data are considered to be applicable. Given the definitions of marine mammal sensitivity provided in Table 10, all marine mammals have been assessed as having either a low or negligible sensitivity to PTS-onset and behavioural disturbance from pile driving and vessel activity (Table 15), with the exception of dolphin species which have been precautionarily assessed as having a medium sensitivity to PTS.

Table 15: Summary of key marine mammal sensitivity assessments.

SPECIES	PTS FROM PILING	PILING DISTRUBANCE	VESSEL DISTURBANCE
Harbour porpoise	Low	Low	Low
Bottlenose dolphin	Medium	Low	Low
Common dolphin	Medium	Low	Low
Risso's dolphin	Medium	Low	Low
Minke whale	Low	Low	Low
Grey seal	Low	Negligible	Negligible

7.6 Uncertainty and technical difficulties encountered

107 There are uncertainties relating to the underwater noise modelling and impact assessment for AyM. Broadly, these relate to predicting exposure of animals to underwater noise, predicting the response of animals to underwater noise and predicting potential population consequences of disturbance from underwater noise. Further detail of such uncertainty is presented in Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties.

7.7 Existing environment

108 The existing environment for marine mammals is detailed in Volume 4: Annex 7.1: Marine Mammal Baseline Characterisation, with a summary provided here. This PEIR chapter should therefore be read alongside the detailed Marine Mammal Baseline Characterisation annex which assesses the range of species and the abundance and density of marine mammals that could potentially be impacted by the AyM offshore wind farm, informed by data collected across previous offshore wind farm projects and surveys covering the marine mammal MUs that include the AyM array area.

109 The data available (see section 7.4.2 for details of data sources) have confirmed the likely presence of harbour porpoise, bottlenose dolphins, common dolphins, Risso's dolphin, minke whale and grey seal in the vicinity of AyM and, therefore, these species should be considered within the quantitative impact assessment. The most robust and relevant density estimates within each MU were determined for each species, with harbour porpoise estimated to have the highest density within its respective MU (Table 16).

Table 16: Marine mammal MU and density estimates (#/km^2) taken forward to impact assessment.

SPECIES	MU	MU SIZE	MU REF	DENSITY	DENSITY REF
Harbour porpoise	Celtic and Irish Seas	62,517	IAMMWG (2021)	0.13	JCP Tool
				1.0	Averaged across costal and offshore estimates from Evans et al. (2021)[iii]
Bottlenose dolphin	Irish Sea	293	IAMMWG (2021)	0.035 within the 20 m depth contour, 0.008 beyond	Lohrengel et al. (2018) and SCANS III (Hammond et al. 2017, Hammond et al. 2021)
Common dolphin	Celtic and Greater North Seas	102,656	IAMMWG (2021)	0.0081	SCANS II (Hammond et al. 2006)

[iii] Please see Volume 4: Annex 7.1: Marine Mammal Baseline Characterisation for details as to why this estimate is considered to be highly precautionary.

SPECIES	MU	MU SIZE	MU REF	DENSITY	DENSITY REF
Risso's dolphin	Celtic and Greater North Seas	12,262	IAMMWG (2021)	0.031	SCANS III (Hammond et al. 2017, Hammond et al. 2021)
Minke whale	Celtic and Greater North Seas	20,118	IAMMWG (2021)	0.017	SCANS III (Hammond et al. 2017, Hammond et al. 2021)
Grey seal	OSPAR region III	66,100	Derived from Carter et al. (2020)	Grid cell specific	Carter et al. (2020)
	Wales and NW England MUs	5,000	Derived from (SCOS 2021)		

110 Harbour porpoise within the 'Celtic and Irish Seas' MU have an estimated abundance of 62,517 (95% CI: 48,324 – 80,877, CV: 0.13) (estimated using data from SCANS III and ObSERVE) (IAMMWG 2021). Whilst they are listed as Least Concern on the IUCN red, the 2021 abundance estimate was a significant decrease from the previous estimate using the SCANS II and CODA data which was 104,695 porpoise (95% CI: 56,774 – 193,065, CV: 0.32)(IAMMWG 2015).

111 Harbour porpoise were found to have a widespread distribution within the MU and were observed at the AyM site year-round during the 24 months of site-specific surveys. The high proportion of unidentified sightings during the site-specific surveys meant that the data were unsuitable for baseline characterisation. Instead, the JCP Phase III Tool density estimate for the AyM area (0.13 porpoise/km^2) was identified as the most suitable to take forward to impact assessment, alongside the precautionary density estimate obtained from the Sea Watch Foundation (SWF) report (1.0 porpoise/km^2, averaged across coastal and offshore areas) (Evans et al. 2021) (Table 16).

112 Bottlenose dolphin within the 'Irish Sea' MU have an estimated abundance of 293 dolphins (95% CI: 108 – 793, CV: 0.54) (estimated using data from SCANS III and ObSERVE) (IAMMWG 2021). No bottlenose dolphins were identified during the 24 months of site-specific surveys although there were several sightings of dolphins which could not be identified to species level. They have, however, been recorded year-round in the wider region during the GyM surveys and around Anglesey (Evans et al. 2021). There is evidence of large home ranges and connectivity of bottlenose dolphins within the MU with photo-identification from boat-based and land-based surveys identifying the same individuals in both North Wales and Cardigan Bay SAC (Feingold and Evans 2014). Therefore, density estimates in North Wales are estimated to be similar to that of Cardigan Bay (Lohrengel et al. 2018). The population is known to have a large home range (Pesante et al. 2008) and therefore, the impacts of the development of the AyM offshore wind farm could potentially impact other populations, although the extent of this impact is largely unknown.

113 Common dolphins in the UK are all part of the Celtic and Greater North Seas' MU. The current abundance estimate for this MU is 102,656 (CV=0.29; 95% CI=58,932 –178,822) (estimated using data from SCANS III and ObSERVE)(IAMMWG 2021). No common dolphins were identified during the 24 months of site-specific surveys although there were several sightings of dolphins which could not be identified to species level. They have, however, been recorded in the wider study area for GyM and have been recorded by the Sea Watch Foundation in the coastal waters of North Wales, with sightings recorded year-round. The SCANS II density estimate (0.0081 dolphins/km^2) is slightly higher than the more local scale density estimate of ~0.005 dolphins/km^2 estimated by the Sea Watch Foundation (Evans et al. 2021) and is thus considered to be a conservative estimate for the area.

114 A single MU is implemented for Risso's dolphins in UK waters: 'Celtic and Greater North Seas' MU. The current abundance estimate for this MU is 12,262 (95% CI: 5,227 – 28,764, CV: 0.46) (estimated using data from SCANS III and ObSERVE)(IAMMWG 2021). There have previously been no abundance estimates in UK waters for Risso's dolphins, but as this MU covers all UK waters this estimate is not representative of the potential abundance within the region surrounding the AyM site. No site-specific densities can be calculated due to the absence of Risso's dolphin sightings during the 24 months of AyM site specific surveys. However, other surveys observed Risso's dolphins around north Anglesey and Bardsey Island (Baines and Evans 2012) and north Wales (Evans et al. 2021). The Sea Watch Foundation have recorded Risso's dolphin in north Wales between April and November inclusive, though PAM conducted in the Holyhead Deeps west of Anglesey indicates that the species is present offshore all year round (G. Veneruso, pers. comm.). Therefore, it is considered to be precautionary to include this species quantitatively in the impact assessment.

115 Minke whale abundance is also analysed within the 'Celtic and Greater North Seas' MU and is estimated at 20,118 (95% CI: 14,061 – 28,786, CV: 0.18) (estimated using data from SCANS III and ObSERVE) (IAMMWG 2021). Data shows minke whales have patchy distribution within the Irish Sea with low sightings rates in vicinity of the AyM array area (Baines and Evans 2012), substantiated by the absence of sightings during the 24 months of AyM surveys and multiple GyM surveys conducted. However, given the presence of minke whale within the wider region recorded during SCANS III and ObSERVE survey, minke whales are expected to be present in the Irish Sea in the summer months and therefore should be included in the AyM impact assessment.

116 Grey seal abundance has been examined within two MUs: the OSPAR Region II: Celtic Seas MU (interim MU, proposed by NRW 2020) and the combined Wales and Northwest England seal MUs (as used in SCOS reporting). The OSPAR Region II: Celtic Seas MU has an estimated abundance of 66,100 seals. The combined Wales and Northwest England seal MUs has an estimated abundance of 5,000 seals. The large variability between these two estimates can be attributed to the differing sizes of the MUs and differing survey effort and analysis methods used. Seals were observed during both the AyM and GyM surveys. In North Wales, grey seals mainly haul-out around the coast of Anglesey (including the Skerries), around Llandudno (Angel Bay) and the Dee Estuary (Hilbre North and West Hoyle Sandbank). There are also confirmed pupping sites also around Anglesey and the Lleyn Peninsula, although the majority of pup production in Welsh waters is located in Pembrokeshire, where there is an estimated 4% of the UK breeding population.

7.7.1 Evolution of the baseline

117 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 require that "A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge" is included within the ES (EIA Regulations, Schedule 4, Paragraph 3). From the point of assessment, over the course of the development and operational lifetime of AyM (operational lifetime anticipated to be up to 25 years from first power), long-term trends mean that the condition of the baseline environment is expected to evolve. This section provides a qualitative description of the evolution of the baseline environment, on the assumption that AyM is not constructed, using available information and scientific knowledge of marine mammal ecology.

118 It is challenging to predict the future trajectories of marine mammal populations. Some UK marine mammal populations have undergone periods of significant change in parts of their range, with a limited understanding of the driving factors responsible. For example, there is uncertainty about whether a reduction in pup mortality or an increase in fecundity is the cause of the recent exponential growth of grey seals in the North Sea (Russell et al. 2017). Additionally, there is no appropriate monitoring at the right temporal or spatial scales to really understand the baseline dynamics of some marine mammal populations, including all cetacean species included in this assessment.

119 The results of the most recent UK assessment of favourable conservation status for each marine mammal species included in the assessment are outlined in Table 17. Grey seals are considered to have a favourable conservation status and all other species are considered to have an Unknown conservation status. It is worth noting that while the UK harbour porpoise population has been assessed as having Favourable future prospects, the most recent abundance estimate for the Celtic and Irish Sea MU is significantly lower than the previous estimate. The current estimate is 62,517 porpoise (95% CI: 48,324 – 80,887, CV 0.13) (IAMMWG 2021) which is only 60% of the previous estimate of 104,695 porpoise (95% CI: 56,774 - 193,065, CV: 0.32) (IAMMWG 2015). The updated estimates do not discuss the potential reasons behind the decline in abundance in the Celtic and Irish Sea MU.

Table 17: Summary of the conservation status of each marine mammal species (FV = Favourable, XX = Unknown, + = Improving).

SPECIES	RANGE	POPULATION	HABITAT	FUTURE PROSPECTS	CONSERVATION STATUS	OVERALL TREND	REFERENCE
Harbour porpoise	FV	XX	XX	FV	XX	XX	JNCC (2019c)
Bottlenose dolphin	FV	XX	XX	XX	XX	XX	JNCC (2019a)
Common dolphin	FV	XX	XX	XX	XX	XX	JNCC (2019b)
Risso's dolphin	FV	XX	XX	XX	XX	XX	JNCC (2019e)
Minke whale	FV	XX	XX	XX	XX	XX	JNCC (2019f)

SPECIES	RANGE	POPULATION	HABITAT	FUTURE PROSPECTS	CONSERVATION STATUS	OVERALL TREND	REFERENCE
Grey seal	FV	FV	FV	FV	FV	+	JNCC (2019d)

120 The potential impacts of climate change on marine mammals were reviewed and synthesised by Evans and Bjørge (2013) and they concluded that this topic remains poorly understood. In the UK, changes are predicted to manifest in relation to changes in prey abundance and distribution as a result of warmer sea temperatures. The authors also conclude that species likely to be most affected in the future will be those that have relatively narrow habitat requirements and that shelf sea species like the harbour porpoise, white-beaked dolphin and minke whale may come under increased pressure with reduced available habitat, if their range shifts northwards. Although the main cause of widespread declines in UK harbour seal population is not known, the prevalence of domoic acid derived from toxic algae may be a contributory factor and could be exacerbated by increased sea temperatures (Evans and Bjørge 2013). In addition, sea level rise and an increase in storm frequency and associated wave surges could affect the availability of haul out sites for seals and increased storm frequency and associated conditions could also lead to increased pup and calf mortality (Prime 1985, Gazo et al. 2000, Lea et al. 2009).

7.8 Key parameters for assessment

121 Table 18 identifies the MDS in environmental terms, defined by the project design envelope. This is to establish the maximum potential impact associated with the project.

Table 18: Maximum design scenario.

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
CONSTRUCTION		
PTS from piling	Monopile WTG (Spatial MDS disturbance): - Max 50 WTG - Max 15 m pile diameter - Max hammer energy: 5,000 kJ - Max 2 monopiles/day = 25 piling days - Contingency three days to install 1 monopile = 150 days	The piling scenario with the largest PTS-onset impact ranges represents the spatial MDS for PTS. The piling scenario with the greatest number of piling days represents the temporal MDS for PTS. The maximum number of piled foundations would represent the temporal maximum design scenario for disturbance.
Disturbance from piling	Monopile Other structures: - Max 2 OSP & 1 met mast - Max 2 monopiles for OSP (or total 16 smaller monopiles) - Max 1 monopile for met mast - Max 15 m column diameter - Max hammer energy: 5,000 kJ - Max 2 monopiles/day = 9 piling days - Contingency three days to install 1 monopile = 51 days	The maximum predicted impact range for underwater noise for piled foundations would represent the spatial maximum design scenario for disturbance.

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
	Multi-leg jacket WTG: 1 piling vessel (Temporal MDS disturbance & PTS): - Max 50 WTG - Max 4 legs per jacket - Max 200 legs in total - Max leg diameter: 3.5 m - Max hammer energy: 3,000 kJ - Max 4 legs/day = 50 piling days - Contingency two days to install 1 jacket = 100 days Multi-leg jacket WTG: 2 piling vessels at 1 location (Spatial MDS PTS): - Max 50 WTG - Max 4 legs per jacket - Max 200 legs in total - Max leg diameter: 3.5 m - Max hammer energy: 3,000 kJ - Max 4 legs/day per vessel = 25 piling days	

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
	Multi-leg OSPs: - Max 2 OSP - Max 12 legs per OSP - Max 24 legs in total - Max leg diameter: 3.5 m - Max hammer energy: 3,000 kJ - Max 4 legs/day = 6 piling days Foundation installation: Jan-Dec 2028 Cofferdam: - Max 650 Sheet piles - Max width: 750 mm - Max 8 piles/day = 81 piling days	
Disturbance from other construction activities	- Seabed preparation: levelling and/or dredging of soft mobile sediments as well as boulder and obstacle removal. - Cable route clearance methods: mass flow excavation, dredging	Maximum potential for underwater noise impacts from pre-construction works.

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
	- Cable burial methods: jet-trenching, mechanical trenching, dredging, mass flow excavation, rock cutting Offshore construction indicative dates: Jan 2028-Mar 2030	
PTS from UXO Disturbance from UXO	Expected number of UXO requiring clearance: 10 Up to 2 clearance events every 24 hours Up to 10 detonations in 10 days MDS clearance method: high-order detonation (though low-order is more likely) Expected to occur prior to foundation installation.	Estimated maximum design. A detailed UXO survey will be completed prior to construction. The type, size (net explosive quantities (NEQ)) and number of possible detonations and duration of UXO clearance operations is not known at this stage. The Applicant is not seeking to license the disposal of UXO in this application, but it is included in the impact assessment.
Collision risk from vessels Disturbance from vessels	Max total construction vessels: 101 Indicative peak vessels on-site simultaneously: 35 Offshore construction indicative dates: Jan 2028-Mar 2030	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
	Construction Vessels: - 4 Filter layer installation/seabed prep vessels - 2 Gravity base ballast installation vessels - 16 Foundation Installation Vessels - 6 Transition Piece Installation Vessels - 2 Scour Vessel - 15 WTG Installation Spread - 3 Commissioning Vessels - 12 inter array Cable Vessels - 12 Export Cable Vessels - 4 Substation Installation Vessels - 8 Substation Foundation Vessels - 15 Other Vessels Max round trips over 1.5 years: - Scour Layers Vessel x170 - Gravity Base Foundation Ballast Vessel x315	

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
	- Foundation Installation Spread x133 - Transition Piece Installation x24 - WTG Installation Spread x45 - Commissioning Vessels x78 - Accommodation vessels x52 - Inter array Cable Vessels x24 - Inter array Rock Berm Vessels x84 - Export Cable Vessels x23 - Export Cable Rock Berm Vessels x164 - Substation Installation Vessels Topside x8 - Substation Installation Vessels Foundation x16 - Other Vessels x2,300	
Change in water quality	Maximum amount of suspended sediment released during construction activities and associated duration - see Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 2 Chapter 3: Marine Water and Sediment Quality.	
Change in fish abundance/ distribution	Assessment is based on the MDS presented in Volume 2, Chapter 6: Fish and Shellfish Ecology.	

<table>
<tr><th>POTENTIAL EFFECT</th><th>MAXIMUM ADVERSE SCENARIO ASSESSE</th><th>JUSTIFICATION</th></tr>
<tr><td colspan="3">OPERATION</td></tr>
<tr><td>Collision risk from vessels</td><td rowspan="2">Annual round trips:
- Jack-up vessel: 6
- Service operation vessel (SOV): 52
- Small O&M vessel (CTV): 1,095
- Lift vessels: 6
- Cable maintenance vessel: 1
- Auxiliary vessel: 48

Peak vessel quantities:
- Jack-ups: 2
- SOVs: 2
- Small O&M vessel (CTV): 6
- Lift vessels: 2
- Cable maintenance vessels: 2
- Auxiliary vessels: 8</td><td rowspan="2">The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.</td></tr>
<tr><td>Disturbance from vessels</td></tr>
<tr><td>Barrier effects</td><td>Maximum number of offshore structures: 50 WTG, 2 OSP, 1 met mast.</td><td>The maximum numbers of offshore structures represent the maximum potential for a perceived barrier effect.</td></tr>
</table>

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
Change in water quality	Maximum amount of suspended sediment released during operation and associated duration - see Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 2 Chapter 3: Marine Water and Sediment Quality.	
Change in fish abundance/ distribution	Assessment is based on the MDS presented in Volume 2, Chapter 6: Fish and Shellfish Ecology.	
DECOMMISSIONING		
PTS and Disturbance	Maximum levels of underwater noise during decommissioning would be from underwater cutting required to remove structures. This is much less than pile driving and therefore impacts would be less than as assessed during the construction phase. Piled solutions assumed to be cut off at or below seabed. Three-year duration (offshore and onshore decommissioning)	
Collision risk from vessels	Assumed to be similar vessel types, numbers and movements to construction phase (or less).	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.
Disturbance from vessels		

POTENTIAL EFFECT	MAXIMUM ADVERSE SCENARIO ASSESSE	JUSTIFICATION
Change in water quality	Maximum amount of suspended sediment released during decommissioning activities and associated duration - see Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 2 Chapter 3: Marine Water and Sediment Quality.	
Change in fish abundance/ distribution	Assessment is based on the MDS presented in Volume 2, Chapter 6: Fish and Shellfish Ecology.	
CUMULATIVE EFFECTS		
See Table 48.		

7.9 Mitigation measures

122 Mitigation measures that were identified and have been adopted as part of the evolution of the project design (embedded into the project design) and that are relevant to marine mammals are listed in Table 19. The mitigation includes embedded measures such as design changes and applied mitigation which is subject to further study or approval of details; these include avoidance measures that will be informed by pre-construction surveys, and necessary additional consents where relevant. The composite of embedded and applied mitigation measures apply to all parts of the AyM development works, including pre-construction, construction, O&M and decommissioning.

Table 19: Mitigation measures relating to marine mammals.

PARAMETER	MITIGATION MEASURES
GENERAL	
Pollution prevention	A Project Environment Management Plan (PEMP) is proposed to be produced to ensure that the potential for contaminant release is strictly controlled. The PEMP will include a Marine Pollution Contingency Plan (MPCP) and will also incorporate plans to cover accidental spills, potential contaminant release and include key emergency contact details (e.g. NRW, Maritime Coastguard Agency and the project site co-ordinator). The PEMP will be secured as a condition in the Marine Licence.
Vessel codes of conduct	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) will minimise the potential for any impact. The final codes of conduct will be discussed and agreed with NRW and JNCC.
CONSTRUCTION	

PARAMETER	MITIGATION MEASURES
Project design	Inclusion of soft-start and ramp up procedures for pile driving. In the case of monopiles, piling will only occur at one location at a time. There is no possibility of simultaneous or concurrent piling. In the case of pin-piled multi-leg jacket foundations, pin-piles may be installed concurrently, but only on adjacent legs of the same jacket foundation. There is no possibility of simultaneous or concurrent piling at two separate foundation locations.
Marine Mammal Mitigation Protocol (Piling specific)	A piling Marine Mammal Mitigation Protocol will be implemented as a condition in the Marine Licence (see Volume 4, Annex 7.2: Draft Outline MMMP). The MMMP will be secured as a condition within the Marine Licence.
Marine Mammal Mitigation Protocol (UXO specific).	Implementation of a UXO Marine Mammal Mitigation Protocol subject to a separate Marine License application should UXO clearance be required.
OPERATION	
None	NA
DECOMMISSIONING	
Decommissioning Plan	A Decommissioning Programme will be developed to cover the decommissioning phase as required under Chapter 3 of the Energy Act 2004. As the decommissioning phase will be a similar process to the construction phase but in reverse (i.e., increased project vessels on-site, partially deconstructed structures) the embedded mitigation measure will be similar to those for the construction phase. The Decommissioning Plan will be secured as a condition in the Marine Licence.

PARAMETER	MITIGATION MEASURES
Marine Mammal Mitigation Protocol (Decommissioning)	Implementation of a decommissioning Marine Mammal Mitigation Protocol subject to a separate Marine License application prior to decommissioning should this be required.

7.10 Environmental assessment: construction phase

123 The potential environmental impacts arising from the construction of AyM are listed in Table 18 along with the MDS against which each construction phase impact has been assessed. A description of the potential effect on marine mammal ecology receptors caused by each identified impact is given below.

7.10.1 PTS from piling

124 The assessment below focuses on underwater noise from pile-driving (monopiles and pin piles) for the installation of foundations for offshore structures.

Harbour porpoise

125 Table 20 presents the PTS-onset impact area, impact range and number of porpoise within the PTS-onset impact area. The instantaneous PTS-onset impact ranges are low (maximum 1.3 km) which equates to less than a single harbour porpoise using the JCP density estimate. For the onset of cumulative PTS, the maximum predicted impact is predicted to occur when two pin piles are installed simultaneously at the NW location, resulting in a cumulative PTS-onset range of 6.3 km, equating to 11 harbour porpoise using the JCP Tool and 83 porpoise using the SWF density estimate (averaged density estimate presented in Evans et al. (2021))[iv].

[iv] Please see Volume 4: Annex 7.1: Marine Mammal Baseline Characterisation for details as to why this estimate is considered to be highly precautionary.

126 As stated in Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties, these predictions assume that all animals within the PTS-onset range are impacted, which will overestimate the true number of impacted animals as only 18-19% of the animals are predicted to actually experience PTS at the PTS-onset threshold level. In addition, as stated in Volume 4, Annex 7.3, the sound is modelled as being fully impulsive irrespective of distance from the pile, which is highly precautionary and results in predictions that are unlikely to be realised (e.g. it is unlikely that the sound will be fully impulsive at >6 km from the pile). Finally, Volume 4, Annex 7.3 outlines the over-precautions built into the calculation of cumulative PTS impact, and how the resulting impact ranges are considered to be highly over-precautionary and unrealistic.

127 Despite the precautions inherent in the modelling, the numbers of individual harbour porpoise predicted to be at risk of PTS are low. It is also likely that the presence of vessels and associated construction activity will ensure that the vicinity of the pile is free of harbour porpoise by the time that piling begins. In the absence of any mitigation, given the very low number of animals potentially impacted, the magnitude of this impact (in the absence of any mitigation) is **negligible**, as there is not expected to be any change to the population size or trajectory.

128 As outlined in section 7.5.1: Sensitivity to PTS, harbour porpoise have been assessed as having a **Low** sensitivity to PTS-onset from pile driving.

129 The magnitude of the impact (in the absence of any mitigation) has been assessed as **negligible** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of PTS-onset from unmitigated pile driving for harbour porpoise is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Table 20: Impact area, maximum range, number of harbour porpoise predicted to experience PTS-onset from piling.

PILE TYPE	MONOPILE (5,000 KJ)		MULTILEG (3,000 KJ)		MULTILEG 2 AT 1 LOCATION	
MODELLING LOCATION	NW	SE	NW	SE	NW	SE
INSTANTANEOUS PTS: 202 DB UNWEIGHTED SPL_{PEAK}						
Area (km^2)	1.3	0.7	0.9	0.5	NA	NA
Max range (km)	0.64	0.50	0.54	0.42		
# Porpoise (JCP 0.13/km^2) # Porpoise (SWF 1.0/km^2)	<1 1	<1 <1	<1 <1	<1 <1		
CUMULATIVE PTS: 155 DB VHF WEIGHTED SEL_{CUM} (2 MONOPILES OR 4 PIN-PILES IN 24 HRS)						
Area (km^2)	48	13	28	5.8	83	25
Max range (km)	4.7	2.9	3.6	2.0	6.3	4.0
# Porpoise (JCP 0.13/km^2) # Porpoise (SWF 1.0/km^2)	6 48	2 13	4 28	1 6	11 83	3 25

Bottlenose, common and Risso's dolphin

130 Table 21 presents the PTS-onset impact area and impact range for bottlenose, common and Risso's dolphins. Both the instantaneous and cumulative PTS-onset ranges are very small for all scenarios (<50 m and <100 m respectively) which results in <1 individual predicted to be impacted. Therefore, the impact of PTS-onset from piling for bottlenose, common and Risso's dolphins is assessed as having a **negligible** adverse magnitude given the negligible impact ranges.

131 As outlined in section 7.5.1: Sensitivity to PTS, bottlenose, common and Risso's dolphins have been assessed as having a **medium** sensitivity to PTS-onset from pile driving.

132 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **medium**. Therefore, the significance of the effect of PTS-onset from unmitigated pile driving for bottlenose, common and Risso's dolphins is concluded to be of ***medium adverse significance***, which is not significant in terms of the EIA regulations.

Table 21: Impact area and maximum range for bottlenose, common and Risso's dolphins predicted to experience PTS-onset from piling.

PILE TYPE	MONOPILE (5,000 KJ)		MULTILEG (3,000 KJ)		MULTILEG 2 AT 1 LOCATION	
MODELLING LOCATION	NW	SE	NW	SE	NW	SE
INSTANTANEOUS PTS: 230 DB UNWEIGHTED SPL_{PEAK}						
Area (km²)	<0.1	<0.1	<0.1	<0.1	NA	NA
Max range (km)	<0.05	<0. 05	<0.05	<0.05		
CUMULATIVE PTS: 185 DB VHF WEIGHTED SEL_{CUM} (2 MONOPILES OR 4 PIN-PILES IN 24 HRS)						
Area (km²)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Max range (km)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Minke whale

133 Table 22 presents the PTS-onset impact area, impact range and number of minke whales within the PTS-onset impact area. The instantaneous PTS-onset impact ranges are very low (50 m) across all scenarios. For the onset of cumulative PTS, the maximum predicted impact is for the simultaneous installation of two pin piles at the NW location, where impact ranges reach 10 km, however, given the low densities of minke whales predicted at the site, this equates to only three whales using the SCANS III density estimate.

134 As stated in Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties, these predictions assume that all animals within the PTS-onset range are impacted, which will overestimate the true number of impacted animals as only 18-19% of the animals are predicted to actually experience PTS at the PTS-onset threshold level. In addition, as stated in Volume 4, Annex 7.3, the sound is modelled as being fully impulsive irrespective of distance from the pile, which is highly precautionary and results in predictions that are unlikely to be realised (e.g. it is highly unlikely that the sound will be fully impulsive at 10 km from the pile). Finally, Volume 4, Annex 7.3, outlines the over-precautions built into the calculation of cumulative PTS impact, and how the resulting impact ranges are considered to be highly over-precautionary and unrealistic.

135 Despite the precautions inherent in the modelling, the numbers of individual minke whales predicted to be at risk of PTS are very low (maximum three per piling day). In the absence of any mitigation, given the very low number of animals potentially impacted, the magnitude of this impact is **negligible**, as there is not expected to be any change to the population size or trajectory.

136 As outlined in section 7.5.1: Sensitivity to PTS, minke whales have been assessed as having a **low** sensitivity to PTS-onset from pile driving.

137 The magnitude of the impact (in the absence of mitigation) has been assessed as **negligible** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of PTS-onset from pile driving for minke whales is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Table 22: Impact area, maximum range and number of minke whales predicted to experience PTS-onset from piling.

PILE TYPE	MONOPILE (5,000 KJ)		MULTILEG (3,000 KJ)		MULTILEG 2 AT 1 LOCATION	
MODELLING LOCATION	NW	SE	NW	SE	NW	SE
INSTANTANEOUS PTS: 219 DB UNWEIGHTED SPL_{PEAK}						
Area (km^2)	<0.1	<0.1	<0.1	<0.1	NA	NA
Max range (km)	0.06	0.05	0.05	0.05		
# whales	<1	<1	<1	<1		
CUMULATIVE PTS: 183 DB VHF WEIGHTED SEL_{CUM} (2 MONOPILES OR 4 PIN-PILES IN 24 HRS)						
Area (km^2)	120	19	70	5.9	170	29
Max range (km)	8.5	4.2	6.5	2.6	10.0	5.5
# whales	2	<1	1	<1	3	<1

Grey seal

138 Table 23 presents the PTS-onset impact area and impact range for grey seals. Both the instantaneous and cumulative PTS-onset ranges are very small for all scenarios (60 m and <100 m respectively) which results in <1 individual predicted to be impacted. Therefore, the impact of PTS-onset from piling for grey seals is assessed as having a **negligible** adverse magnitude given the negligible impact ranges in addition to the embedded mitigation of a MMMP.

139 As outlined in section 7.5.1, grey seals have been assessed as having a **low** sensitivity to PTS-onset from pile driving.

140 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **low.** Therefore, the significance of the effect of PTS-onset from pile driving for grey seals is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Table 23: Impact area, maximum range and number of grey seals predicted to experience PTS-onset from piling.

PILE TYPE	MONOPILE (5,000 KJ)		MULTILEG (3,000 KJ)		MULTILEG 2 AT 1 LOCATION	
MODELLING LOCATION	NW	SE	NW	SE	NW	SE
INSTANTANEOUS PTS: 219 DB UNWEIGHTED SPL_{PEAK}						
Area (km^2)	<0.1	<0.1	<0.1	<0.1	NA	NA
Max range (km)	0.07	0.06	0.06	0.06		
# seals	<1	<1	<1	<1		
CUMULATIVE PTS: 183 DB VHF WEIGHTED SEL_{CUM} (2 MONOPILES OR 4 PIN-PILES IN 24 HRS)						
Area (km^2)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Max range (km)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
# seals	<1	<1	<1	<1	<1	<1

Cofferdam sheet piles

141 Table 24 presents the PTS-onset impact area and maximum impact range for all species. For all marine mammal species, both the instantaneous and cumulative PTS-onset ranges are very small (<100 m). Therefore, the impact of PTS-onset from piling of sheet piles for all marine mammal species is assessed as having a **negligible** adverse magnitude given the negligible impact ranges.

Table 24: Impact area and maximum range for PTS-onset from piling of cofferdam sheet piles.

SPECIES		INSTANTANEOUS P		CUMULATIVE PTS (8 SHEETS IN 24 HRS)	
		8.0 M ABOVE LA	0.6 M ABOVE LAT	8.0 M ABOVE LA	0.6 M ABOVE LA
Harbour porpoise	Area (km²)	<0.01	<0.01	<0.01	<0.01
	Max range (km)	<0.05	<0.05	<0.1	<0.1
Bottlenose, common & Risso's dolphins	Area (km²)	<0.01	<0.01	<0.01	<0.01
	Max range (km)	<0.05	<0.05	<0.1	<0.1
Minke whale	Area (km²)	<0.01	<0.01	<0.01	<0.01
	Max range (km)	<0.05	<0.05	<0.1	<0.1
Grey seal	Area (km²)	<0.01	<0.01	<0.01	<0.01
	Max range (km)	<0.05	<0.05	<0.1	<0.1

PTS summary

142 The impact of PTS-onset from piling noise under the maximum design scenario is not considered to have a significant effect on any marine mammal species considered in this assessment (Table 25).

Table 25: Summary of the assessment for PTS-onset from pile driving for each marine mammal species.

SPECIES	MAGNITUDE	SENSITIVITY	SIGNIFICANCE
Harbour porpoise	Negligible adverse	Low	Negligible adverse significance
Bottlenose dolphin	Negligible adverse	Medium	Minor adverse significance
Common dolphin	Negligible adverse	Medium	Minor adverse significance
Risso's dolphin	Negligible adverse	Medium	Minor adverse significance
Minke whale	Negligible adverse	Low	Negligible adverse significance
Grey seal	Negligible adverse	Low	Negligible adverse significance

7.10.2 TTS from piling

143 Full details of the underwater noise modelling and the resulting TTS-onset impact areas and ranges are detailed in Volume 4, Annex 6.2: Subsea Noise Technical Report. As outlined in Section 7.4.3: TTS Assessment there are no thresholds to determine a biologically significant effect from TTS-onset, therefore the predicted ranges and area for the onset of TTS are presented in Table 26, but no assessment of the number of animals, magnitude, sensitivity or significance of effect is given. This approach was agreed with members of Marine Mammals & Marine Ecology Expert Topic Group (21st September 2020) and follows the advice provided in the Scoping Opinion (The Planning Inspectorate, July 2020).

Table 26: TTS-onset impact area (km^2) and maximum range (km) for each marine mammal hearing group.

THRESHOLD			MONOPILE (5,00 KJ)		MULTILEG (3,000 KJ)		MULTILEG 2 AT 1 LOCATION
			NW	SE	NW	SE	NW
INSTANTANEOUS TTS: SPL$_{PEAK}$ DB RE 1µPA							
VHF	196	Area	6.9	3.7	5	2.6	NA
		Range	1.5	1.1	1.3	0.94	
HF	230	Area	<0.01	<0.01	<0.01	<0.01	
		Range	<0.05	<0.05	<0.05	<0.05	
LF	219	Area	0.05	0.03	0.03	0.02	
		Range	0.13	0.11	0.05	0.09	
PW	212	Area	0.07	0.04	0.05	0.03	
		Range	0.15	0.13	0.13	0.11	
CUMULATIVE TTS: SEL$_{CUM}$ DB RE 1µPA^{2}S (2X MONOPILE, 4X MULTILEG							
VHF	140	Area	960	470	820	390	1200
		Range	23	19	21	17	26
HF	170	Area	<0.1	<0.1	<0.1	<0.1	<0.1
		Range	<0.1	<0.1	<0.1	<0.1	<0.1
LF	168	Area	1400	59	1100	460	1500
		Range	30	23	27	20	33
PW	170	Area	210	60	170	44	330
		Range	10	6.3	9.2	5.5	13

Table 27: Impact area and maximum range for TTS-onset from piling of cofferdam sheet piles.

SPECIES		INSTANTANEOUS T		CUMULATIVE TTS (8 SHEETS IN 24 HRS)	
		8.0 M ABOVE LA	0.6 M ABOVE LAT	8.0 M ABOVE LA	0.6 M ABOVE LA
Harbour porpoise	Area (km^2)	0.02	<0.01	0.4	<0.01
	Max range (km)	0.7	<0.05	480	<0.1
Bottlenose, common & Risso's dolphins	Area (km^2)	<0.01	<0.01	<0.01	<0.01
	Max range (km)	<0.05	<0.05	<0.1	<0.1
Minke whale	Area (km^2)	<0.01	<0.01	0.1	<0.01
	Max range (km)	<0.05	<0.05	210	<0.1
Grey seal	Area (km^2)	<0.01	<0.01	<0.01	<0.01
	Max range (km)	<0.05	<0.05	<0.1	<0.1

7.10.3 Disturbance from piling

Harbour porpoise

144 The method used to calculate the number of porpoise predicted to experience behavioural disturbance is shown in Table 29 for the installation of a monopile at the NW location, using the JCP density estimate and the Graham et al. (2017) dose-response curve.

145 Using the JCP density estimate, for all scenarios modelled, the number of harbour porpoise predicted to experience behavioural disturbance is low (<0.5% of the MU). The scenario with the maximum level of disturbance is the installation of a monopile foundation at the NW modelling location, which results in a predicted 275 porpoise experiencing disturbance on each day of pile driving activities using the JCP density estimate (0.13 porpoise/km^2).

146 Given the results of the expert elicitation on the likely effects of behavioural disturbance on harbour porpoise vital rates (Booth et al. 2019) (see section 7.5.2), an absolute worst case maximum of 201 days of piling is unlikely to cause any effect on fertility rates, although there is the potential for calf survival to be affected. However, it is highly unlikely that the same mother-calf pair would repeatedly return to the area in order to receive these levels of repeated disturbance over this many days. Any potential impact on calf survival rates is likely to be temporary and is not expected to result in any changes in the population trajectory or overall size. The impact is predicted to be of local spatial extent, short term duration, intermittent and is reversible.

147 Using the JCP density estimate, the low number of porpoise predicted to be impacted and the low proportion of the population this represents, results in a **low** adverse magnitude, where short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population, and any impact to vital rates of individuals occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

148 Using the SWF density estimate (1.0 porpoise/km^2, averaged across the coastal and offshore areas), the number of harbour porpoise predicted to experience behavioural disturbance is higher. The maximum level of disturbance results from a monopile foundation at the NW modelling location, which results in a predicted 2,112 porpoise experiencing disturbance on each day of pile driving activities (3.38% MU) [v]. Using the SWF density estimate, the number of porpoise predicted to be impacted and the proportion of the population this represents, results in a precautionary **medium** adverse magnitude, where any changes to individual vital rates are very unlikely to affect the population trajectory over a generational scale.

149 As outlined in section 7.5.2, disturbance as result of pile driving may temporarily affect harbour porpoise fertility and the probability of calf survival. Due to observed responsiveness to piling, and their income breeder life history, harbour porpoise are considered to have a **low** sensitivity to disturbance from pile driving.

150 The magnitude of the impact has been assessed as **low** adverse (using the JCP density estimate) or **medium** (using the SWF density estimate) and the sensitivity of receptor as **low**. Therefore, the significance of the effect of disturbance from pile driving on harbour porpoise is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 28: Number of harbour porpoise and percentage of the MU predicted to experience potential behavioural disturbance from piling.

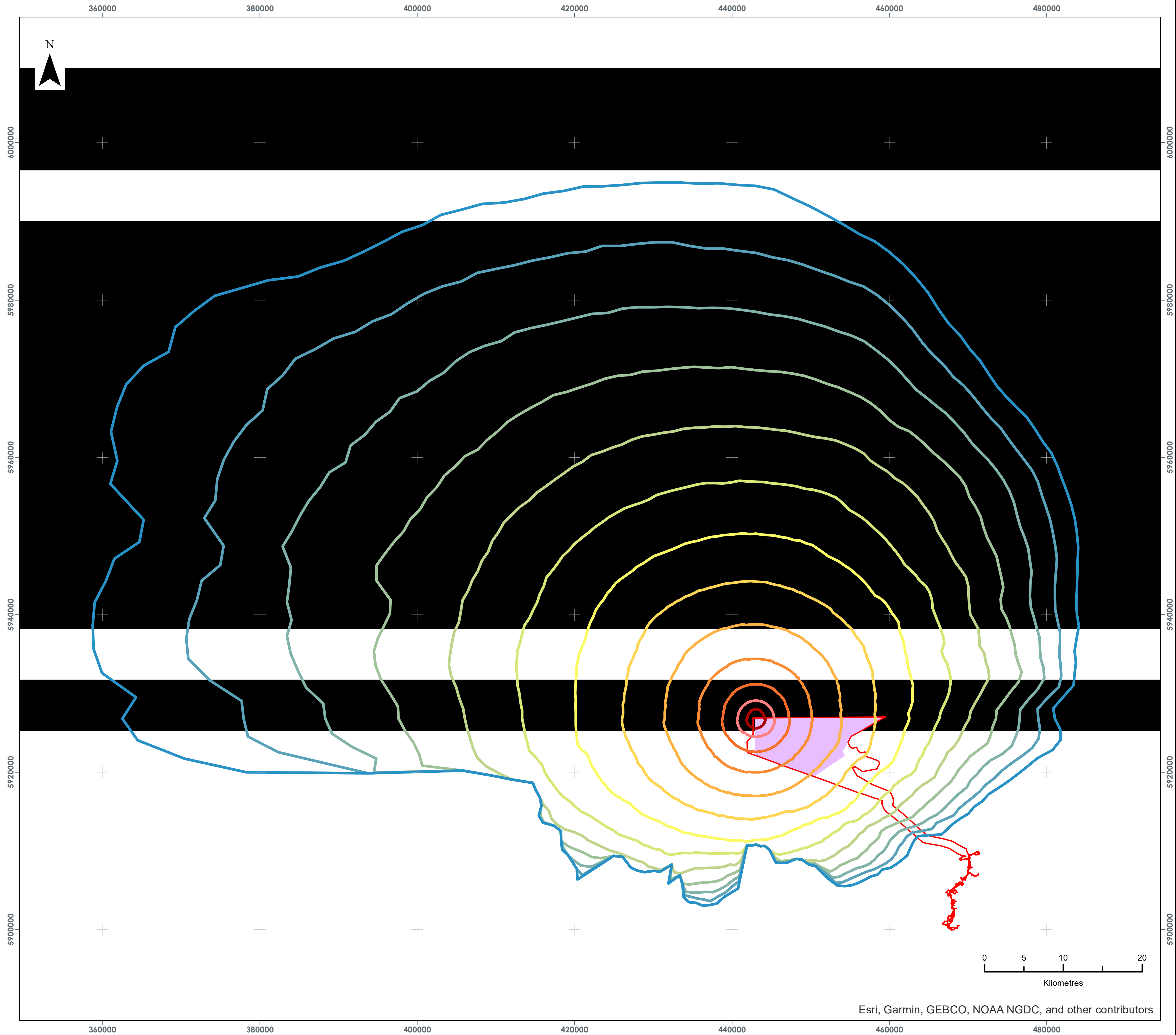
PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
MODELLING LOCATION	NW	SE	NW & SE	NW	SE	NW & SE
JCP DATA TOOL (0.13 PORPOISE/KM^2)						
# porpoise	275	158	NA	244	136	NA
% MU	0.44%	0.25%		0.39%	0.22%	

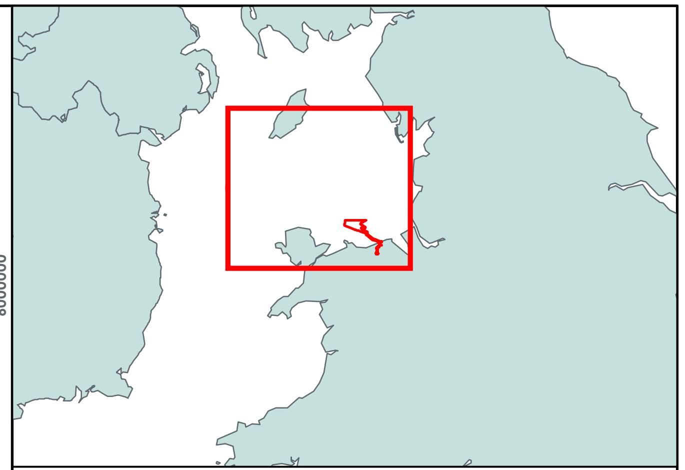
[v] Please see Volume 4: Annex 7.1: Marine Mammal Baseline Characterisation for details as to why this estimate is considered to be highly precautionary.

PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
SWF AVERAGED ESTIMATE (1.0 PORPOISE/KM^2)						
# porpoise	2,112	1,217	NA	1,878	1,048	NA
% MU	3.38%	1.95%		3.00%	1.68%	

Table 29: Calculation of the number of harbour porpoise predicted to experience behavioural disturbance for the installation of a monopile at the NW location, using the JCP III density estimate and the Graham et al. (2017a) dose-response curve.

RECEIVED LEVEL (SEL$_{SS}$ D RE 1 µPA^{2}S)	AREA (KM^2)	# PORPOISE (JCP III DENSITY)	% PORPOISE PREDICTED TC RESPOND	# PORPOISE PREDICTED TO RESPOND
180+	4.3	0.6	99.9	0.6
175<180	12.8	1.7	99.7	1.7
170<175	40.3	5.2	99.0	5.2
165<170	106.7	13.9	96.8	13.4
160<165	223.2	29.0	91.9	26.7
155<160	379.1	49.3	82.7	40.7
150<155	550.9	71.6	68.5	49.1
145<150	732.0	95.2	50.9	48.4
140<145	902.8	117.4	33.1	38.9
135<140	1079.1	140.3	18.5	26.0
130<135	1293.3	168.1	8.8	14.8
125<130	1462.7	190.1	3.5	6.6
120<125	1737.4	225.9	1.2	2.6
TOTAL NUMBER OF HARBOUR PORPOISE IMPACTED				275





LEGEND

- Order Limits
- Array Area

NW Monopile Disturbance Dose-Response Contours

- 120 SELss dB re 1 μPa²s
- 125 SELss dB re 1 μPa²s
- 130 SELss dB re 1 μPa²s
- 135 SELss dB re 1 μPa²s
- 140 SELss dB re 1 μPa²s
- 145 SELss dB re 1 μPa²s
- 150 SELss dB re 1 μPa²s
- 155 SELss dB re 1 μPa²s
- 160 SELss dB re 1 μPa²s
- 165 SELss dB re 1 μPa²s
- 170 SELss dB re 1 μPa²s
- 175 SELss dB re 1 μPa²s
- 180 SELss dB re 1 μPa²s

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Harbour Porpoise Disturbance Contours

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 18

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM30N

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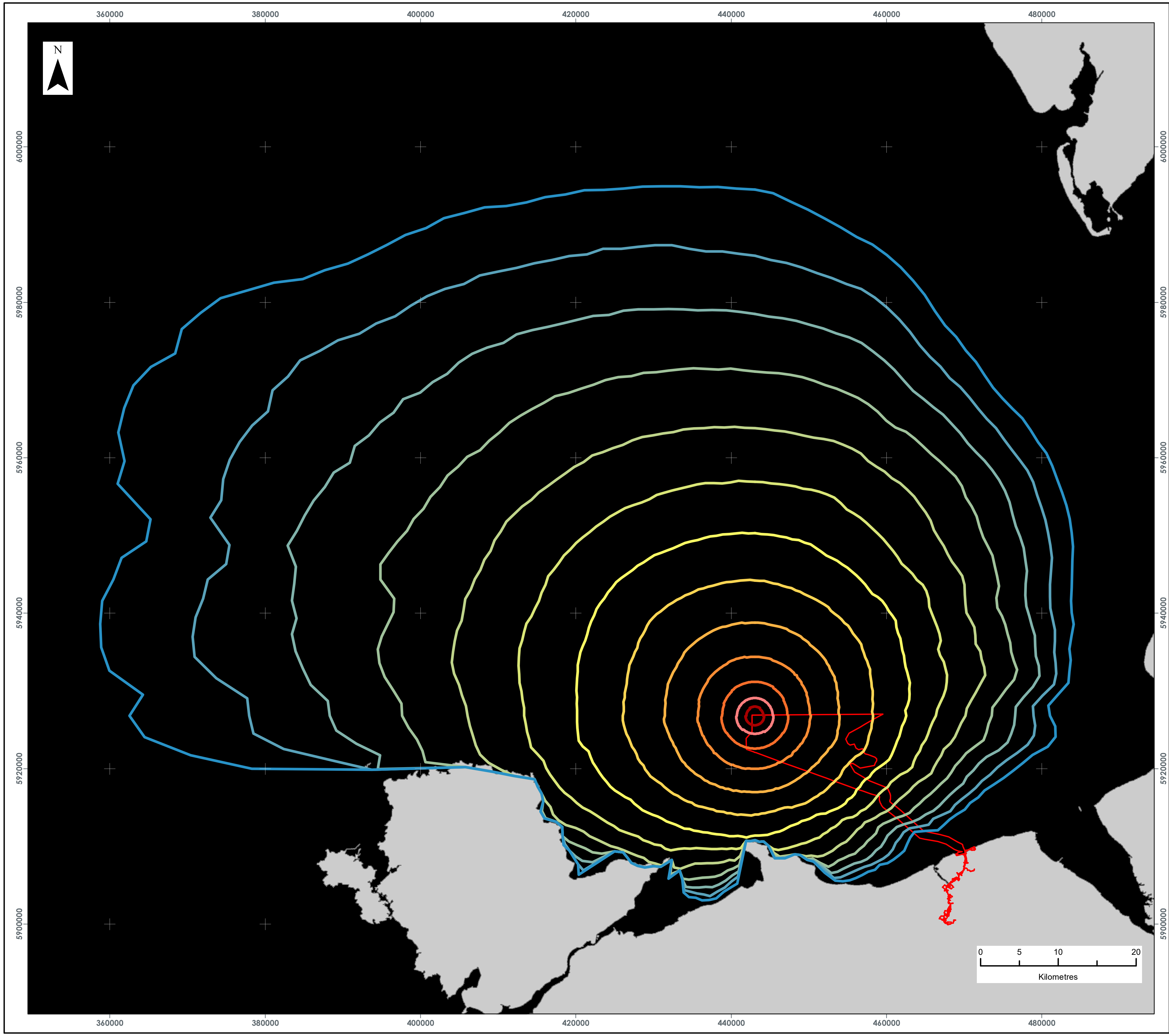
Bottlenose dolphin

151 Table 30 outlines the number of bottlenose dolphins predicted to be disturbed by pile driving at both the NW and SE locations for both monopiles and multi-leg jacket foundations. Most of the area covered by the impact contours are located in offshore waters beyond the 20 m depth contour, where bottlenose dolphin density is expected to be low (Figure 19). This results in fairly low numbers of dolphins predicted to be disturbed on each piling day (up to 23 individuals which represents 7.9% of the MU).

Table 30: Number of bottlenose dolphins and percentage of the MU predicted to experience potential behavioural disturbance from piling.

	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
	NW	SE	NW & SE	NW	SE	NW & SE
# dolphins	23	16	NA	20	14	NA
% MU	7.9%	5.5%		6.8%	4.8%	



LEGEND

Order Limits

NW Monopile Disturbance Dose-Response Contours

- 120 SELss dB re 1 μPa²s
- 125 SELss dB re 1 μPa²s
- 130 SELss dB re 1 μPa²s
- 135 SELss dB re 1 μPa²s
- 140 SELss dB re 1 μPa²s
- 145 SELss dB re 1 μPa²s
- 150 SELss dB re 1 μPa²s
- 155 SELss dB re 1 μPa²s
- 160 SELss dB re 1 μPa²s
- 165 SELss dB re 1 μPa²s
- 170 SELss dB re 1 μPa²s
- 175 SELss dB re 1 μPa²s
- 180 SELss dB re 1 μPa²s

% British Isles At-Sea Population per 25 km² cell

- 0.00
- 0.00 - 0.001
- 0.001 - 0.005
- 0.005 - 0.01
- 0.01 - 0.025
- 0.025 - 0.05
- >0.05

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Grey Seal Disturbance Contours

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 21

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM30N

[redacted]

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152 In order to assess whether the predicted level of disturbance would be sufficient to cause a population level effect, the interim PCoD model (version 5.2) was run[vi]. Conservative input values were used in the model, such that 23 bottlenose dolphins were predicted to be disturbed on every piling day. The model assumed the worst-case scenario where it could take up to three days to install one monopile, equating to 201 piling days. An indicative piling schedule was not available for use, and therefore the piling days were randomly spread throughout the 12-month construction period.

153 The results of the modelling showed that there was some predicted impact on the MU population as a result of the piling activity at AyM (Table 31 and Figure 20). The median ratio of the impacted:un-impacted population size after 6 years of simulation (1 year of impact followed by 5 years with no impact) was 1 and the impacted mean population size after 6 years of simulation (1 year of impact followed by 5 years with no impact) was only 5 individuals smaller than the un-impacted mean population size (such that the impacted population size is expected to be 98.3% of the un-impacted population size). The population size remained the same after 12 years of simulation (1 year of impact followed by 11 years with no impact) and thus the population trajectory of both the impacted and un-impacted populations are expected to be stable in the long term.

Table 31 Bottlenose dolphin population modelling inputs and results

PARAMETERS INPUT INTO IPCOD		
Number of simulations run	nboot	1000
Species	spec	BND
Proportion of population that is female	propfemale	0.5
Population size at the start of simulations	pmean	293
Calf survival rate	Surv[1]	0.86
Juvenile survival rate	Surv[7]	0.94

vi [redacted]

PARAMETERS INPUT INTO IPCOD		
Adult survival rate	Surv[13]	0.94
Fecundity rate	Fertility	0.25
Age at independence	age1	2
Age at first birth	age2	9
Number of piling years	pile_years	1
Proportion of animals in vulnerable component	vulnmean	c(1.0)
Days of "residual" disturbance	days	0
Proportion of disturbed experiencing "days"	prop_days_dist	1
Number of piling Operations	pilesx1	1
Seasonal variation (1=no variation)	seasons	1
Number of animals predicted to experience disturbance during 1 day of piling	numDt[1,]	23
Years for simulation	years	25
Density dependence (0=no density dependence)	z	0
Piling schedule		201 days
RESULTS		
Un-impacted pop mean (after 1 year)		292
Impacted pop mean (after 1 year)		289
Impacted pop as % of un-impacted pop (after 1 year)		99.0%
Median impacted:un-impacted population size (after 1 year)		1

PARAMETERS INPUT INTO IPCOD	
Un-impacted pop mean (after 6 years)	292
Impacted pop mean (after 6 years)	287
Impacted pop as % of un-impacted pop (after 6 years)	98.3%
Median impacted:un-impacted population size (after 6 years)	1
Un-impacted pop mean (after 12 years)	293
Impacted pop mean (after 12 years)	288
Impacted pop as % of un-impacted pop (after 12 years)	98.3%
Median impacted:un-impacted population size (after 12 years)	1

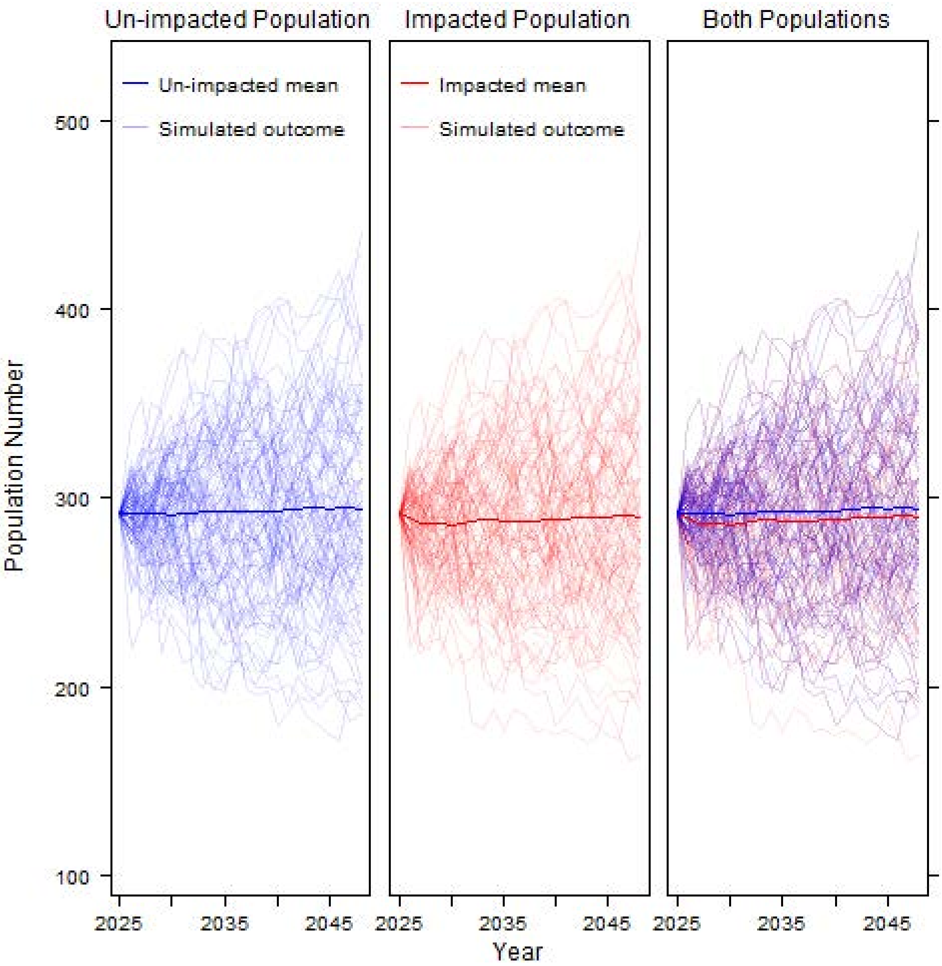


Figure 20: Population trajectory for both the impacted and un-impacted bottlenose dolphin population resulting from 201 days of piling disturbance.

154 The impact is predicted to be of local spatial extent, short term duration (limited to a one-year construction window), intermittent and is reversible. However, given the number of dolphins predicted to be impacted and the proportion of the population this represents, this is conservatively considered to be a **medium** adverse magnitude, where temporary changes in behaviour and/or distribution of individuals could result in potential reductions to lifetime reproductive success to some individuals although not enough to affect the population trajectory over a generational scale (as demonstrated by the population modelling).

155 As outlined in section 7.5.3, disturbance as result of pile driving may result in small spatial and temporal scale disturbance to bottlenose dolphins, however direct evidence for this species is generally lacking. There is evidence that pile driving can result in temporary displacement of bottlenose dolphins, but that this displacement may be limited to small temporal and spatial scales. While there remains the potential for disturbance and displacement to affect individual behaviour and in particular calf survival rates, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. Therefore, bottlenose dolphins are considered to have a **low** sensitivity to disturbance form pile driving.

156 The magnitude of the impact has been assessed as **medium** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of disturbance from pile driving on bottlenose dolphins is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Common dolphin

157 Table 32 outlines the number of common dolphins predicted to be disturbed by pile driving at both the NW and SE locations for both monopiles and multi-leg jacket foundations. The scenario with the maximum level of disturbance is the installation of a monopile foundation at the NW modelling location, which results in a predicted 17 common dolphins (0.02% MU) experiencing disturbance on each day of pile driving activities using the JCP density estimate.

158 The movement patterns of common dolphins in UK waters are poorly understood, and as such, it is not known how much repeated disturbance an individual dolphin would be expected to receive. Common dolphins are generally thought to be wide-ranging, capable of travelling large distances, based on tag and genetic data (e.g. Evans 1982, Natoli et al. 2006, Genov et al. 2012). This would suggest that it is more likely that the turn-over of common dolphins in the area is high and that each dolphin would be unlikely to be subjected to multiple repeated days of disturbance. Based on the current evidence on the effects of disturbance on dolphin species, it is not expected that exposure to a single day/low number of days of pile driving would result in any changes to vital rates.

159 Therefore the worst-case scenario would consist of the same animals being repeatedly exposed, thus increasing the potential for the repeated disturbance to result in changes to vital rates. However, given the low proportion of the MU predicted to be impacted repeatedly, and the short-term duration of the impact (limited to a one year construction window), this is assessed as a **Low** adverse magnitude, where short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population, and any impact to vital rates of individuals occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

160 As outlined in section 7.5.3, disturbance as result of pile driving may result in small spatial and temporal scale disturbance to common dolphins, however direct evidence for this species is generally lacking. Given that they are of the same hearing group, it is expected that common dolphins may respond in a similar way to bottlenose dolphins. There is evidence that pile driving can result in temporary displacement of bottlenose dolphins, but that this displacement may be limited to small temporal and spatial scales. While there remains the potential for disturbance and displacement to affect individual behaviour and in particular calf survival rates, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. Therefore, using bottlenose dolphins as a proxy, common dolphins are considered to have a **low** sensitivity to disturbance form pile driving.

161 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of disturbance from pile driving on common dolphins is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 32: Number of common dolphins predicted to experience potential behavioural disturbance from piling.

PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
MODELLING LOCATION	NW	SE	NW & SE	NW	SE	NW & SE
# dolphins	17	10	NA	15	8	NA
% MU	0.02%	0.01%		0.01%	0.01%	

Risso's dolphin

162 Table 33 outlines the number of Risso's dolphins predicted to be disturbed by pile driving at both the NW and SE locations for both monopiles and multi-leg jacket foundations on each piling day. Given the low predicted densities of Risso's dolphins in the area (0.031 dolphins/km^2 using SCANS III data) this results in low numbers of individuals predicted to be disturbed on any given piling day. The maximum estimate of disturbance is 65 dolphins for the installation of a monopile at the NW location, which represents 0.53% of the MU.

163 The impact is predicted to be of local spatial extent, short term duration (within a one-year construction window), intermittent and is reversible. As outlined above, the worst-case scenario would consist of the same animals being repeatedly exposed, thus increasing the potential for the repeated disturbance to result in changes to vital rates. However, given the low number of dolphins predicted to be impacted and the low proportion of the population this represents, this is considered to be a **low** adverse magnitude, where short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population, and any impact to vital rates of individuals occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

164 As outlined in section 7.5.3, there is no evidence on the sensitivity of Risso's dolphins to disturbance from pile driving. Risso's dolphins are categorised as being in the high-frequency cetacean hearing group (Southall et al. 2019) along with bottlenose dolphins, therefore it is considered appropriate, given the lack of species-specific data, to use bottlenose dolphins as a proxy. There is evidence that pile driving can result in temporary displacement of bottlenose dolphins, but that this displacement may be limited to small temporal and spatial scales. While there remains the potential for disturbance and displacement to affect individual behaviour and in particular calf survival rates, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. Therefore, based on the evidence available for bottlenose dolphins as a proxy, Risso's dolphins are considered to have a **low** sensitivity to disturbance form pile driving.

165 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of disturbance from pile driving on Risso's dolphins is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 33: Number of Risso's dolphins predicted to experience potential behavioural disturbance from piling.

PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
MODELLING LOCATION	NW	SE	NW & SE	NW	SE	NW & SE
# dolphins	65	38	NA	58	33	NA
% MU	0.53%	0.31%		0.47%	0.27%	

Minke whale

166 Table 34 outlines the number of minke whales predicted to be disturbed by pile driving at both the NW and SE locations for both monopiles and multi-leg jacket foundations. Given the low predicted densities of minke whales in the area (0.017 whales/km^2 using SCANS III data) this results in low numbers of individuals predicted to be disturbed on any given piling day. The maximum estimate of disturbance is 36 whales from the installation of a monopile at the NW location, which represents 0.18% of the MU. It is important to note here that minke whales are expected to only be present in the summer months, and therefore any pile driving activities that occur outside the summer months is expected to have no impact on minke whales as none are expected to be present.

167 The impact is predicted to be of local spatial extent, short term duration (within a one-year construction window), intermittent and is reversible. As outlined above, the worst-case scenario would consist of the same animals being repeatedly exposed, thus increasing the potential for the repeated disturbance to result in changes to vital rates. However, given the low number of whales predicted to be impacted and the low proportion of the population this represents, this is considered to be a **low** adverse magnitude, where short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population, and any impact to vital rates of individuals occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

168 As outlined in section 7.5.4, there is a lack of evidence of strong behavioural responses of minke whales to piling noise. Therefore, they are considered to have a **low** sensitivity to disturbance form pile driving.

169 147 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of disturbance from pile driving on minke whales is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 34: Number of minke whales and percentage of the MU predicted to experience potential behavioural disturbance from piling.

PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
MODELLING LOCATION	NW	SE	NW & SE	NW	SE	NW & SE
# whales	36	21	NA	32	18	NA
% MU	0.18%	0.09%		0.14%	0.08%	

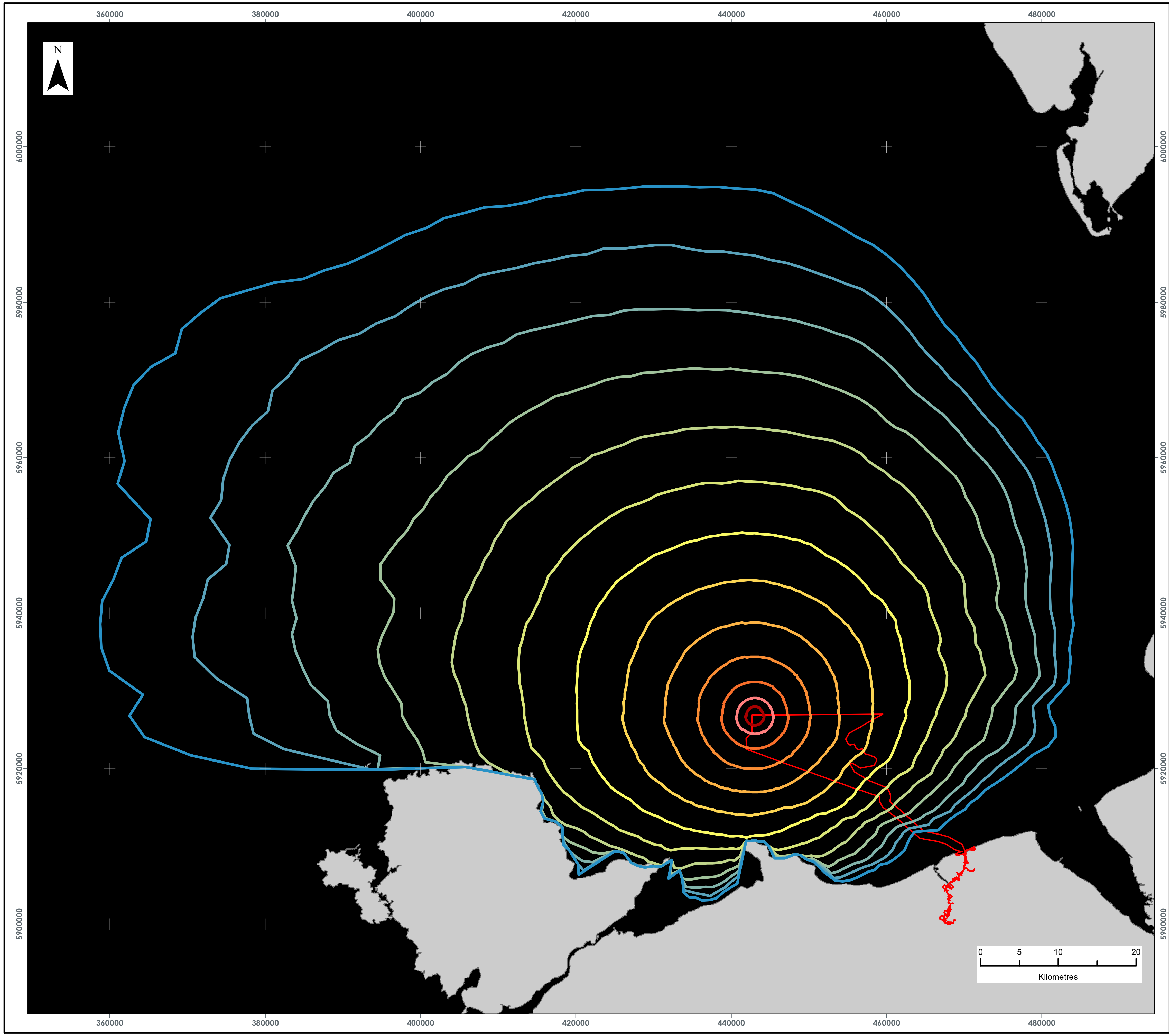
Grey seal

170 Table 35 outlines the number of grey seals predicted to be disturbed by pile driving at both the NW and SE locations for both monopiles and multi-leg jacket foundations. 95% confidence intervals are provided for grey seals as there was a large amount of uncertainty in the results that informed the dose-response curve. A total of 81 grey seals (95% CI: 9-151) are predicted to experience behavioural disturbance from the piling of a monopile at the NW location, which represents 1.6% of the Wales and NW England MU (0.2-3%) or 0.1% of the Ospar region III MU (0.0-0.2%). There is little overlap between the predicted noise contours and the area of higher grey seal density in the Dee estuary or inner Liverpool Bay area (Figure 21).

Table 35: Number of grey seals and percentage of the MU predicted to experience potential behavioural disturbance from piling.

PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
MODELLING LOCATION	NW	SE	NW & SE	NW	SE	NW & SE
# seals (mean & 95% CI)	81 9 – 151	72 11 – 128	NA	70 8 – 130	62 9 - 112	NA

PILE TYPE	MONOPILE (5,000 KJ)			MULTILEG (3,000 KJ)		
% MU (Wales & NW Eng Mus)	1.6% 0.2-3.0	1.4% 0.2-2.6		1.4 0.2-2.6	1.2% 0.2-2.2	
% MU (Ospar region III)	0.1% 0.0 – 0.2	0.1% 0.0 – 0.2		0.1% 0.0 – 0.2	0.1% 0.0 – 0.2	



LEGEND

Order Limits

NW Monopile Disturbance Dose-Response Contours

- 120 SELss dB re 1 μPa²s
- 125 SELss dB re 1 μPa²s
- 130 SELss dB re 1 μPa²s
- 135 SELss dB re 1 μPa²s
- 140 SELss dB re 1 μPa²s
- 145 SELss dB re 1 μPa²s
- 150 SELss dB re 1 μPa²s
- 155 SELss dB re 1 μPa²s
- 160 SELss dB re 1 μPa²s
- 165 SELss dB re 1 μPa²s
- 170 SELss dB re 1 μPa²s
- 175 SELss dB re 1 μPa²s
- 180 SELss dB re 1 μPa²s

% British Isles At-Sea Population per 25 km² cell

- 0.00
- 0.00 - 0.001
- 0.001 - 0.005
- 0.005 - 0.01
- 0.01 - 0.025
- 0.025 - 0.05
- >0.05

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Grey Seal Disturbance Contours

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 21

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM30N

[redacted]

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171 In order to assess whether the predicted level of disturbance would be sufficient to cause a population level effect, the interim PCoD model (version 5.2) was run[vii]. Conservative input values were used in the model, such that 81 grey seals were predicted to be disturbed on every piling day and two scenarios were run, one assuming the OSPAR Region III MU (66,100 individuals) and one assuming the Wales and NW England MUs (5,000 individuals). The model assumed the absolute worst-case scenario, that there could be a total of up to 201 days on which piling might occur (where it was precautionarily assumed that it could take up to three days to install each monopile, resulting in 150 piling days for 50 WTGs, 48 piling days for the two OSPs and 3 piling days for one met mast). An indicative piling schedule was not available for use, and therefore the piling days were randomly spread throughout the 12-month construction period.

172 The results of the modelling showed that there was no impact on the MU population as a result of the piling activity at AyM (Table 36 and Figure 22). The median ratio of the impacted:un-impacted population size after 6 years of simulation (1 year of impact followed by 5 years with no impact) was 1 and the impacted mean population size after 6 years of simulation (1 year of impact followed by 5 years with no impact) was the same as the un-impacted mean population size.

Table 36: Grey seal population modelling inputs and results

PARAMETERS INPUT INTO IPCOD		OSPAR REGION MU	WALES & NE ENG MU
Number of simulations run	nboot	1000	1000
Species	spec	GS	GS
Proportion of population that is female	propfemale	0.5	0.5

vii [redacted]

PARAMETERS INPUT INTO IPCOD		OSPAR REGION MU	WALES & NE ENG MU
Population size at the start of simulations	pmean	66100	5000
Pup survival rate	Surv[1]	0.222	0.222
Juvenile survival rate	Surv[7]	0.94	0.94
Adult survival rate	Surv[13]	0.94	0.94
Fecundity rate	Fertility	0.84	0.84
Age at independence	age1	1	1
Age at first birth	age2	5	5
Number of piling years	pile_years	1	1
Proportion of animals in vulnerable component	vulnmean	c(1.0)	c(1.0)
Days of "residual" disturbance	days	0	0
Proportion of disturbed experiencing "days"	prop_days_dist	1	1

PARAMETERS INPUT INTO IPCOD		OSPAR REGION MU	WALES & NE ENG MU
Number of piling Operations	pilesx1	1	1
Seasonal variation (1=no variation)	seasons	1	1
Number of animals predicted to experience disturbance during 1 day of piling	numDt[1,]	81	81
Years for simulation	years	25	25
Density dependence (0=no density dependence)	z	0	0
Piling schedule		201 days	201 days
RESULTS			
Un-impacted pop mean (after 1 year)		66,100	5,038
Impacted pop mean (after 1 year)		66,100	5,038
Impacted pop as % of un-impacted pop (after 1 year)		100%	100%
Median impacted:un-impacted population size (after 1 year)		1	1

PARAMETERS INPUT INTO IPCOD	OSPAR REGION MU	WALES & NE ENG MU
Un-impacted pop mean (after 6 years)	69,689	5,302
Impacted pop mean (after 6 years)	69,689	5,302
Impacted pop as % of un-impacted pop (after 6 years)	100%	100%
Median impacted:un-impacted population size (after 6 years)	1	1
Un-impacted pop mean (after 12 years)	73,772	5,633
Impacted pop mean (after 12 years)	73,772	5,633
Impacted pop as % of un-impacted pop (after 12 years)	100%	100%
Median impacted:un-impacted population size (after 12 years)	1	1

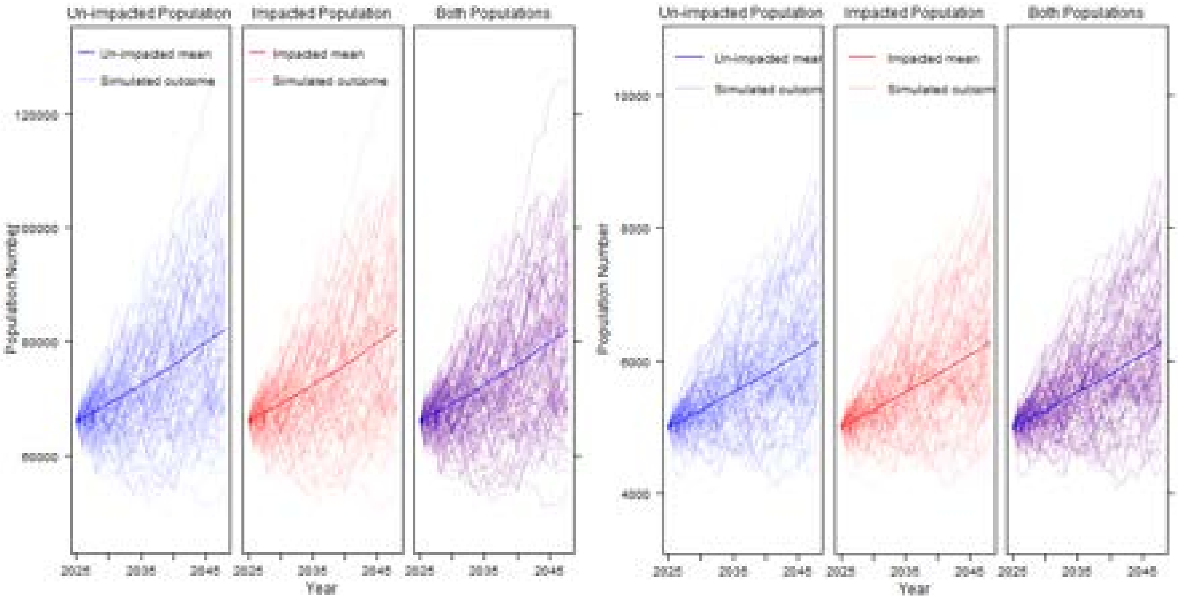


Figure 22: Population trajectory for both the impacted and un-impacted grey seal OSPAR Region III MU (left) and the Wales & NW England's MU (right) resulting from 201 days of piling disturbance.

173 The impact is predicted to be of local spatial extent, short term duration (within a one-year construction window), intermittent and is reversible. Given their ability to store energy, and the fact that they are generalist and adaptable foragers, it is expected that grey seals would require moderate-high levels of repeated disturbance before there was any effect on fertility rates. Given the number of grey seals predicted to be impacted and the proportion of the population this represents, along with the short-term duration of the overall impact, this is considered to be a **low** adverse magnitude, where short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population, and any impact to vital rates of individuals occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered (as shown by the population modelling).

174 As outlined in section 7.5.5, there is limited information available on the behavioural responses of grey seals to pile driving. The data that are available suggests large variation in response level between individuals but that seals returned to the area once pile driving ceased (Aarts et al. 2018). Grey seals are highly adaptable to a changing environment and are capable of adjusting their metabolic rate and foraging tactics, to compensate for different periods of energy demand and supply (Beck et al. 2003, Sparling et al. 2006), consequently, they are unlikely to be particularly sensitive to displacement from foraging grounds during periods of active piling.

175 Based on the data presented in Aarts et al. (2018) and Hastie et al. (2021), it is possible that some grey seals may show no behavioural response at all, if they are motivated to remain in the area for foraging (if the area contains a high-quality prey patch). The quality of the AyM array area as a prey patch is unknown, and the importance of this area to grey seals specifically for foraging has not been quantitatively assessed. However, some inference can be made from movement and distribution data. Habitat preference data do not appear to indicate that the AyM array area itself is an important foraging location, though densities are higher in the Dee estuary. Given the wide-ranging behaviour of grey seals, travelling up to 448 km from a haul-out site (Carter et al. 2020), it is highly likely that any grey seals displaced from lower quality prey patches will be able to compensate by travelling to a different foraging patch, and thus it is expected that any displacement would result in minimal energetic cost. Should the seals choose to remain in the area during piling then this indicates that the energetic benefit outweighs the perceived risk from piling.

176 Therefore, grey seals are considered to have a **negligible** sensitivity to disturbance form pile driving.

177 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **negligible**. Therefore, the significance of the effect of disturbance from pile driving on grey seals is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Cofferdam sheet piles

178 Table 37 outlines the number of marine mammals of each species predicted to be disturbed per piling day by pile driving installation of sheet piles for the cofferdam. The numbers predicted to be disturbed are very low for all species (0-20 individuals) given the low hammer energies required.

179 For bottlenose dolphins, common dolphins and minke whales, <1 individual is predicted to be disturbed per piling day. Therefore, for these species the magnitude is assessed as **negligible** as there is no potential for any changes in the individual reproductive success or survival, and therefore no changes to the population size or trajectory. Therefore, the significance of the effect of disturbance from cofferdam sheet pile driving on bottlenose dolphins, common dolphins and minke whales is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

180 Though the number of animals and proportion of the MU predicted to be impacted per day of piling is low for harbour porpoise, Risso's dolphins and grey seals, there is the potential for 81 days of cofferdam sheet piling to potentially result in short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered. Therefore, the magnitude is assessed as **low** adverse.

181 Both harbour porpoise and Risso's dolphins have been assessed as having a **low** sensitivity to disturbance from pile driving. Therefore, the significance of the effect of disturbance from cofferdam sheet pile driving on harbour porpoise and Risso's dolphins is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

182 Grey seals have been assessed as having a **negligible** sensitivity to disturbance from pile driving. Therefore, the significance of the effect of disturbance from cofferdam sheet pile driving on grey seals is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Table 37: Number of animals predicted to experience behavioural disturbance from piling of cofferdam sheet piles.

SPECIES	DISTURBANCE	8 M ABOVE LAT	0.6 M ABOVE LAT
Harbour porpoise	# disturbed (JCP) % MU	3 0.00%	1 0.00%
	#disturbed (SWF) % MU	20 0.03%	4 0.01%
Bottlenose dolphin	# disturbed	<1	<1
	% MU	<0.05%	<0.05%
Common dolphin	# disturbed	0	0
	% MU	0.00%	0.00%
Risso's dolphin	# disturbed	1	0
	% MU	0.01%	0.00%
Minke whale	# disturbed	0	0
	% MU	0.00%	0.00%
Grey seal	# disturbed	6 (1-10)	3 (1-5)
	% MU (Wales & NW Eng)	0.12% (0.02-0.20)	0.06% (0.02-0.10)
	% MU (OSAR region III)	0.01% (0.00-0.02)	0.00% (0.00-0.01)

Disturbance summary

183 The impact of behavioural disturbance from piling noise under the maximum design scenario is not considered to have a significant effect on any marine mammal species considered in this assessment (Table 38).

Table 38: Summary of the assessment of disturbance from pile driving for each marine mammal species.

SPECIES	MAGNITUDE	SENSITIVITY	SIGNIFICANCE
Harbour porpoise	Low-Medium adverse	Low	Minor adverse significance
Bottlenose dolphin	Medium adverse	Low	Minor adverse significance
Common dolphin	Low adverse	Low	Minor adverse significance
Risso's dolphin	Low adverse	Low	Minor adverse significance
Minke whale	Low adverse	Low	Minor adverse significance
Grey seal	Low adverse	Negligible	Negligible adverse significance

7.10.4 Other construction activities

PTS from other construction activities

184 A simple assessment of the noise impacts from non-piling noise is presented in Volume 4, Annex 6.2: Subsea Noise Technical Report. This includes an assessment of the potential PTS and TTS-onset impact ranges for:

- Cable laying: Noise from the cable laying vessel and any other associated noise during the offshore cable installation.

- Dredging: Dredging may be required on site for seabed preparation work for certain foundation options, as well as for the export cable, array cables and interconnector cable installation. Suction dredging has been assumed as a worst-case.
- Trenching: Plough trenching may be required during offshore cable installation.
- Rock placement: Potentially required on site for installation of offshore cables (cable crossings and cable protection) and scour protection around foundation structures.
- Vessel noise: Jack-up barges for piling substructure and WTG installation. Other large and medium sized vessels to carry out other construction tasks and anchor handling. Other small vessels for crew transport and maintenance on site.

185 Using the non-impulsive weighted SEL_{CUM} PTS-onset thresholds from Southall et al. (2019) resulted in estimated PTS impact ranges of <100 m for all marine mammal species for each non-piling construction activity (Table 39). These values mean that animals would have to stay within these very small ranges for 24 hours before they experienced injury, which is an extremely unlikely scenario as it is far more likely that any marine mammal within the injury zone would move away from the vicinity of the vessel and the construction activity.

186 Using the non-impulsive weighted SEL_{CUM} TTS-onset thresholds from Southall et al. (2019) resulted in an estimated TTS impact ranges of <100 m for all HF and LF cetaceans and PCW for all non-piling construction activity. Estimated TTS for HF cetaceans was variable depending on the non-piling construction activity: cable laying, trenching and vessel noise (medium) also had TTS impact ranges of <100 m but suction dredging and vessel noise (large) had an increased TTS impact range of 200 m and vessel noise (large) was increased to a 1 km TTS impact range (Table 39). These values are assuming that the animal would be stationary within these small ranges for 24 hours before they experienced a TTS in hearing, which is an extremely unlikely scenario as it is far more likely that any marine mammal within the injury zone would move away from the vicinity of the vessel and the construction activity. Vessel noise (large) had the greatest estimated TTS impact range of 1 km so presents an increased potential for an animal to be within this range for 24 hours, but is still considered an unlikely scenario.

187 The impact of non-piling construction noise under the maximum design scenario is not considered to have a significant effect on any marine mammal species considered in this assessment. These noise sources will have a local spatial extent, short-term duration and are intermittent, meaning a marine mammals would have to remain within close proximity (<100 m) for a 24-hour period for PTS-onset to occur. Therefore, the impact of these sources will have a **negligible** adverse magnitude**.**

188 As stated in Section 7.5.1, cetaceans are assessed as having a **low** sensitivity to PTS and grey seals are assessed as having a **negligible** sensitivity.

189 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as low (cetaceans) or negligible (grey seals). Therefore, the significance of the effect of PTS-onset from other construction activities is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Table 39: Summary of the source level (SEL_{cum} dB re 1 µPa@1m(RMS)) and impact ranges for the different construction noise sources using the non-impulsive criteria from Southall et al. (2019)

SOURCE	SOURCE LEVEL	VHF	HF	LF	PCW
PTS-onset Impact Range					
Cable laying	171	<100 m	<100 m	<100 m	<100 m
Suction dredging	186	<100 m	<100 m	<100 m	<100 m
Trenching	172	<100 m	<100 m	<100 m	<100 m
Rock placement	172	<100 m	<100 m	<100 m	<100 m
Vessel noise (large)	168	<100 m	<100 m	<100 m	<100 m
Vessel noise (medium)	161	<100 m	<100 m	<100 m	<100 m
TTS-onset Impact Range					
Cable laying	171	<100 m	<100 m	<100 m	<100 m

SOURCE	SOURCE LEVEL	VHF	HF	LF	PCW
Suction dredging	186	200 m	<100 m	<100 m	<100 m
Trenching	172	<100 m	<100 m	<100 m	<100 m
Rock placement	172	1 km	<100 m	<100 m	<100 m
Vessel noise (large)	168	200 m	<100 m	<100 m	<100 m
Vessel noise (medium)	161	<100 m	<100 m	<100 m	<100 m

Disturbance from other construction activities

190 There is little evidence on the impact of disturbance of marine mammals from other construction activities such as rock placing, dredging, trenching etc.). There are some studies which have reported potential disturbance ranges from dredging activities, and these are summarised in

191 Table 40. Note: disturbance from vessels is assessed separately (section 7.10.8).

Table 40: Summary of the potential for disturbance from dredging on marine mammal species.

SPECIES	EVIDENCE
Harbour porpoise	Dredging at a source level of 184 dB re 1 µPa at 1 m would result in avoidance up to 5 km from the dredging site (Verboom 2014). Conversely, Diederichs et al. (2010) found much more localised impacts; using Passive Acoustic Monitoring there was short term avoidance (~3 hours) at distances of up to 600 m from the dredging vessel, but no significant long-term impacts. Modelling potential impacts of dredging using a case study of the Maasvlatke port expansion (assuming maximum source levels of 192 dB re 1 µPa) predicted a disturbance range of 400 m, while a more conservative approach predicted avoidance of harbour porpoise up to 5 km (McQueen et al. 2020).

SPECIES	EVIDENCE
Bottlenose dolphin	Increased dredging activity at Aberdeen Harbour was associated with a reduction in bottlenose dolphin presence and, during the initial dredge operations, bottlenose dolphins were absent for five weeks (Pirotta et al. 2013).
Common dolphin	In northwest Ireland, construction related activity (including dredging) did not result in any evidence of a negative impact to common dolphins (Culloch et al. 2016).
Risso's dolphin	There is currently no information available on the impacts of dredging for Risso's dolphins.
Minke whale	In northwest Ireland, construction related activity (including dredging) has been linked to reduced minke whale presence (Culloch et al. 2016).
Grey seal	Based on the generic threshold of behavioural avoidance of pinnipeds (140 dB re 1 μPa SPL)(Southall et al. 2007), acoustic modelling of dredging demonstrated that disturbance could be caused to individuals between 400 m to 5 km from site (McQueen et al. 2020).

192 As with piling activities, there is the potential for disturbance and displacement of marine mammals from other construction sources. Animals will likely move away from the sound source before the onset of PTS or TTS, thereby exhibiting a behavioural response.

193 Given the location of the ECC and the landfall, it is not expected that any construction related activity will disturb grey seals hauled-out on land at the main haul-out sites along the north Wales coastline (the Skerries, Angel Bay, Hilbre and West Hoyle).

194 It is expected that changes will be temporary due to the short-term duration of the activities. Given the potential for other construction activities such as dredging to impact animals out to 5 km from the source, the impact is likely to be of a **low** magnitude. It has been assumed that marine mammal sensitivity to other construction activities will be similar to that of disturbance from pile driving or vessel activity (see Table 15).

195 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low** (cetaceans) or **negligible** (grey seals). Therefore, the significance of the effect of disturbance from other construction activities is concluded to be of ***minor adverse significance*** (for cetaceans) and ***negligible adverse significance*** (for grey seals), both of which is not significant in terms of the EIA regulations.

7.10.5 PTS-onset from UXO

196 If found, a risk assessment will be undertaken and items of UXO are either avoided, removed or detonated in situ. Recent advancements in the available methods for UXO clearance mean that high-order detonation may be avoided. The methods of UXO clearance considered for AyM may include:

- High-order detonation;
- Low-order detonation (deflagration);
- Removal/ relocation; and
- Other less intrusive means of neutralising the UXO.

197 As the detailed pre-construction surveys have not yet been completed, it is not possible at this time to determine how many items of UXO will require clearance. As a result, a separate Marine Licence will be applied for post-consent for the clearance (where required) of any UXO identified. In order to define the design envelope for consideration of UXO within the EIA, a review of recent information has been undertaken, in conjunction with experience from nearby offshore wind farms (including GyM). It should be noted that AyM is generally in an area considered to be low risk for UXO when compared to areas closer to Liverpool and for other recent wind farm projects in the southern North Sea; indeed, the construction of GyM required the clearance of only three UXO. The Applicant commissioned a study to establish the potential for UXO presence at AyM. Based on the results of this study, the design envelope for UXO clearance is for a total of 370 UXOs expected, of which, 52 are expected to require inspection and only ten of which are expected to require clearance.

198 Current advice from the SNCBs (Natural England and the MMO) is that Southall et al. (2019) should be used for assessing the impacts from UXO detonation on marine mammals. However, the suitability of these criteria for UXO is under discussion due to the lack of empirical evidence from UXO detonations using these metrics, in particular the range dependent characteristics of the peak sounds, and whether current propagation models can accurately predict the range at which these thresholds are reached.

199 An estimation of the source level and predicted PTS-onset impact ranges were calculated for a range of expected UXO sizes. The UXO ALARP Strategy report produced by Ordtek (ref. JM5694_UXO_DTS_RARMS_V1.0) indicates that it is possible that the project may encounter German mines, large projectiles and small projectiles. The potential for any other device is unlikely or very unlikely. On this basis, the range of equivalent charge weights for the potential UXO devices that could be present at AyM have been estimated as:

- Small projectile (small artillery or rocket): 5 kg TNT NEQ
- Large artillery projectile: 15 kg TNT NEQ
- German mine: 164 kg TNT NEQ

200 The use of a donor charge represents the worst case for additional noise. Although the donor charges have yet to be specified, donor charge weights of between 5 and 25 kg have been used on similar projects. As these are the same order as the smaller UXO devices identified above, the results for the smaller projectiles can be used as a proxy for these, with an extra item for 25 kg to clear larger UXO.

201 Full details of the underwater noise modelling and the resulting PTS-onset impact areas and ranges are detailed in Volume 4, Annex 6.2: Subsea Noise Technical Report. 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. This is therefore considered to be an indication of the potential maximum noise output from each charge size and, as such, likely results in an overestimate of PTS-onset impact ranges, especially for larger charge sizes.

202 The impact of PTS-onset is predicted to be of local spatial extent, short term duration and intermittent, however since PTS is a permanent change in the hearing threshold, it is not recoverable. As part of any future consent for UXO removal AyM will be required to implement a UXO specific MMMP to ensure that the risk of PTS is reduced to negligible. The exact mitigation measures contained with the UXO MMMP are yet to be determined and will be agreed with NRW, however, multiple measures are available and have been implemented elsewhere for UXO clearance, such as the use of ADDs and scarer charges to displace animals to beyond the PTS-onset impact range, the use of noise abatement techniques where appropriate or the use of low-order clearamnce methods as an alternative. The magnitude of this impact is therefore considered to be **negligible** adverse.

Table 41: PTS-onset impact range for various potential UXO charge sizes.

CHARGE SIZE			5 KG	25 KG	164 KG
PTS-ONSET SPL_{PEAK} (DB RE 1µPA)					
VHF	202	Impact Range	2.7 km	4.6 km	8.6 km
		# Porpoise (JCP 0.13/km^2)	3	9	30
		# Porpoise (SWF 1.0/km^2)	23	66	232
HF	203	Impact Range	150 m	260 m	500 m
		# Bottlenose (0.0178/km^2)*	<1	<1	<1
		# Common (0.0081/km^2)	<1	<1	<1
		# Risso's (0.031/km^2)	<1	<1	<1
LF	219	Impact Range	470 m	810 m	1.5 km
		# Whales (0.017/km^2)	<1	<1	<1
PCW	218	Impact Range	530 m	900 m	1.6 km
		# Seals (0.43/km^2)**	<1	1	3
PTS-ONSET SEL_{SS} (DB RE 1µPA^2S)					

CHARGE SIZE			5 KG	25 KG	164 KG
VHF	155	Impact Range	300 m	560 m	1 km
		# Porpoise (JCP 0.13/km^2)	<1	<1	<1
		# Porpoise (SWF 1.0/km^2)	<1	1	3
HF	185	Impact Range	<50 m	<50 m	<50 m
		# Bottlenose (0.0178/km^2)*	<1	<1	<1
		# Common (0.0081/km^2)	<1	<1	<1
		# Risso's (0.031/km^2)	<1	<1	<1
LF	183	Impact Range	990 m	2.1 km	5.4 km
		# Whales (0.017/km^2)	<1	<1	2
PCW	185	Impact Range	170 m	380 m	960 m
		# Seals (0.43/km^2)**	<1	<1	1

* mean density within AyM + 26 km buffer
** mean density within AyM + 26 km buffer from Carter et. al (2020)

7.10.6 Disturbance from UXO

203 In the absence of agreed thresholds to assess the potential for behaviour disturbance in marine mammals from UXO detonations, this assessment presents results for each of the following behavioural disturbance thresholds:

- 26 km EDR for high-order detonations;
- 5 km EDR for low-order detonations; and
- TTS-onset thresholds for high-order detonations.

204 Please see Volume 4, Annex 7.3: Marine Mammal Quantitative Noise Impact Assessment – Assumptions, Limitations and Uncertainties for full details on the selection of these thresholds to assess disturbance from UXO clearance.

205 The impact of UXO disturbance is predicted to be of local spatial extent, short term duration and intermittent and extremely infrequent (expected absolute maximum of 10 UXOs require clearing). As part of any future consent for UXO removal AyM will be required to implement a specific MMMP during UXO operations to minimise the risk of injury to marine mammals. As previously stated, the exact mitigation measures contained with the UXO MMMP are yet to be determined and will be agreed with NRW. However, multiple measures are available and have been implemented elsewhere for UXO clearance, such as the use of ADDs and scarer charges to displace animals to beyond the PTS impact range, the use of noise abatement techniques where appropriate and theconsideration of low order clearance methods as an alternative.

26 km EDR – High order

206 It has been advised by JNCC that an EDR of 26 km around the source location is used to determine the impact area from UXO clearance with respect to disturbance of harbour porpoise in SACs (JNCC et al. 2020). In the absence of agreed metrics for other species, and given a lack of empirical data on the likelihood of response to explosives, this 26 km radius (area of 2,124 km^2) has been applied here for all species. The resulting number of animals, proportion of the reference population and impact magnitude is detailed in Table 42. This is quantified by calculating the numbers of animals likely to be within the effective deterrence range by multiplying the area of the impact footprint by the appropriate density estimate.

Table 42: Estimated number of marine mammals potentially at risk of disturbance during high-order UXO clearance (assuming an EDR of 26 km, resulting in a 2,123.72 km^2 impact area).

SPECIES	DENSITY	# IMPACTED	% MU
Harbour porpoise	JCP 0.13 porpoise/km^2	276	0.44%
	SWF 1.0 porpoise/km^2	2,124	3.40%
Bottlenose dolphin	0.0178 dolphins/km^2 *	38	12.9%
Common dolphin	0.0081 dolphins/km^2	17	0.02%

SPECIES	DENSITY	# IMPACTED	% MU
Risso's dolphin	0.031 dolphins/km^2	66	0.54%
Minke whale	0.017 whales/km^2	36	0.18%
Grey Seal	0.43 grey seals/km^2 **	913***	1.38% ****

* mean density within AyM + 26 km buffer
** mean density within AyM + 26 km buffer from Carter et. al (2020)
*** this is considered to be a vast overestimate since the dose-response curve predicts low levels of disturbance to grey seals
**** using OSPAR region III MU

207 NRW have expressed concerns with the 26 km EDR approach, and have stated that: *"NRW considers that there is still considerable uncertainty in the evidence underpinning the calculation of Effective Deterrent Range (EDR), especially in Welsh waters, and as such are not a signatory to the cited JNCC guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England& Northern Ireland)"* (NRW s42 comments).

208 The 26 km EDR was advised by JNCC for harbour porpoise only. There is no evidence that a 26 km EDR is suitable for any other species of marine mammal. Thus the 26 km EDR has been used here for illustrative purposes for other marine mammal species but should be viewed with caution as there is no evidence to support this impact range.

209 Therefore, there are limitations in the confidence levels for the number of animals predicted to experience behavioural disturbance using this approach. As such, the alternative approach of using TTS-onset as a proxy for disturbance is also presented below.

5 km EDR – Low order

210 It is important to note that while high-order detonation represents the very worst-case scenario for UXO clearance, it is highly likely that low-order clearance methods (deflagration) will be used instead. Current risk assessments conducted to support UXO Marine Licence Applications that are including deflagration as the preferred method, are assuming an EDR of 5 km (e.g. Sofia offshore wind farm). As a consequence, due to the absence of formal guidance, this approach has been adopted here for the assessment of disturbance from low-order detonation of UXOs at the Project.

211 There is no evidence that a 5 km EDR is suitable for any species of marine mammal. Thus the 5 km EDR has been used here for illustrative purposes but should be viewed with caution as there is no evidence to support this impact range. As such, the alternative approach of using TTS-onset as a proxy for disturbance is also presented below.

Table 43: Estimated number of marine mammals potentially at risk of disturbance during low-order UXO clearance (assuming an EDR of 5 km, resulting in a 78.54 km^2 impact area).

SPECIES	DENSITY	# IMPACTED	% MU
Harbour porpoise	JCP 0.13 porpoise/km^2	10	0.02%
	SWF 1.0 porpoise/km^2	79	0.13%
Bottlenose dolphin	0.0178 dolphins/km^2 *	1	0.48%
Common dolphin	0.0081 dolphins/km^2	<1	0.00%
Risso's dolphin	0.031 dolphins/km^2	2	0.02%
Minke whale	0.017 whales/km^2	1	0.01%
Grey Seal	0.43 grey seals/km^2 **	34***	0.05%****

* mean density within AyM + 26 km buffer
** mean density within AyM + 26 km buffer from Carter et. al (2020)
*** this is considered to be a vast overestimate since grey seals are known to be less responsive than harbour porpoise
**** using OSPAR region III MU

Fixed noise threshold: TTS-onset

212 An estimation of the extent of behavioural disturbance can be based on the sound levels at which the onset of TTS is predicted to occur from impulsive sounds. As stated by Southall et al. (2007): "*Although TTS is not a behavioural effect per se, this approach is used because any compromise, even temporarily, to hearing functions has the potential to affect vital rates by interfering with essential communication and/or detection capabilities. 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*". Therefore, using TTS-onset as a proxy for disturbance for a single pulse sound source is expected to over-estimate the true behavioural response.

213 Full details of the underwater noise modelling and the resulting TTS-onset impact areas and ranges are detailed in Volume 4, Annex 6.2: Subsea Noise Technical Report.

214 Table 44 and Table 45 provide the TTS-onset impact ranges for various UXO charge sizes. Large TTS-onset impact ranges are predicted for both porpoise (16 km using SPL_{peak}) and minke whales (65 km using SEL_{ss}) for UXO charge size of 164 kg. These impact ranges are predicted to be highly over-precautionary as a proxy for disturbance, since a) TTS-onset is unlikely to have serious biological consequences and b) these ranges do not account for the fact that impulsive sound will lose its harmful impulsive characteristics and become non-impulsive as it propagates from the source (see Annex 7.3 for further details).

215 Despite this, even when the full TTS-onset impact ranges are considered, the number of animals predicted to experience TTS-onset is only 105 porpoise (0.17% MU) using the JCP density, or 804 porpoise (1.29% MU) using the SWF density, <1 dolphin, 226 minke whales (1.12% MU) and 195 grey seals (0.29% OSPAR Region III MU) per detonation event. Given that Southall et al. (2007) state that *"TTS at onset levels is unlikely to […] have serious biological consequences"* it is not expected that vital rates would be significantly impacted, and therefore the sensitivity of marine mammals to TTS-onset as a proxy for disturbance is ***low***. Since it is expected that only a maximum of ten UXOs might require detonation, this results in a maximum of 10 days of disturbance from detonations. Given this low level of repeated disturbance it is unlikely to result in any change in the population trajectory for any of the marine mammal species considered, and so is assessed as being of **low** magnitude.

216 The magnitude of the impact has been assessed as ***low***, and the sensitivity of receptors as ***low***. Therefore, the significance of the effect of disturbance from UXO clearance is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 44: TTS-onset impact ranges (SPL_{peak}) for various potential UXO charge sizes.

CHARGE SIZE			5 KG	25 KG	164 KG
TTS-ONSET SPL_{PEAK} (DB RE 1µPA)					
VHF	196	Impact Range (km)	5.0	8.5	16
		Area (km^2)	78.5	227.0	804.2
		JCP # Porpoise (%MU)	10 (0.02%)	30 (0.05%)	105 (0.17%)
		SWF # Porpoise (%MU)	79 (0.13%)	227 (0.36%)	804 (1.29%)
HF	224	Impact Range (km)	0.28	0.49	0.92
		Area (km^2)	0.2	0.8	2.7
		# Bottlenose	<1	<1	<1
		# Common	<1	<1	<1

CHARGE SIZE			5 KG	25 KG	164 KG
		# Risso's	<1	<1	<1
LF	213	Impact Range (km)	0.88	1.5	2.8
		Area (km²)	2.4	7.1	24.6
		# Whales	<1	<1	<1
PCW	212	Impact Range (km)	1.0	1.6	3.1
		Area (km²)	3.1	8.0	30.2
		# Seals (%MU)	1	3 (0.00%)	13 (0.02%)

Table 45 TTS-onset impact ranges (SEL_{ss}) for various potential UXO charge sizes.

CHARGE SIZE			5 KG	25 KG	164 KG
TTS-ONSET SEL_{SS} (DB RE 1µPA²S)					
VHF	140	Impact Range (km)	1.7	2.4	3.3
		Area (km²)	9.1	18.1	34.2
		JCP # Porpoise (%MU)	1	2 (0.00%)	4 (0.01%)
		SWF # Porpoise (%MU)	9	18	34
HF	170	Impact Range (km)	0.08	0.15	0.34
		Area (km²)	<0.1	0.1	0.4
		# Bottlenose	<1	<1	<1
		# Common	<1	<1	<1
		# Risso's	<1	<1	<1
LF	168	Impact Range (km)	14	29	65
		Area (km²)	615.8	2,642.1	13,273.2
		# Whales	10 (0.05%)	45 (0.22%)	226 (1.12%)

CHARGE SIZE			5 KG	25 KG	164 KG
PCW	170	Impact Range (km)	2.4	5.2	12
		Area (km^2)	18.1	84.9	452.4
		# Seals (%MU)	8 (0.01%)	37 (0.06%)	195 (0.29%)

7.10.7 Collision risk from construction vessels

217 The area surrounding AyM already experiences high levels of vessel traffic (Figure 23 and Figure 24) (see Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline for full details). The Shipping and Navigation Baseline study recorded an average of 58 vessels per day recorded within study area[viii] in the winter (busiest day was 73 vessels) (Figure 25), comprised of mainly cargo and tanker vessels as well as recreational and offshore wind farm vessels (Figure 27). Similarly, the study recorded an average of 57 vessels per day recorded within study area in the summer (busiest day was 71 vessels) (Figure 26), comprised of mainly cargo and tanker vessels as well as recreational and offshore wind farm vessels (Figure 27).

218 Therefore, the introduction of additional vessels during construction of AyM is not a novel impact for marine mammals present in the area.

[viii] Shipping and Navigation Technical Baseline defines the Study Area as a 10 nm buffer of the array, and 5 nm buffer of the offshore ECC.

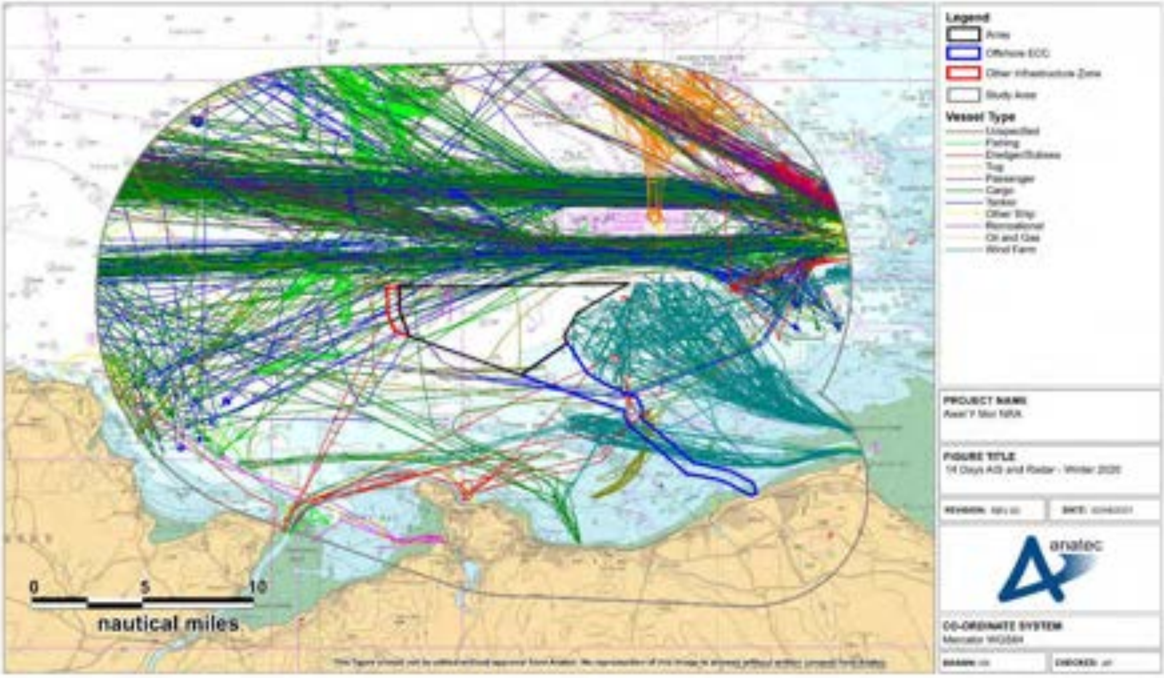


Figure 23: Vessel Types – Winter 2020 Survey Period (Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline).

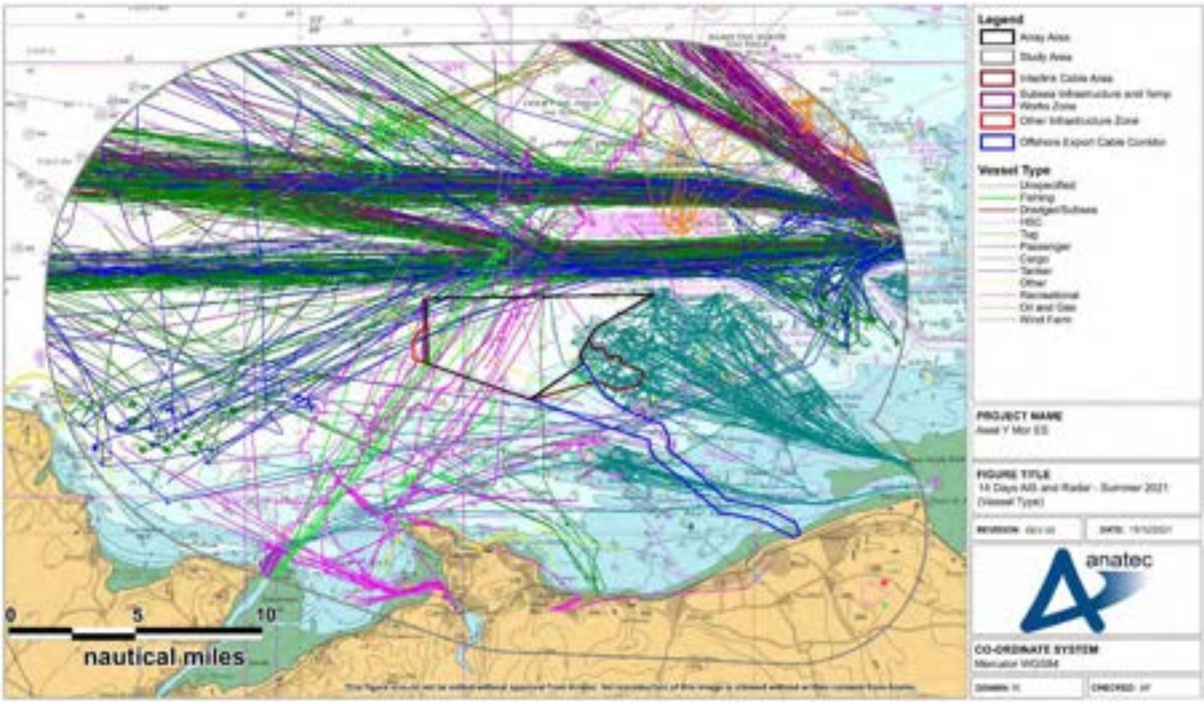


Figure 24 Vessel Types – Summer 2021 Survey Period (Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline).

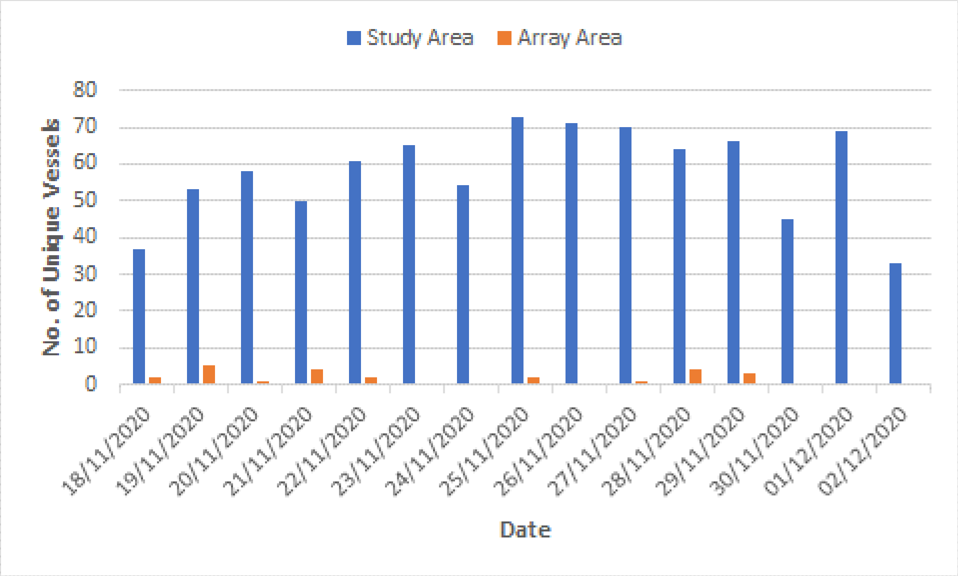


Figure 25: Unique Vessels Per Day – Winter 2020 Survey Period (Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline).

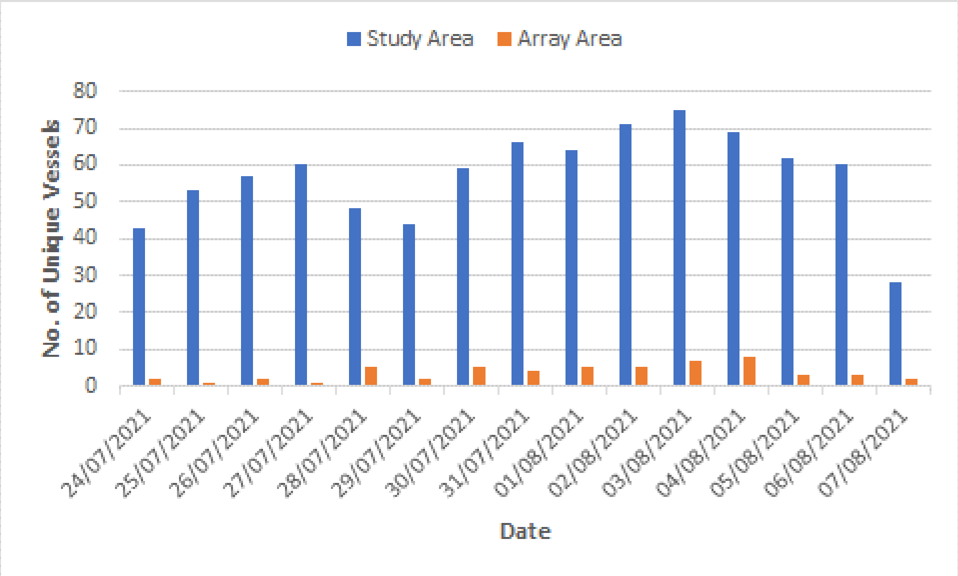


Figure 26: Unique Vessels Per Day – Summer 2021 Survey Period (Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline).

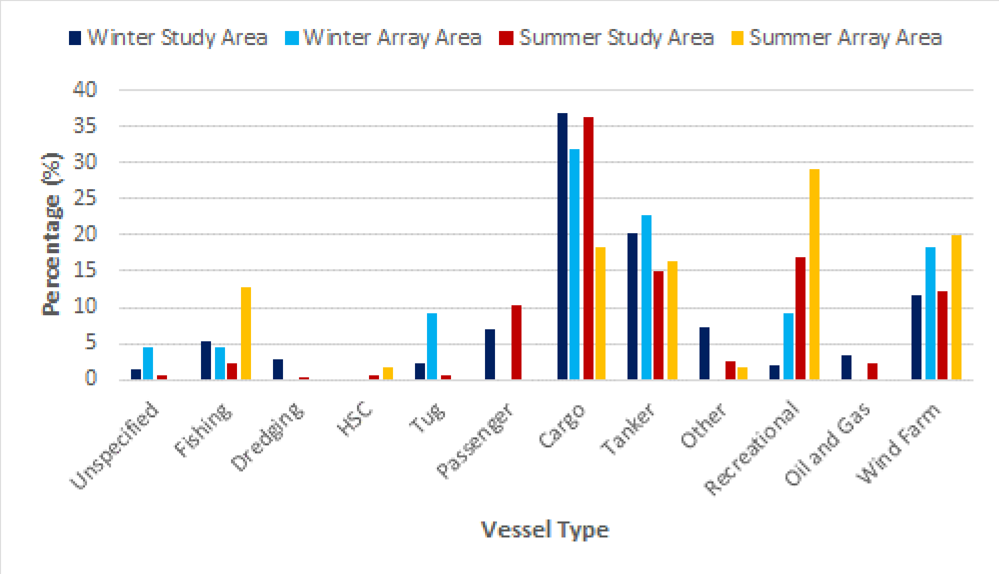


Figure 27: Vessel Type Distribution – Winter 2020 and Summer 2021 Survey Periods combined (Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline).

219 During construction of the wind farm, a potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship. These injuries include blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision of marine mammals with vessels would be directly influenced by the type of vessel and the speed with which it is travelling (Laist et al. 2001) and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

220 There is currently a lack of information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality, and there is little evidence from marine mammals stranded in the UK that injury from vessel collisions is an important source of mortality. The UK Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. The CSIP data shows that very few strandings have been attributed to vessel collisions[ix], therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post-mortem examinations.

[ix] (CSIP 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

221 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek et al. 2001, Lusseau 2003, 2006). The Applicant has committed to the adoption of best practice vessel handing protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme[x], Scottish Marine Wildlife Watching Code[xi] or Guide to Best Practice for Watching Marine Wildlife[xii]) during construction in order to minimise the potential for any impact. It is highly likely that a proportion of vessels will be stationary or slow moving throughout construction activities for significant periods of time. Therefore, the actual increase in vessel traffic moving around the site and to/from port to the site will occur over short periods of the offshore construction activity.

222 It is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions. The commitment to the adoption of best practice vessel handing protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme[xiii], Scottish Marine Wildlife Watching Code[xiv] or Guide to Best Practice for Watching Marine Wildlife[xv]) during construction will minimise the potential for any impact. Therefore, the risk of vessel collisions occurring is of **negligible** adverse magnitude.

223 All marine mammal receptors are deemed to be of low vulnerability given that vessel collision is not considered to be a key source of mortality highlighted from post-mortem examinations of stranded animals. However, should a collision event occur, this has the potential to kill the animal. As a result of the low vulnerability to a strike but the serious consequences of a strike, marine mammal receptors are considered to have a **high** sensitivity to vessel collisions.

[redacted]

224 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **high**. Therefore, the significance of the effect of collisions from vessels is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

7.10.8 Disturbance from construction vessels

225 As stated in 7.10.7, the area surrounding AyM already experiences high levels of vessel traffic (Figure 23 and Figure 24) (see Volume 2, Chapter 7: Shipping and Navigation for full details). Therefore, the introduction of additional vessels during construction AyM is not a novel impact for marine mammals present in the area.

226 Vessel noise levels from construction vessels will result in an increase in non-impulsive, continuous sound in the vicinity of the AyM array, typically in the range of 10 – 100 Hz (although higher frequencies may also be produced)(Sinclair et al. 2021) with an estimated source level of 161 – 168 SEL_{cum} dB re 1 μPa@1m (RMS) for medium and large construction vessels travelling at a speed of 10 knots (Volume 4, Annex 6.2: Subsea Noise Technical Report).

227 Porpoise displacement has been observed up to 4 km from construction vessels (Benhemma-Le Gall et al. 2021). It is expected that other cetacean species will be displaced to a similar extent.

228 It is anticipated there will be a maximum of 99 construction vessels in total, of which 35 may be on site during peak periods. There are very few studies that indicate a critical level of activity in relation to risk of collisions but an analysis presented in Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 80 per day (within a 5 km^2 area). Even considering the existing levels of vessel traffic in the area, the addition of AyM construction traffic will still be well below this figure.

229 The 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. Therefore, the impact is expected to be of **low** adverse magnitude.

230 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low** (cetaceans) or **negligible** (grey seals). Therefore, the significance of the effect of disturbance from vessels is concluded to be of ***minor adverse significance*** for cetaceans and ***negligible adverse significance*** for grey seals, which is not significant in terms of the EIA regulations.

7.10.9 Change in water quality from construction activities

231 Disturbance to water quality as a result of construction activities can have both direct and indirect impacts on marine mammals. Indirect impacts include effects on prey species (see section 7.10.10). Direct impacts include the impairment of visibility and therefore foraging ability which might be expected to reduce foraging success.

232 During construction of the project, sediment will be disturbed and released into the water column. This will give rise to suspended sediment plumes and localised changes in bed levels as material settles out of suspension. The main activities resulting in disturbance of seabed sediments are:

- Pre-lay cable trenching;
- Sandwave clearance;
- Cable installation;
- Dredge spoil disposal; and
- Drill arisings release.

233 The maximum distance (and therefore the overall spatial extent) that any local plume effects might be (temporarily) experienced can be reasonably estimated as the spring tidal excursion distance. The assessment provided in Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes found that:

- Within 5 m of the activity, SSC might be millions of mg/l or more locally, i.e. more sediment than water in parts of the local plume. The effect is very localised and of very short duration.
- During the first half tidal cycle (~6 hours), the width of the plume increases through dispersion to 50-100 m, all non-silt sediments have settled to the seabed, and SSC consequentially reduces rapidly to 5-10 mg/l.

234 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 seals in the UK have been documented foraging in areas with high tidal flows (Pierpoint 2008, Marubini et al. 2009, Hastie et al. 2016); therefore, low light levels, turbid waters and suspended sediments are unlikely to negatively impact marine mammal foraging success. It is important to note that it is hearing, not vision that is the primary sensory modality for most marine mammals. 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 mystacial vibrissae; while odontocetes primarily use echolocation to navigate and find food in darkness.

235 Any disturbance to the seabed will be localised and any resultant increase in SSC will be temporary so will be of **negligible** adverse magnitude. Short-term increased turbidity is not anticipated to impact marine mammals which rely primarily on hearing, resulting in **negligible** sensitivity to changes in water quality.

236 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **negligible**. Therefore, the significance of the effect of changes in water quality is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

7.10.10 Change in fish abundance/distribution from construction activities

237 Given that marine mammals are dependent on fish prey, there is the potential for indirect effects on marine mammals as a result of impacts upon fish species or the habitats that support them. The key prey species for each marine mammal receptor are listed in Table 46.

238 During construction activities, there is the potential for fish mortality, PTS, TTS, behavioural impacts and auditory masking arising from low level continuous noise and vibration. The assessment of impacts upon fish species is presented in Volume 2, Chapter 6: Fish and Shellfish Ecology. The greatest impact is likely to be from UXO operations conducted as part of construction. Individual UXO detonations will have the potential to result in mortality, mortal injury, recoverable injury, TTS and disturbance to fish species, depending on the proximity of the individuals to the UXO location and the size of the UXO. Small scale mortality of fish as a result of UXO detonation are frequently recorded, with dead fish recorded floating at the surface in the immediate vicinity of the detonation. As such, this is expected to be a small-scale impact.

239 Direct damage and disturbance of subtidal habitat resulting from construction activities is predicted to directly impact approximately 9.49% of the total seabed area within the AyM draft Order Limits (see Volume 2, Chapter 6: Fish and Shellfish Ecology). Implementation of structures may result in habitat damage as well as direct damage to receptors e.g. crushing.

240 Fishing pressure may be reduced during construction at AyM due to the required safety distances around construction vessels and fishing effort may be displaced into the surrounding area. However, it would not be expected that any changes in fishing activities in this area would lead to changes in populations of these species as any increase would be very localised and any population level effects would be minimised by fisheries management measures.

Table 46: Key prey species of the marine mammal receptors (bold = species present at AyM).

	SITE	KEY PREY SPECIES	REFERENCE
HP	Scotland	Whiting, sandeel, haddock, saithe, pollock, Norway pout, poor-cod, cod, ling, blue whiting	Santos et al. (2004)
	Ireland	Poor-cod, whiting, herring	Berrow and Rogan (1995), Hernandez-Milian et al. (2011)
BND	Wales	Mackerel, seabass, herring, whiting	Pesante et al. (2008), Nuuttila et al. (2017)
	Wales	Seabass, salmon, conger eel, garfish, sandeel, small sharks	Evans and Hintner (2013)
	Ireland	Whiting, blue whiting, pollock, saithe, haddock, poor-cod	Hernandez-Milian et al. (2011)
	Scotland	Cod, saithe, whiting, salmon, haddock	Santos et al. (2001)
CD	UK	Seabass, goby, cod, cephalopods, mackerel, lanternfish, blue whiting	Brophy et al. (2009)
RD	UK	Cephalopods (octopus, cuttlefish, squid)	Clarke and Pascoe (1985)
MW	Scotland	Sandeel, herring, sprat, mackerel, goby, Norway pout/poor cod	Pierce et al. (2004)
GS	Wales	Cod, righteye flounders, large-tooth flounders, harbour porpoise	Nelms et al. (2019), Stringell et al. (2015)
	Wales	Whiting, poor-cod, sole, herring	Evans and Hintner (2013)

	SITE	KEY PREY SPECIES	REFERENCE
	UK	Sandeel, cod, whiting, haddock, ling, plaice, sole, flounder, dab	SCOS (2020)

241 While there may be certain species that comprise the main part of their diet, all marine mammals in this assessment are considered to be generalist feeders and are thus not reliant on a single prey species (with the exception of Risso's dolphins which predominantly eat cephalopods). Therefore, they are assessed as having a **low** sensitivity to changes in prey abundance and distribution. The assessment provided in Volume 2, Chapter 6: Fish and Shellfish Ecology indicates that the overall adverse impacts to fish species from the construction of AyM will be of negligible to minor adverse significance and thus the predicted impact on marine mammals is of **negligible** adverse magnitude.

242 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of changes in fish abundance/distribution is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

7.11 Environmental assessment: operational phase

243 The impacts of the offshore operation and maintenance of AyM have been assessed on marine mammals. The environmental impacts arising from the operation and maintenance of Hornsea Four are listed in Table 18 along with the MDS against which each operation and maintenance phase impact has been assessed.

7.11.1 Barrier effects from operation

244 Potential barrier effects have been assessed at a number of previously constructed offshore windfarm sites. For example, at the Horns Rev and Nysted offshore wind farms in Denmark, long-term monitoring showed that both harbour porpoise and harbour seals were sighted regularly within the operational OWFs, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs et al. 2008). Similarly, a monitoring programme at the Egmond aan Zee OWF in the Netherlands reported that significantly more porpoise activity was recorded within the OWF compared to the reference area during the operational phase (Scheidat et al. 2011), indicating the presence of the windfarm was not adversely affecting harbour porpoise presence. Other studies at Dutch and Danish OWFs (Lindeboom et al. 2011) also suggest that harbour porpoise may be attracted to increased foraging opportunities within operating offshore wind farms. In addition, recent tagging work by Russell et al. (2014) found that some tagged harbour and grey seals demonstrated grid-like movement patterns as these animals moved between individual WTGs, strongly suggestive of these structures being used for foraging.

245 Other reviews have also concluded that operational wind farm noise will have negligible effects (Madsen et al. 2006, Teilmann et al. 2006a, Teilmann et al. 2006b, CEFAS 2010, Brasseur et al. 2012). Based on results of studies conducted at other offshore windfarm locations, it is not anticipated that the AyM offshore windfarm will create a barrier to marine mammals and therefore will not prevent their access to or transit through the area.

246 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **negligible**. Therefore, the significance of barrier effects is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations

7.11.2 Collision risk from O&M vessels

247 As stated in 7.10.7, the area surrounding AyM already experiences a high amount of vessel traffic (Figure 23 and Figure 24) (see Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline for full details). Therefore, the introduction of additional vessels during O&M of AyM is not a novel impact for marine mammals present in the area.

248 Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek et al. 2001, Lusseau 2003, 2006). The adoption of best practice vessel handing protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme[xvi], Scottish Marine Wildlife Watching Code[xvii] or Guide to Best Practice for Watching Marine Wildlife[xviii]) will minimise the potential for any impact. Additional traffic during operations includes an increased frequency and greater variety of vessel types than in the construction phase e.g. jack-up vessels, SOV, small O&M vessels, lift vessels, cable maintenance vessels and auxiliary vehicles, and will take place over a longer period of time e.g. lifetime of AyM offshore windfarm (see Table 18 for maximum estimated annual round trips). Therefore, vessel traffic increase will be greater during this phase. However, it is still highly likely that a proportion of vessels will be stationary or slow moving throughout operations at AyM for significant periods of time.

249 It is not expected that the level of vessel activity during operations would cause an increase in the risk of mortality from collisions. 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 O&M will minimise the potential for any impact. Therefore, the risk of vessel collisions occurring is of **negligible** adverse magnitude.

xvi [redacted]

[redacted]

250 All marine mammal receptors are deemed to be of low vulnerability given that vessel collision is not considered to be a key source of mortality highlighted from post-mortem examinations of stranded animals. However, should a collision event occur, this has the potential to kill the animal, from which they have no ability to recover from. As a result of the low vulnerability to a strike but the serious consequences of a strike, marine mammal receptors are considered to have a **high** sensitivity to vessel collisions.

251 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **high**. Therefore, the significance of the effect of collisions from O&M vessels is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

7.11.3 Disturbance from O&M vessels

252 As stated in section 7.10.7, the area surrounding AyM already experiences a high amount of vessel traffic (Figure 23 and Figure 24) (see Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline for full details). Therefore, the introduction of additional vessels during O&M of AyM is not a novel impact for marine mammals present in the area.

253 Vessel noise levels from vessels during operations will result in an increase in non-impulsive, continuous sound in the vicinity of the AyM array, typically in the range of 10 – 100 Hz (although higher frequencies may also be produced)(Sinclair et al. 2021) with an estimated source level of 161 – 168 SEL_{cum} dB re 1 µPa@1m (RMS). It is anticipated that numerous different vessel types would be conducting round trips to and from port and the AyM array area, but only two jack-up vessels and two SOVs would be present at any one time.

254 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 80 per day (within a 5 km^2 area). Vessel traffic in the AyM area, even considering the addition of AyM O&M traffic will still be well below this figure. 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 O&M will minimise the potential for any impact. Therefore, the impact is expected to be of **low** adverse magnitude.

255 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low** (cetaceans) or **negligible** (grey seals) (see sections 7.5.6 to 7.5.9). Therefore, the significance of the effect of disturbance from O&M vessels is concluded to be of ***minor adverse significance*** for cetaceans and ***negligible adverse significance*** for grey seals, which is not significant in terms of the EIA regulations.

7.11.4 Change in water quality from operation

256 There are no changes to water quality indicated in Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes or Chapter 3: Marine Water and Sediment Quality as a result of operations at AyM. Therefore, water quality is anticipated to have no impact on marine mammals during AyM operation.

7.11.5 Change in fish abundance/distribution from operation

257 Any change in fish abundance and/or distribution as a result of AyM operations is important to assess as, given marine mammals are dependent on fish as prey species, there is the potential for indirect effect on marine mammals. The key prey species for each marine mammal receptor are listed in Table 46.

258 The presence of turbine infrastructure has the potential to impact on fish species by removing essential habitats (e.g. spawning, nursery and feeding habitats) (see Volume 2, Chapter 6: Fish and Shellfish Ecology). The AyM array area overlaps with sandeel spawning grounds, but comparable habitats are present and widespread within the wider area. The long-term habitat loss due to the presence of foundations, scour protection and cable protection is expected to be up to a maximum of 1.7 km^2, which represents less than 0.1% of the fish and shellfish study area. The assessment provided in Volume 2, Chapter 6: Fish and Shellfish Ecology indicates that the overall adverse impacts to fish species from the operation of AyM will be of negligible to minor adverse significance and thus the predicted impact on marine mammals is of **negligible** adverse magnitude.

259 Fishing pressure in the AyM array area will be reduced as a result of operations due to advisory safety zones around infrastructure and the physical presence of the infrastructure preventing access to fishing vessels. Conversely, fishing pressure outside the AyM array area may be increased due to displacement. These effects will be highly localised and therefore will have a **negligible** adverse magnitude on prey availability for marine mammals.

260 While there may be certain species that comprise the main part of their diet, all marine mammals in this assessment are considered to be generalist feeders and are thus not reliant on a single prey species (with the exception of Risso's dolphins which predominantly eat cephalopods). Therefore, they are assessed as having a **low** sensitivity to changes in prey abundance and distribution.

261 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of changes in fish abundance/distribution during O&M is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

7.12 Environmental assessment: decommissioning phase

262 The impacts of the offshore decommissioning of AyM have been assessed on marine mammals. The environmental impacts arising from the decommissioning of AyM are listed in Table 18 along with the MDS against which each decommissioning phase impact has been assessed. Decommissioning would involve the dismantling of structures and removal of offshore structures above the seabed, in reverse order to the construction sequence. The effects of these activities on marine mammals are considered to be similar to or less (as a result of there being no piling) than those occurring as a result of construction. Therefore, the effects of decommissioning are considered to be no greater than those described for the construction phase.

7.12.1 PTS and disturbance from decommissioning

263 It is envisaged that piled foundations would be cut below seabed level, and the protruding section removed. Typical current methods for cutting piles are abrasive water jet cutters or diamond wire cutting. The final method chosen shall be dependent on the technologies available at the time of decommissioning. The indicative methodology would be:

- Deployment of ROV's or divers to inspect each pile footing and reinstate lifting attachments if necessary.
- Mobilise a jack-up barge/heavy lifting vessel.
- Remove any scour protection or sediment obstructing the cutting process. It may be necessary to dig a small trench around the foundation.
- Deploy crane hooks from the decommissioning vessel and attach to the lift points.
- Cut piles at just below seabed level.
- Inspect seabed for debris and remove debris where necessary.
- Considering the current technology, the decommissioned components are likely to be transported back to shore by lifting onto a jack-up or heavy lift vessels, freighter, barge, or by buoyant tow.
- Transport all components to an onshore site where they will be processed for reuse/recycling/disposal.
- Inspect seabed and remove debris.

264 As the exact methods to be used for decommissioning are to be decided, the impact from PTS and disturbance levels of decommissioning activities cannot be accurately determined at this time. However, it is anticipated that with the implementation of embedded mitigation in the form of a Decommissioning Plan/Program and a MMMP specific to decommissioning activities (Table 19) the significance of these impacts will be reduced. The impacts of decommissioning activities will likely be similar or of a lesser extent than during piling in the construction phase and therefore will be of ***negligible adverse significance*** to ***minor adverse significance,*** which is not significant in terms of the EIA regulations.

7.12.2 Collision risk from decommissioning vessels

265 As stated in section 7.10.7, the area surrounding AyM already experiences a high amount of vessel traffic (Figure 23 and Figure 24) (see Volume 4, Annex 9.1: Navigational Risk Assessment Technical Baseline for full details). Therefore, the introduction of additional vessels during decommissioning of AyM is not a novel impact for marine mammals present in the area.

266 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 decommissioning will minimise the potential for any impact. It is assumed that similar vessel types and number will be present in the AyM array area as during the construction phase. Therefore, it is highly likely that a proportion of vessels will be stationary or slow moving throughout decommissioning activities for significant periods of time. Therefore, the actual increase in vessel traffic moving around the site and to/from port to the site will occur over short periods of the offshore decommissioning activity.

267 It is not expected that the level of vessel activity during decommissioning operations would cause an increase in the risk of mortality from collisions. The adoption of best practice vessel handing protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme[xix], Scottish Marine Wildlife Watching Code[xx] or Guide to Best Practice for Watching Marine Wildlife[xxi]) will minimise the potential for any impact. Therefore, the risk of vessel collisions occurring is of **negligible** adverse magnitude.

268 All marine mammal receptors are deemed to be of low vulnerability given that vessel collision is not considered to be a key source of mortality highlighted from post-mortem examinations of stranded animals. However, should a collision event occur, this has the potential to kill the animal, from which they have no ability to recover from. As a result of the low vulnerability to a strike but the serious consequences of a strike, marine mammal receptors are considered to have a **high** sensitivity to vessel collisions.

269 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **high**. Therefore, the significance of the effect of collision risk from decommissioning vessels is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

7.12.3 Disturbance from decommissioning vessels

270 Vessel noise levels from decommissioning vessels will result in an increase in non-impulsive, continuous sound in the vicinity of the AyM array, typically in the range of 10 – 100 Hz (although higher frequencies may also be produced)(Sinclair et al. 2021) with an estimated source level of 161 – 168 SEL_{cum} dB re 1 µPa@1m(RMS). It is anticipated that levels and types of vessel traffic during decommissioning would be similar to that during construction.

[redacted]

271 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 80 per day (within a 5 km^2 area). Vessel traffic in the AyM area, even considering the addition of AyM decommissioning traffic will still be well below this figure. 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 decommissioning will minimise the potential for any impact. Therefore, the impact is expected to be of ***low magnitude***.

272 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low** (cetaceans) or **negligible** (grey seals) (see sections 7.5.6 to 7.5.9). Therefore, the significance of the effect of disturbance from decommissioning vessels is concluded to be of ***minor adverse significance*** for cetaceans and ***negligible adverse significance*** for grey seals, which is not significant in terms of the EIA regulations.

7.12.4 Change in water quality from decommissioning

273 During decommissioning, SSC could potentially be increased and associated deposition of material within the AyM array and the offshore ECC from the following activities:

- Removal of foundation structures;
- Cutting off of monopiles and jacket foundation legs; and
- (Possible) removal of cables from the intertidal zone.

274 Any disturbance to the seabed will be localised and any resultant increase in SSC will be temporary. The changes in SSC and resultant water quality during decommissioning are anticipated to be lesser than those associated with construction. Short-term increased turbidity is not anticipated to impact marine mammals which rely primarily on hearing, resulting in **negligible** sensitivity to changes in water quality.

275 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **negligible**. Therefore, the significance of the effect of changes in water quality is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

7.12.5 Change in fish abundance/distribution from decommissioning

276 Any change in fish abundance and/or distribution as a result of AyM decommissioning is important to assess as, given marine mammals are dependent on fish as prey species, there is the potential for indirect effect on marine mammals. The key prey species for each marine mammal receptor are listed in Table 46. While there may be certain species that comprise the main part of their diet, all marine mammals in this assessment are considered to be generalist feeders and are thus not reliant on a single prey species (with the exception of Risso's dolphins which predominantly eat cephalopods). Therefore, they are assessed as having a **low** sensitivity to changes in prey abundance and distribution.

277 Decommissioning of offshore infrastructure for AyM may result in temporarily elevated underwater noise levels which may have effects on fish. However, the Volume 4, Annex 6.2: Subsea Noise Technical Report assesses the maximum noise levels to be far below that during pile driving during construction phase, therefore, the impacts would also be less. The assessment provided in Volume 2, Chapter 6: Fish and Shellfish Ecology indicates that the overall adverse impacts to fish species from the decommissioning of AyM will be of negligible adverse significance and thus the predicted impact on marine mammals is of **negligible** adverse magnitude.

278 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the effect of changes in fish abundance/distribution is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

7.13 Environmental assessment: cumulative effects

279 Cumulative effects can be defined as effects upon a single receptor from AyM when considered alongside other proposed and reasonably foreseeable projects and developments. This includes all projects that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind projects. A screening process has identified a number of reasonably foreseeable projects and developments which may act cumulatively with AyM. The full list of such projects that have been identified in relation to the offshore environment are set out in Volume 1, Annex 3.1: Cumulative Effects Assessment.

280 In assessing the potential cumulative impacts for AyM, it is important to bear in mind that some projects, predominantly those 'proposed' or identified in development plans, may not actually be taken forward, or fully built out as described within their MDS. There is, therefore, a need to build in some consideration of certainty (or uncertainty) with respect to the potential impacts which might arise from such proposals. For example, those projects under construction are likely to contribute to cumulative impacts (providing effect or spatial pathways exist), whereas those proposals not yet approved are less likely to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors.

281 With this in mind, all projects and plans considered alongside AyM have been allocated into 'tiers' reflecting their current stage within the planning and development process. This allows the cumulative impact assessment to present several future development scenarios, each with a differing potential for being ultimately built out. This approach also allows appropriate weight to be given to each scenario (tier) when considering the potential cumulative impact. The proposed tier structure is intended to ensure that there is a clear understanding of the level of confidence in the cumulative effects assessment (CEA). An explanation of each tier is included in Table 47. The proposed tier structure for marine mammals is different to that presented for other receptors. This is due to the need to take into account greater levels of uncertainty in the degree and timing of overlap of activities which will generate significant levels of underwater noise during the construction phase of projects. This is the established approach for marine mammal assessments and has been accepted by the Stakeholders and used in the most recent offshore wind farm EIAs in UK waters (for example: Hornsea Project Four PEIR Volume 2 Chapter 4, Norfolk Vanguard ES Volume 1 Chapter 12 and East Anglia Three ES Volume 1 Chapter 12).

Table 47: Description of tiers of other developments considered within the marine mammal cumulative effect assessment.

TEIR	DESCRIPTION
Tier 1	Operational and under construction projects which were not in place when baseline data was collected. Projects with a legally secure consent (i.e. projects which are not on hold subject to an ongoing judicial review process) that have been awarded a Contract for Difference (CFD) but have not yet been implemented. All Tier 1 offshore wind farm projects are due to be commissioned prior to the construction of AyM but will have an ongoing operational cumulative impact not considered part of the baseline. Therefore, there is no potential for the overlap in the construction and pile driving of these projects with the pile driving at AyM.

TEIR	DESCRIPTION
	All other Tier 1 projects that were operational or ongoing at the time of the baseline data collection have been screened out of the assessment.
Tier 2	Tier 2 includes all projects/plans that have a legally secure consent but have no CFD therefore there is uncertainty about the timeline for construction of these projects. Tier 2 offshore windfarms have the potential for cumulative operational and maintenance and decommissioning impacts. The potential for cumulative construction phase impacts have been considered where there is a reasonable chance of overlap of pile driving with AyM.
Tier 3	Tier 3 projects are projects for which an application has been submitted, but not yet determined. There is therefore information on which to base a quantitative assessment of cumulative impact but there is a degree of uncertainty as to the final approved design of the project and the timeline for construction. Tier 3 offshore wind farm projects have the potential for cumulative construction, operational and maintenance and decommissioning impacts with AyM.
Tier 4	Tier 4 projects are relevant marine infrastructure projects that the regulatory body are expecting to be submitted for determination and for projects for which Preliminary Environmental Information Report (PEIR) has been submitted, but a full ES has not yet been submitted. There is, therefore, some information on which to base a quantitative assessment of cumulative impact but there is a large degree of uncertainty as to the final design of the project and the timeline for construction. Tier 4 offshore wind farm projects have the potential for cumulative construction, operational and maintenance and decommissioning impacts with AyM.
Tier 5	Tier 5 projects are relevant marine infrastructure projects that the regulatory body are expecting to be submitted for determination

TEIR	DESCRIPTION
	(e.g. projects listed under the Planning Inspectorate programme of projects). For Tier 5 projects there is a lot of uncertainty and not enough information to allow AyM to undertake an assessment. Projects that have low data confidence and no established timeline are screened out of assessment.

282 **Screening Projects:** The CEA methodology and long-list are described in Volume 1, Annex 3.1: Cumulative Effects Assessment. The long-list of projects, plans and activities was used to generate a list of projects initially screened into the marine mammal CEA. The long-list of projects was screened to remove all projects that have:

- no data available,
- no timeline available,
- no conceptual effect-receptor pathway,
- no physical effect-receptor overlap, and
- no temporal overlap.

283 Following this initial screening, as one or more of the above criteria applied, the following project types were all screened out of the marine mammal CEA:

- Aggregates and disposal,
- Commercial fisheries,
- Oil and gas,
- Shipping,
- Military, aviation and radar, and
- Coastal developments.

284 This resulted in only offshore energy projects being screened into the marine mammal CEA.

285 **Screening Impacts:** Certain impacts assessed for AyM alone are not considered in the marine mammal CEA due to:

- the highly localised nature of the impacts,

- management and mitigation measures in place at AyM and on other projects will reduce the risk occurring, and
- where the potential significance of the impact from AyM alone has been assessed as negligible.

286 The impacts excluded from the marine mammal CEA for these reasons are:

- Auditory injury (PTS): where PTS may result from activities such as pile driving and UXO clearance, suitable mitigation will be put in place to reduce injury risk to marine mammals to negligible levels (as a requirement of European Protected Species legislation)
- Collision with vessels: it is expected that all offshore energy projects will employ a vessel management plan or follow best practice guidance to reduce the already low risk of collisions with marine mammals
- Changes in water quality: highly localised and negligible significance
- Changes in prey availability: highly localised and negligible significance
- Barrier effects/ operational noise: highly localised and negligible significance.

287 Therefore, the impacts that are considered in the marine mammal CEA are as follows:

- The potential for disturbance from underwater noise during construction and decommissioning of offshore energy developments; and
- The potential for disturbance from vessel activity during construction, operation and decommissioning of offshore energy developments.

288 The MDS for the marine mammal CEA is described in Table 48. Projects with impacts that overlap with the AyM construction period (2026-2030 inclusive) or with impacts that are expected to occur 1 year before or after the AyM construction period are included in the assessment. This therefore limits the CEA to projects that have impact pathways predicted to occur between 2025 and 2031 inclusive.

Table 48: Cumulative MDS for marine mammals.

POTENTIAL EFFECT	SCENARIO	JUSTIFICATION
Disturbance	Underwater noise produced by construction (piling and UXO clearance) and decommissioning activities in combination with ongoing seismic activities. Included in CEA: Only projects where construction or decommissioning periods are expected to overlap with or occur ±1 year either side of the construction activity at AyM.	Maximum potential for cumulative effects from underwater noise associated with offshore wind farm construction and decommissioning activities is considered within the relevant MU for each species. This spatial scale was chosen as a result of the spatial extent of noise related impacts as well as the high mobility of marine mammal receptors.
	Vessel activity during construction, O&M and decommissioning. Included in CEA: All projects that have vessel activity between 2025-2031 that wasn't included in the baseline.	Maximum potential for cumulative effects from the increased risk of disturbance from an increase in vessel activity is considered within the relevant MU for each species. This spatial scale was chosen as a result of the high mobility of marine mammal receptors.

7.13.1 Disturbance from underwater noise

289 Only projects within the relevant species MU, where construction or decommissioning periods are expected to overlap with or occurring ±1 year either side of the construction activity at AyM were screened into the CEA for disturbance from underwater noise. This therefore included all projects that are constructing or decommissioning between 2025-2031 inclusive (Table 50, Figure 28, and Table 51).

290 While the construction period for AyM covers a five-year period (Table 49), Year 1 (2026) is expected to be onshore construction activity only. Offshore construction work is not expected to commence until Year 2 (2027), and foundation installation activities (including UXO clearance and piling) could occur any time between 2027 and 2029 inclusive, but only for a 12-month period within that three-year window (expected indicative date is 2028). Therefore, the underwater noise impact from UXO and piling for AyM is limited to 2027-2029 inclusive (Table 49 and Table 51).

291 It has been conservatively assumed that pile driving and decommissioning activities can occur at any time during the construction or decommissioning phase identified for each Project.

292 Different OWF EIAs have assessed disturbance using a variety of thresholds and methods, including effective deterrence ranges, fixed noise thresholds and dose-response curves. This means that the predicted number of animals disturbed is not comparable between projects. In order to standardise the CEA approach, the assessment of disturbance from construction and decommissioning activities at OWF sites follows the advice provided in JNCC et al. (2020) where unabated pile driving of a monopile and clearance of a UXO is precited to have an effective deterrence range of 26 km for harbour porpoise. It is assumed that the impact of decommissioning is the same or lower than that of construction, and therefore in the absence of a recommended EDR for decommissioning activities, the 26 km EDR has also been assumed. In the absence of recommended EDRs for other species, this has been applied to all marine mammals.

293 In order to quantify the number of animals predicted to experience disturbance at each OWF project, the SCANS III density (Hammond et al. 2017) for the corresponding survey block has been applied for each cetacean species. For grey seals, the average at-sea density (Carter et al. 2020) within the corresponding OWF Project (+ 26 km buffer) has been used.

294 The potential number of seismic surveys that could be undertaken is unknown. Therefore, it has been assumed that one seismic survey is conducted in the Irish Sea at any one time, and four seismic surveys are conducted within the North Sea at any one time (to account for concurrent surveys in the northern and southern North Sea in both UK waters and those of neighbouring North Sea nations). It has been assumed that the EDR for seismic surveys is 12 km as per the advice provided in JNCC et al. (2020). It is considered that this approach is sufficiently precautionary (i.e. it is unlikely that this number of seismic surveys will be occurring concurrently, less so concurrently with AyM construction) to also account for any behavioural disturbance resulting from high-resolution geophysical site surveys (HRGS) within relevant regions (e.g. to support wind farm development). While the potential for behavioural disturbance from HRGS is poorly understood, it is acknowledged to be of a considerably lower magnitude than that of seismic survey (e.g. precautionary 5 km EDR suggested in JNCC et al. 2020).

295 To quantify the number of minke whales predicted to experience disturbance from seismic surveys in the Irish Sea, SCANS III block E density estimate was used (0.017 whales/km^2). To estimate the number of whales predicted to be disturbed from seismic surveys in the North Sea, the average density across the North Sea was calculated[xxii].

296 To quantify the number of grey seals predicted to be disturbed by seismic surveys in the Irish Sea, the average at-sea density (Carter et al. 2020) for the Irish Sea was calculated.

[xxii] SCANS III estimate of 8,900 minke whales in the North Sea / 575,000 km^2 = 0.015 whales/km^2

Table 49: Indicative construction schedule for AyM.

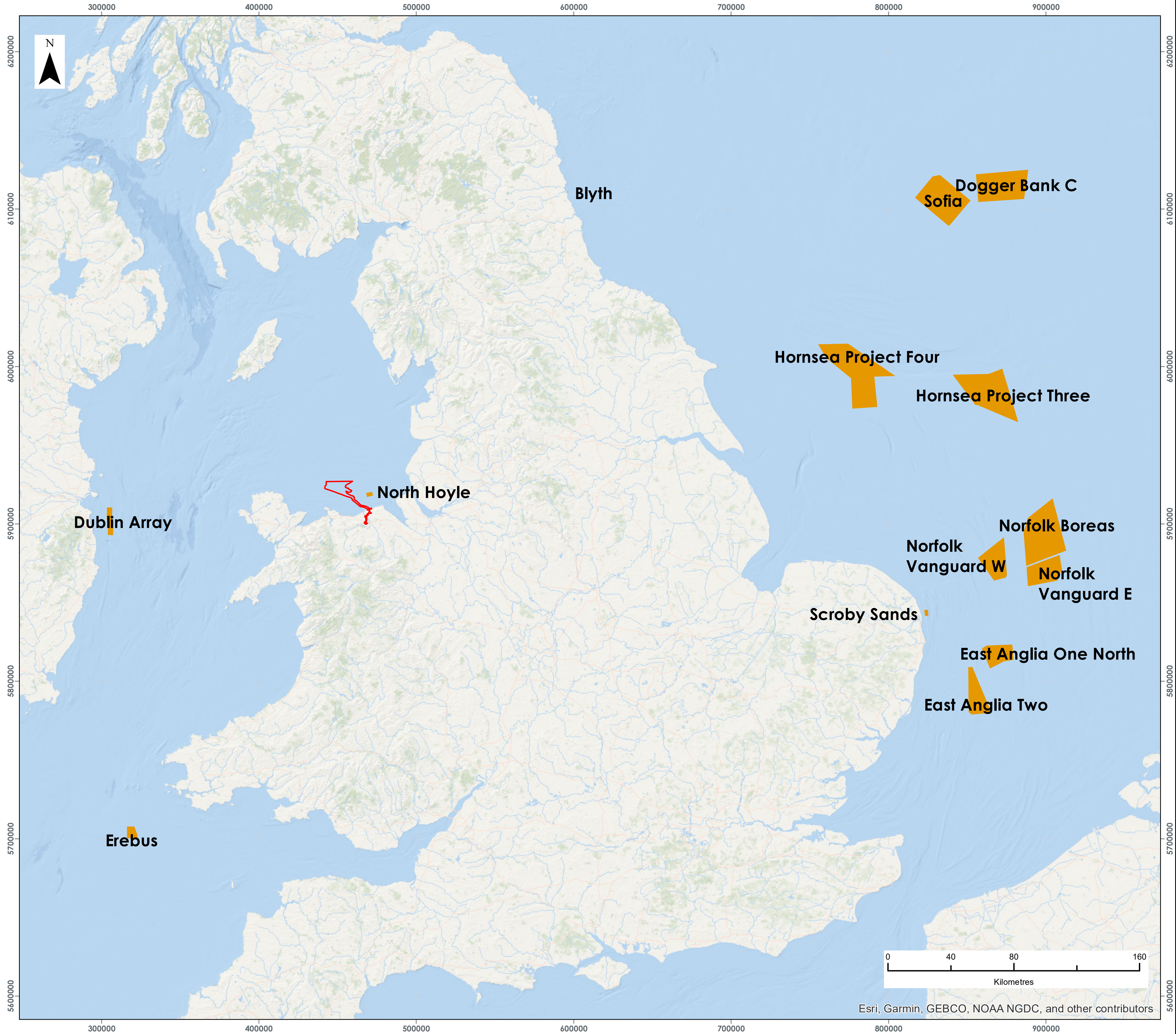
	2026				2027				2028				2029				2030			
ACTIVITY	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Onshore construction																				
Offshore substation installation & commissioning																				
Offshore export cable installation																				
Foundation installation																				
Array cable installation																				
Wind turbine installation																				
First generation																				
Offshore wind turbine and foundation commissioning																				
Commercial Operations																				

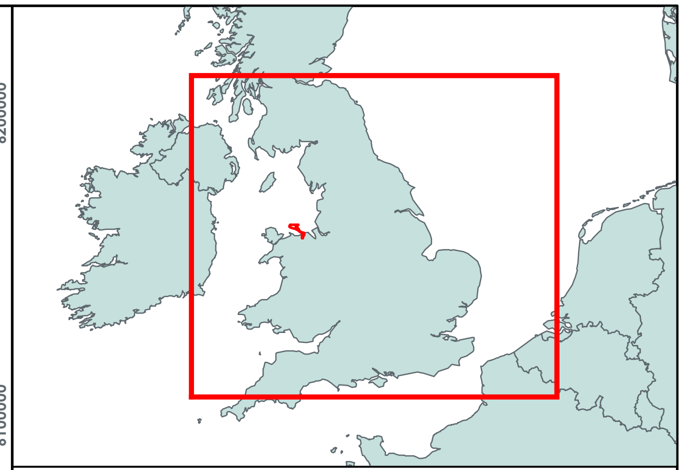
grey = potential date range for activity, aqua = indicative duration, dark teal = indicative date

Table 50: Projects considered within the marine mammal CEA for disturbance from underwater noise, including relevant species (according to Management Units).

TYPE	PROJECT	STATUS	DATA	TIER	IMPACT	HP	BD	GS	RD, CD & MW
OWF	North Hoyle	Operational	High	1	Decommissioning noise	Y	Y	Y	Y
OWF	Blyth	Operational	High	1	Decommissioning noise	N	N	N	Y
OWF	Hornsea Project Four	Application submitted	High	3	Construction noise	N	N	N	Y
OWF	Scroby Sands	Operational	High	1	Decommissioning noise	N	N	N	Y
OWF	Hornsea Project Three	Consented	High	2	Construction noise	N	N	N	Y
OWF	Sofia	Consented	High	1	Construction noise	N	N	N	Y
OWF	Norfolk Vanguard West	Consented	High	2	Construction noise	N	N	N	Y
OWF	East Anglia Two	Application submitted	High	3	Construction noise	N	N	N	Y
OWF	East Anglia One North	Application submitted	High	3	Construction noise	N	N	N	Y
OWF	Norfolk Boreas	Consented	High	2	Construction noise	N	N	N	Y

TYPE	PROJECT	STATUS	DATA	TIER	IMPACT	HP	BD	GS	RD, CD & MW
OWF	Norfolk Vanguard East	Consented	High	2	Construction noise	N	N	N	Y
OWF	Dogger Bank C	Consented	High	1	Construction noise	N	N	N	Y
OWF	Dublin Array	In-planning	Med	5	Construction noise	Y	Y	Y	Y
OWF	Erebus (floating)	Application submitted	High	3	Construction noise	Y	N	Y	Y
SS	Seismic survey Irish sea	Ongoing	Low	5	Survey noise	Y	Y	Y	Y
SS	Seismic survey North Sea	Ongoing	Low	5	Survey noise	N	N	N	Y





LEGEND

- Order Limits
- OWF Projects Considered

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Marine Mammal CEA
Underwater Noise Disturbance

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 28

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:2,500,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

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Table 51: OWF projects constructing or decommissioning at the same time as AyM is constructing (± 1 year), in addition to seismic surveys in the Irish Sea and the North Sea.

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NORFOLK VANGUARD W	NORFOLK VANGUARD E	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SEISMIC (IRISH SEA)	SEISIMIC (NORTH SEA)
Tier		1	1	3	1	2	1	2	2	3	3	2	1	5	3	5	
SCANS III	F	F	R	O	L	O	O/N	O/L	L	L	L	O/L	O	E	D	-	
2025				Of		Of	Of	Of	Of	Of	Of	Of	Of	Of		x1	x4
2026	On		De	Of		Of	Of	Of	Of		Of		Of		Of	x1	x4
2027	Of		De	Of		Of		Of	Of		Of					x1	x4
2028	Of			Of		Of		Of	Of							x1	x4
2029	Of	De		Of		Of										x1	x4
2030	Cm	De			De	Of										x1	x4

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NORFOLK VANGUARD W	NORFOLK VANGUARD E	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SEISMIC (IRISH SEA)	SEISIMIC (NORTH SEA)
2031					De	Of										x1	x4

On = onshore construction, Of= offshore construction, De = decommissioning, Cm = turbine and foundation commissioning

Harbour porpoise

297 The only OWF projects in the Celtic and Irish Seas MU that are predicted to have a cumulative effect on harbour porpoise alongside AyM are decommissioning activities at North Hoyle, and construction activities at Dublin Array, alongside ongoing seismic surveys in the Irish Sea. The JCP Data Tool density estimate of 0.13 porpoise/km^2 was used to quantify the number of porpoise potentially disturbed at AyM and North Hoyle (as this was the higher than the SCANS III density estimate for the relevant survey block), while the SCANS III density estimate of 0.239 porpoise/km^2 was used to quantify the number of porpoise potentially disturbed at Dublin Array (different SCANS III survey block) and by ongoing seismic surveys in the Irish Sea (conservative to use higher density estimate of the two SCANS III survey blocks in the Irish Sea). The maximum number of animals predicted to be disturbed on any one day occurs when construction activities at AyM overlap with decommissioning activities at North Hoyle and ongoing seismic activity in the Irish Sea, resulting in up to 659 porpoise potentially disturbed (1.1% MU) (Table 52). Given the low number of porpoise predicted to be impacted, this is considered to be a **low** adverse magnitude.

298 As outlined in section 7.5.2, disturbance may temporarily affect harbour porpoise fertility and the probability of calf survival. Due to observed responsiveness to underwater noise, harbour porpoise are considered to have a **low** sensitivity to disturbance form low-frequency impulsive underwater noise.

299 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the CEA for disturbance from underwater noise to harbour porpoise is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 52: Number of harbour porpoise disturbed (per day of impact) for OWF projects constructing or decommissioning and ongoing seismic surveys at the same time as AyM is constructing (± 1 year).

	AYM	NORTH HOYLE	DUBLIN ARRAY	EREBUS	SEISMIC (IRISH SEA X1)	TOTAL	%MU
DENSITY	0.13‡	0.13‡	0.239*	0.118*	0.239*		
2025			508		108	616	1.0%
2026				251	108	359	0.6%
2027	275				108	383	0.6%
2028	275				108	383	0.6%
2029	275	276			108	659	1.1%
2030		276			108	384	0.6%
2031					108	108	0.2%

‡ JCP Data Tool density estimate

* SCANS III

Bottlenose dolphin

300 The only OWF projects in the Irish Sea MU that are predicted to have a cumulative effect on bottlenose dolphins alongside AyM are decommissioning of North Hoyle, and construction of Dublin Array, alongside ongoing seismic surveys in the Irish Sea. The SCANS III density estimate of 0.008 dolphins/km^2 was used to quantify the number of bottlenose dolphins potentially disturbed. In terms of the number of animals disturbed, this simple EDR approach was considered to be comparable to the more complex assessment for AyM alone (paragraph 151 et. seq.): the assumption of 100% disturbance within the EDR of 26 km resulted in a similar number of animals predicted to be disturbed (n=17) as was predicted to experience behavioural disturbance from the AyM assessment of pile driving using a dose-response curve and the assumed dolphin density surface (n=23 for the installation of a monopile at the NW location).

301 The maximum number of animals predicted to be disturbed on any one day occurs when construction activities at AyM overlap with decommissioning activities at North Hoyle and ongoing seismic activity in the Irish Sea, resulting in up to 44 dolphins potentially disturbed (14.9% MU) (Table 53). Given the number of dolphins predicted to be impacted, this is assessed as a high magnitude. However, this is considered to be an overestimate as it is highly unlikely that pile driving activities at AyM would actually overlap temporally with decommissioning activities at North Hoyle.

302 While the CEA has conservatively assumed AyM construction activities between 2027 to 2019, in reality the piling of foundations is expected to occur in a 12-month period (likely in 2028) with UXO clearance sometime in the year prior to piling, and thus is likely that the piling activities will be complete before the decommissioning activities at North Hoyle commence. In addition, the assumption of an EDR of 26 km from decommissioning activities is highly precautionary. It is expected that most decommissioning work would involve cutting techniques such as diamond wire cutting, which is highly unlikely to disturb any species of marine mammal (Panjerc et al. 2016). Furthermore, an EDR of 26 km relates to guidance for harbour porpoise (JNCC et al. 2020), which are known to show a greater extent of behavioural disturbance to impulsive underwater noise than bottlenose dolphins. Taking these overestimates and precautions into account, it is more likely that the cumulative impact is of **medium** adverse magnitude.

303 As outlined in section 7.5.3, disturbance from underwater noise may result in disturbance to bottlenose dolphins at a small spatial and temporal scale, and as such, they are considered to have a **low** sensitivity to disturbance from low-frequency impulsive underwater noise.

304 The magnitude of the impact has been assessed as **medium** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the CEA for disturbance from underwater noise to bottlenose dolphins is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 53: Number of bottlenose dolphins disturbed (per day of impact) for OWF projects under construction or decommissioning and ongoing seismic surveys at the same time as AyM is under construction (± 1 year).

	AYM	NORTH HOYLE	DUBLIN ARRAY	SEISMIC (IRISH SEA X1)	TOTAL	% MU
DENSITY		0.008*	0.008*	0.008*		
2025			17	4	21	7.0%
2026				4	4	1.2%
2027	23			4	27	9.1%
2028	23			4	27	9.1%
2029	23	17		4	44	14.9%
2030		17		4	21	7.0%
2031				4	4	1.2%

* No bottlenose dolphin density for SCANS III Block F. Used adjacent Block E.

Risso's dolphin

305 Most of the OWF projects screened into the CEA for Risso's dolphins are in the North Sea, where the SCANS III density estimate was 0.0 dolphins/km^2 (blocks R, O, L and N). Therefore, even though these North Sea projects are screened in, as they are within the Celtic and Greater North Sea MU, they are predicted to have no cumulative impact on the Risso's dolphin MU. Therefore, the only OWF projects that are predicted to have a cumulative effect alongside AyM are decommissioning of North Hoyle and construction of Dublin Array, alongside ongoing seismic surveys in the Irish Sea. The maximum number of animals predicted to be disturbed on any one day occurs when construction activities at AyM overlap with decommissioning activities at North Hoyle and ongoing seismic activity in the Irish Sea, resulting in up to 145 dolphins potentially disturbed (1.2% MU) (Table 54). Given the number of dolphins predicted to be impacted, this is considered to be a **medium** adverse magnitude.

306 As outlined in section 7.5.3, there is no evidence on the sensitivity of Risso's dolphins to disturbance from underwater noise. Risso's dolphins are categorised as being in the high-frequency cetacean hearing group (Southall et al. 2019) along with bottlenose dolphins; therefore, it is considered appropriate, given the lack of species-specific data, to use bottlenose dolphins as a proxy. Therefore, Risso's dolphins are considered to have a **low** sensitivity to disturbance from low-frequency impulsive underwater noise.

307 The magnitude of the impact has been assessed as **medium** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the CEA for disturbance from underwater noise to Risso's dolphins is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Common dolphin

308 Most of the OWF projects screened into the CEA for common dolphins are in the North Sea, where the SCANS III density estimate was 0.0 dolphins/km^2 (blocks R, O, L and N). Therefore, even though these North Sea projects are screened in, as they are within the Celtic and Greater North Sea MU, they are predicted to have no cumulative impact on the common dolphin MU. Therefore, the only OWF projects that are predicted to have a cumulative effect alongside AyM are decommissioning of North Hoyle and construction of Dublin Array and Erebus, alongside ongoing seismic surveys in the Irish Sea. The maximum number of animals predicted to be disturbed on any one day occurs prior to the construction of AyM, when construction activities at Erebus overlaps with seismic surveys in the the Irsiah Sea, resulting in precited impact to 799 common dolphins (1.2% MU) (Table 55). Given the number of dolphins predicted to be impacted, this is considered to be a **low** adverse magnitude.

Minke whale

309 The maximum number of animals predicted to be disturbed on any one day occurs when construction activities at Hornsea Project Four, Hornsea Project Three, Sofia, Norfolk Vanguard West, Dogger Bank C, Erebus, ongoing seismic surveys in both the Irish Sea and the North Sea and decommissioning activities at Blyth, resulting in up to 269 minke whales potentially disturbed (1.3% MU) (Table 56). Given the number of whales predicted to be impacted, this is considered to be a **medium** adverse magnitude. However, it is worth noting that this is considered to be an overestimate since it is extremely unlikely that all of these activities would occur on the same day.

310 As outlined in section 7.5.4, there is a lack of evidence of strong behavioural responses of minke whales to piling noise. Given the limited data that is available on minke whale responses to vessel and sonar signals, they are considered to have a **low** sensitivity to disturbance from low-frequency impulsive underwater noise.

311 The magnitude of the impact has been assessed as **medium** adverse and the sensitivity of receptors as **low**. Therefore, the significance of the CEA for disturbance from underwater noise to minke whales is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 54: Number of Risso's dolphins disturbed (per day of impact) for OWF projects constructing or decommissioning and ongoing seismic surveys at the same time as AyM is constructing (± 1 year).

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NVG W	NVG E	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SS (IRISH SEA X1)	SS (NORTH SEA X4)	TOTAL PER DAY	% MU
Density	0.031*	0.031*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.031	0.00	0.031	0.00		
2025				0		0	0	0	0	0	0	0	0	66		14	0	80	0.7%
2026			0	0		0	0	0	0		0		0		0	14	0	14	0.1%
2027	65		0	0		0		0	0		0					14	0	79	0.6%
2028	65			0		0		0	0							14	0	79	0.6%
2029	65	66		0		0										14	0	145	1.2%
2030		66			0	0										14	0	80	0.7%
2031					0	0										14	0	14	0.1%

* No Risso's dolphin density for SCANS III Block F. Used adjacent Block E density as per AyM assessment

Table 55: Number of common dolphins disturbed (per day of impact) for OWF projects constructing or decommissioning and ongoing seismic surveys at the same time as AyM is constructing (± 1 year).

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NVG W	NVG E	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SS (IRISH SEA X1)	SS (NORTH SEA X4)	TOTAL PER DAY	% MU
Density	0.0081	0.0081	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0081	0.3743	0.0081	0.00		
2025				0		0	0	0	0	0	0	0	0	17		4	0	21	0.0%

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NVG W	NVG E	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SS (IRISH SEA X1)	SS (NORTH SEA X4)	TOTAL PER DAY	% MU
2026			0	0		0	0	0	0		0		0		795	4	0	799	1.2%
2027	17		0	0		0		0	0		0					4	0	21	0.0%
2028	17			0		0		0	0							4	0	21	0.0%
2029	17	17		0		0										4	0	38	0.1%
2030		17			0	0										4	0	21	0.0%
2031					0	0										4	0	4	0.0%

Table 56: Number of minke whales disturbed (per day of impact) for OWF projects constructing or decommissioning and ongoing seismic surveys at the same time as AyM is constructing (± 1 year).

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NVG W	NVGE	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SS (IRISH SEA X1)	SS NORTH SEA X4)	TOTAL PER DAY	% MU
Density	0.017*	0.017*	0.039	0.01	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.017	0.0112	0.017	0.015*		
2025				21		21	42	21	0	0	0	21	21	36		8	27	220	1.1%
2026			83	21		21	42	21	0		0		21		24	8	27	269	1.3%
2027	36		83	21		21		21	0		0					8	27	217	1.1%
2028	36			21		21		21	0							8	27	135	0.7%
2029	36	36		21		21										8	27	150	0.7%

	AYM	NORTH HOYLE	BLYTH	HORNSEA 4	SCROBY SANDS	HORNSEA 3	SOFIA	NVG W	NVGE	EAST ANGLIA 2	EAST ANGLIA 1N	NORFOLK BOREAS	DOGGER BANK C	DUBLIN ARRAY	EREBUS	SS (IRISH SEA X1)	SS (NORTH SEA X4)	TOTAL PER DAY	% MU
2030		36			0	21										8	27	128	0.6%
2031					0	21										8	27	56	0.3%

* No minke whale density for SCANS III Block F. Used adjacent Block E density.
* Average minke whale density in the North Sea (SCANS III estimate of 8,900 / 575,000 km2)

Grey seal

312 The only OWF projects in the MU that are predicted to have a cumulative effect on grey seals alongside AyM are decommissioning activities at North Hoyle, and construction activities at Dublin Array and Erebus, alongside ongoing seismic surveys in the Irish Sea. The maximum number of animals predicted to be disturbed on any one day occurs when construction activities at AyM overlap with decommissioning activities at North Hoyle and ongoing seismic activities in the Irish Sea, resulting in up to 1,593 grey seals potentially disturbed (2.4% MU) (Table 57).

313 However, as outlined above for bottlenose dolphins, this is considered to be an overestimate as it is highly unlikely that pile driving activities at AyM would actually overlap temporally with decommissioning activities at North Hoyle. In addition, the assumption of an EDR of 26 km from decommissioning activities is highly precautionary. The EDR of 26 km was recommended for harbour porpoise, which is considerably more sensitive to underwater noise and disturbance than grey seals (Booth et al. 2019). Using the seal dose-response curve to estimate the number of grey seals potentially disturbed by piling activities at AyM, only 81 grey seals are predicted to be impacted, which is considerably less than the estimate obtained using the EDR approach (913). Therefore, it is realistic to assume that the number of grey seals predicted to be disturbed at North Hoyle is also a vast overestimate using the 26 km EDR method. Given the proximity of North Hoyle to AyM it is expected that the number of grey seals predicted to be disturbed by decommissioning activities at North Hoyle would be similar to the number predicted for construction activities at AyM, and thus in reality it is more likely that <100 grey seals would be impacted by decommissioning activities at North Hoyle. This more realistic assumption of impact is considered to be of **medium** adverse magnitude.

314 As outlined in section 7.5.5, grey seals are considered to have a **negligible** sensitivity to disturbance from underwater noise.

315 The magnitude of the impact has been assessed as **medium** adverse and the sensitivity of receptors as **negligible**. Therefore, the significance of the CEA for disturbance from underwater noise to grey seals is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

Table 57: Number of grey seals disturbed (per day of impact) for OWF projects under construction or decommissioning and ongoing seismic surveys at the same time as AyM is under construction (± 1 year).

	AYM	NORTH HOYLE	DUBLIN ARRAY	EREBUS	SS IRISH SEA X1	TOTAL	% MU
Density		0.68	0.26		0.15		
2025			552		68	620	0.9%
2026				87	68	155	0.2%
2027	81				68	149	0.2%
2028	81				68	149	0.2%
2029	81	1444			68	1593	2.4%
2030		1444			68	1512	2.3%
2031					68	68	0.1%

316 In conclusion, the CEA for disturbance from underwater noise to all marine mammal receptors is to be of ***negligible adverse significance*** to ***minor adverse significance***, which is not significant in terms of the EIA regulations.

7.13.2 Disturbance from vessel activity

317 This CEA considers the effects of increased vessel noise causing disturbance to marine mammals, due to the potential increase in vessel movements from the construction of AyM alongside expected vessel activity for other planned or existing projects, plans and activities.

318 Most projects were screened out of assessment of disturbance from vessels for the following reasons:

- Project was operational during the baseline,

- Project was under construction during the baseline (assumed that vessel levels would be lower during the O&M phase and as such the worst case had been included already), and
- No timeline data available for the project.

319 **Bottlenose dolphin:** The list of projects screened into the assessment of disturbance from vessels are almost all located in the North Sea, and therefore are not within the relevant MU for bottlenose dolphins (Table 58). Most of the projects that are relevant for these species (Dublin Array, Arklow Bank phase 2 and WestWave demo) are Tier 5 projects that have submitted a Scoping Report but where no other data are available upon which to base a quantitative assessment. Therefore, it is not possible to conduct a quantitative cumulative impact for these species from vessel disturbance at these projects.

320 **Harbour porpoise & grey seal**: The list of projects screened into the assessment of disturbance from vessels are almost all located in the North Sea, and therefore are not within the relevant MUs for harbour porpoise or grey seals (Table 58). Most of the projects that are relevant for these species (Dublin Array, Arklow Bank phase 2 and WestWave demo) are Tier 5 projects that have submitted a Scoping Report but where no other data are available upon which to base a quantitative assessment. Therefore, it is not possible to conduct a quantitative cumulative impact for these species from vessel disturbance at these projects. Project Erebus is the only development for which vessel information is available, and vessel activity at this project is exected to be low (maximum of 6 vessels on site at any one time during construction). The magnitude of the impact has been assessed as **negligible** adverse.

321 **Risso's dolphin, common dolphin & minke whale**: The list of projects included in the assessment of disturbance from vessels are almost all located in the North Sea, however, given that the relevant MUs for Risso's dolphins, common dolphins and minke whales is the Celtic and Greater North Seas, these Projects are screened in for these two species (Table 58). Table 59 presents the quantitative information that is available for all projects screened into the CEA for vessel disturbance, covering the construction and/or O&M phase vessel types, numbers and movements expected for each project.

322 It is extremely difficult to quantify reliably the level of increased noise-related disturbance to marine mammals resulting from increased vessel activity on a cumulative basis given the large degree of temporal and spatial variation in vessel movements between projects and regions, coupled with the spatial and temporal variation in marine mammal movements across the region. Vessel routes to and from offshore windfarms and other projects will use existing vessel routes where marine mammals will be accustomed to, and potentially habituated to regular vessel movements and therefore the additional risk is confined mainly to construction sites. Vessel movements within construction areas are likely to be limited and relatively slow. In addition, most projects are likely to adopt vessel management plans or follow best practice guidance in order to minimise any potential effects on marine mammals. Therefore, increases in underwater noise from vessels from offshore energy projects are likely to be small in relation to current and ongoing levels of shipping.

323 **Risso's dolphin**: The cumulative impact of increased underwater noise from vessels is predicted to be of local spatial extent, long term duration (vessel presence expected throughout the lifespan of a windfarm), intermittent (vessel activity will not be constant) and reversible (disturbance effects are temporary). However, given that the projects included quantitatively here are all located in the North Sea, where Risso's dolphins are expected to be virtually absent, the impact is predicted to be of **negligible** adverse magnitude.

324 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **low** (section 7.5.7). Therefore, the significance of the CEA for disturbance from vessel noise to Risso's dolphins is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

325 **Common dolphin**: The cumulative impact of increased underwater noise from vessels is predicted to be of local spatial extent, long term duration (vessel presence expected throughout the lifespan of a windfarm), intermittent (vessel activity will not be constant) and reversible (disturbance effects are temporary). However, given that the projects included quantitatively here are all located in the North Sea, where common dolphins are expected to be virtually absent, the impact is predicted to be of **negligible** adverse magnitude.

326 The magnitude of the impact has been assessed as **negligible** adverse and the sensitivity of receptors as **low** (section 7.5.7). Therefore, the significance of the CEA for disturbance from vessel noise to common dolphins is concluded to be of ***negligible adverse significance***, which is not significant in terms of the EIA regulations.

327 **Minke whale**: The cumulative impact of increased underwater noise from vessels is predicted to be of local spatial extent, long term duration (vessel presence expected throughout the lifespan of a windfarm), intermittent (vessel activity will not be constant) and reversible (disturbance effects are temporary). The low level of predicted additional disturbance is not expected to have a significant effect on the trajectory of the minke whale population. It is therefore predicted that the impact will be of **low** adverse magnitude.

328 The magnitude of the impact has been assessed as **low** adverse and the sensitivity of receptors as **low** (section 7.5.8). Therefore, the significance of the CEA for disturbance from vessel noise to minke whales is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

Table 58: Projects considered within the marine mammal CEA for disturbance from vessel activity.

TYPE	PROJECT	STATUS	DATA	TIER	VESSEL IMPACT	HP	BD	GS	RD, CD & MW
OWF	Hornsea Project Four	Application submitted	High	3	Construction & O&M	N	N	N	Y
OWF	Dogger Bank B	Consented	High	1	O&M	N	N	N	Y
OWF	Dogger Bank A	Consented	High	1	O&M	N	N	N	Y
OWF	Hornsea Project Three	Consented	High	2	Construction	N	N	N	Y
OWF	Sofia	Consented	High	1	Construction & O&M	N	N	N	Y
OWF	Norfolk Vanguard West	Consented	High	2	Construction & O&M	N	N	N	Y
OWF	East Anglia Two	Application submitted	High	3	Construction & O&M	N	N	N	Y
OWF	East Anglia One North	Application submitted	High	3	Construction & O&M	N	N	N	Y
OWF	Norfolk Boreas	Consented	High	2	Construction & O&M	N	N	N	Y
OWF	Norfolk Vanguard East	Consented	High	2	Construction & O&M	N	N	N	Y
OWF	East Anglia Three	Consented	High	1	O&M	N	N	N	Y

TYPE	PROJECT	STATUS	DATA	TIER	VESSEL IMPACT	HP	BD	GS	RD, CD & MW
OWF	Dogger Bank C	Consented	High	1	Construction & O&M	N	N	N	Y
OWF	Dublin Array	In-planning	Low	5	Construction & O&M	Y	Y	Y	Y
OWF	Erebus	Application submitted	High	3	Construction & O&M	Y	N	Y	Y
OWF	Arklow Bank Phase 2	In-planning	Low	5	O&M	Y	Y	Y	Y
OWF	WestWave Demo	In development	Med	2	O&M	Y	N	Y	Y

OWF = offshore windfarm, O&M = operational and maintenance, HP = harbour porpoise, BD = bottlenose dolphin, GS = grey seal, RD = Risso's dolphin, MW = minke whale, Y/N denotes whether a project is within the species MU

Table 59: Level of vessel activity anticipated for each project included in the marine mammal CEA.

PROJECT	CONSTRUCTION VESSELS			O&M VESSELS			NOTES
	TYPE	#	ROUND TRIPS	TYPE	#	ROUND TRIPS	
Hornsea Project Four	Installation	10	240	Supply vessels & other vessels for visits to wind turbine, turbine foundations, platform visits, jack-up and crew transfer	N/S	2580 for WTG	Turbine Foundation - 12 months Turbine - 24 months Substation foundation - 12 months Substation - 12 months
	Support	79	2122			780 for foundation	
	Transport/feeder	72	1020			65 for platform - Structural	

PROJECT	CONSTRUCTION VESSELS			O&M VESSELS			NOTES
	TYPE	#	ROUND TRIPS	TYPE	#	ROUND TRIPS	
	Main laying	6	300			100 for platform - Electrical	IAC & OIC - 24 months OEC - 24 months
	Main burying	6	300			260 crew shift transfer	
	Main jointing	3	72			124 jack-up visits	
	TOTAL	176	4054	TOTAL	N/S	3909	
Dogger Bank B	Construction screened out			Large O&M	3	50	Max. 28 vessels on site at any time
				Small O&M	13	440	
				Lift	2	40	
				Cable maintenance	2	3	
				Auxiliary	8	150	
				TOTAL	28	683	
Dogger Bank A	Construction screened out			Large O&M	3	50	Max. 28 vessels on site at any time
				Small O&M	13	440	
				Lift	2	40	
				Cable maintenance	2	3	
				Auxiliary	8	150	
				TOTAL	28	683	
Hornsea Project Three	Installation	9	638	O&M screened out			Up to 8 vessels in 5 km² area at any time
	Support (crew boats, SOVs, service, diver & PLGR & dredging)	79	6888				
	Transport	20	2138				
	Main laying (barge & tug)	7	495				
	Main burying	7	495				
	Main jointing	4	120				
	TOTAL	126	10,774				
Sofia				Large O&M	3	40	

PROJECT	CONSTRUCTION VESSELS			O&M VESSELS			NOTES
	TYPE	#	ROUND TRIPS	TYPE	#	ROUND TRIPS	
	Large & medium crane; Floating & dynamic positioning & jack up; Transport & feeder; Tugs & anchor handling; Hotel & accommodation; Personnel transfer; Dredging; Seabed preparation & aggregate handling; Diving support; General offshore & subsea construction; Cable installation & maintenance; Survey		Construction vessel: 5150 Materials transport vessel: 660 For the full construction period	Small O&M	11	430	Max 66 vessels offshore during construction per project (peak in year 2) Max 26 vessels on site at any time during O&M
				Lift	2	40	
				Cable maintenance	2	10	
				Auxiliary	8	210	
				Service	2	52	
				Support	11	4015	
	TOTAL	396	5810	TOTAL	39	4015	
Dogger Bank C	Large & medium crane; Floating & dynamic positioning & jack up; Transport & feeder; Tugs & anchor handling; Hotel & accommodation; Personnel transfer; Dredging; Seabed preparation & aggregate handling; Diving support; General offshore & subsea construction; Cable installation & maintenance; Survey		Construction vessel: 5150 Materials transport vessel: 660 For the full construction period	Large O&M	3	40	Max 66 vessels offshore during construction per project (peak in year 2) Max 26 vessels on site at any time during O&M
				Small O&M	11	430	
				Lift	2	40	
				Cable maintenance	2	10	
				Auxiliary	8	210	
				Service	2	52	
				Support	11	4015	
	TOTAL	396		TOTAL	39	4015	

PROJECT	CONSTRUCTION VESSELS			O&M VESSELS			NOTES
	TYPE	#	ROUND TRIPS	TYPE	#	ROUND TRIPS	
East Anglia Two	Dredging; Tugs & storage barges; Jack-up; Dynamic Position (DP) Heavy Lift (HLV); Support; Platform installation; Accommodation; Windfarm service; Supply; Inter-array cable laying; Export cable laying; Export cable support; Pre-trenching /backfilling; Cable jetting & survey; Workboats.		average 1632 per year and 136 per month	Assumed similar or less than construction phase			Max. 74 vessels on site at any one time (including max 3 IAC vessels and 5 EC vessels) No total for overall vessels given Approx. 27-month construction period
	TOTAL		3672	TOTAL		3672	
East Anglia One North	Dredging; Tugs & storage barges; Jack-up; Dynamic Position (DP) Heavy Lift (HLV); Support; Platform installation; Accommodation; Windfarm service; Supply; Inter-array cable laying; Export cable laying; Export cable support; Pre-trenching /backfilling; Cable jetting & survey; Workboats.		average 1488 per year, 124 per month	Support	NS	687	Max. 74 vessels on site at any one time (including max 3 IAC vessels and 5 EC vessels) No total for overall vessels given Approx. 27-month construction period
	TOTAL		3335	TOTAL		687	
Norfolk Boreas	Seabed preparation, including dredging, Tugs and barges, Jack-up, Dynamic Position Heavy Lift Vessel, Scour, Substation / collector station installation, Array cable laying, Export cable laying, Landfall cable installation, Pre-trenching / backfilling, Cable jetting and			Support	NS	687	Max 57 vessel on site at any time; Approx. 36 vessels per month during the 36-month construction period for single phase development or approximately

PROJECT	CONSTRUCTION VESSELS			O&M VESSELS			NOTES
	TYPE	#	ROUND TRIPS	TYPE	#	ROUND TRIPS	
	survey, Filter layer, Commissioning, Crew transfer, Support and service, Accommodation, WTG installation, Other.						33 vessels per month during 39-month construction period for two phase development.
	TOTAL		1296	TOTAL		445	
Norfolk Vanguard East & West	Seabed preparation; Transition piece installation; Scour Installation; Foundations; WTG installation; Commissioning; Accommodation; Inter-array cable laying; Export cable laying; Landfall cable installation; Substation / collector station installation; Other.			Support	NS	440	
	TOTAL		1180 (590 x 2 phase)	TOTAL		440	
East Anglia Three	Construction screened out			Service	2	52	
				WTG support	11	4015	
				TOTAL	13	4067	
Erebus	Max 6 vessels offshore at any one time			Min 2 vessel visits per turbine per year Max 12 vessel visits per turbine per year			
Dublin Array	No data available						
Arklow Bank Phase 2	No data available						
West Wave Demo	No data available						

7.14 Inter-relationships

329 Inter-relationships are considered to be the 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 project (construction, O&M and decommissioning); to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project stages (e.g. subsea noise effects from piling, operational WTGs, vessels and decommissioning); and
- 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 benthic ecology such as direct habitat loss or disturbance, sediment plumes, scour, jack up vessel use etc., may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects might be short-term, temporary or transient effects, or incorporate longer term effects.

330 A description of the likely inter-related effects arising from AyM on marine mammal ecology provided in Volume 2, Chapter 14: Inter-relationships, with a summary of assessed inter-relationships provided below:

- Collision risk from vessel activity in the area (sections 7.11.2 and 7.12.2;
- Disturbance from vessel activity (sections 7.10.8, 7.11.3 and 7.12.3);
- Changes to water quality (sections 7.10.9, 7.11.4 and 7.12.4); and
- Changes to marine mammal prey species (sections 7.10.10, 7.11.5 and 7.12.5).

331 The impact of inter-relationships between marine mammals and vessel disturbance has been assessed as ***negligible adverse significance*** to ***minor adverse significance***. The impact of inter-relationships between marine mammals and collision risk, changes to water quality and prey species has been assessed as not significant. Overall, no inter-relationships have been identified where an accumulation of residual impacts on marine mammals and the relationship between those impacts gives rise to a need for additional mitigation beyond the embedded mitigation already considered.

7.15 Transboundary effects

332 Transboundary effects are defined as those effects upon the receiving environment of other European Economic Area (EEA) states, whether occurring from AyM alone, or cumulatively with other projects in the wider area.

333 There may be behavioural disturbance or displacement of marine mammals from the AyM site as a result of underwater noise. Behavioural disturbance resulting from underwater noise during construction could occur over large ranges (tens of kilometres) and therefore there is the potential for transboundary effects to occur where subsea noise arising from AyM could extend into waters of other EEA states. AyM OWF is located in close proximity to other states (e.g. Irish waters and Manx waters) and therefore there is the potential for transit of certain species between areas.

334 The mobile nature of marine mammals also results in the potential for transboundary effects to occur. Whilst each species has been assessed within the relevant MU for the AyM array, the MUs under which each species has been assessed varies greatly in the area covered, with the MUs for Risso's dolphin and minke whale covering the 'Celtic and Greater North Sea' area. Furthermore, the respective MUs do not represent closed populations. This means that impacts, whilst localised, could potentially affect other MUs if mixing between the assessed populations occurs.

335 Any transboundary impacts that do occur as a result of AyM are predicted to be short-term and intermittent, with the recovery of marine mammal populations to affected areas following the completion of construction activities.

336 The magnitude of the impact has been assessed as **negligible** adverse to **low** adverse and the sensitivity of receptors as **negligible** to **low**. Therefore, the significance of behavioural disturbance leading to transboundary effects is concluded to be of ***minor adverse significance***, which is not significant in terms of the EIA regulations.

7.16 Summary of effects

337 This chapter has assessed the potential effects on marine mammal receptors arising from AyM. The impacts considered include direct impacts (e.g. disturbance from piling), as well as indirect impacts (e.g. change in prey species abundance), alongside cumulative impacts (e.g. underwater noise from various offshore energy developments within the species MU). Potential impacts considered in this chapter, alongside any mitigation and residual effects are summarised in Table 60.

338 Throughout the construction, operation and decommissioning phases of AyM, all impacts assessed were found to have either negligible, or minor effects on all marine mammal receptors and thus no impact pathway was considered to be significant in regard of the EIA Regulations.

339 The assessment of cumulative impacts from AyM and other developments and activities concluded that the effects of any cumulative impacts would be of minor significance at the most, and thus no cumulative impact pathway was considered to be significant in regard of the EIA Regulations.

Table 60: Summary of effects (HP = harbour porpoise, BND = bottlenose dolphin, CD = common dolphin, RD = Risso's dolphin, MW = minke whale, GS = grey seal).

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY	MITIGATION	RESIDUAL
Construction					
PTS from piling	HP	Negligible	Low	None beyond embedded mitigation (piling MMMP)	Negligible adverse significance
	BND	Negligible	Medium		Minor adverse significance
	CD	Negligible	Medium		Minor adverse significance
	RD	Negligible	Medium		Minor adverse significance
	MW	Negligible	Low		Negligible adverse significance
	GS	Negligible	Low		Negligible adverse significance
Disturbance from piling	HP	Low-Medium	Low	None beyond embedded mitigation (piling MMMP)	Minor adverse significance
	BND	Medium	Low		Minor adverse significance
	CD	Low	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Low	Negligible		Negligible adverse significance
Disturbance from other construction activities	HP	Low	Low	None	Minor adverse significance
	BND	Low	Low		Minor adverse significance
	CD	Low	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Low	Negligible		Negligible adverse significance
PTS from UXO	HP	Negligible	Low	None beyond embedded mitigation (UXO MMMP)	Negligible adverse significance
	BND	Negligible	Medium		Minor adverse significance
	CD	Negligible	Medium		Minor adverse significance
	RD	Negligible	Medium		Minor adverse significance
	MW	Negligible	Low		Negligible adverse significance
	GS	Negligible	Low		Negligible adverse significance

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY	MITIGATION	RESIDUAL
Disturbance from UXO	HP	Low	Low	None beyond embedded mitigation (UXO MMMP)	Minor adverse significance
	BND	Low	Low		Minor adverse significance
	CD	Low	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Low	Negligible		Negligible adverse significance
Collision risk from vessels	All	Negligible	High	None beyond embedded mitigation (vessel codes of conduct)	Minor adverse significance
Disturbance from vessels	HP	Low	Low	None beyond embedded mitigation (vessel codes of conduct)	Minor adverse significance
	BND	Low	Low		Minor adverse significance
	CD	Low	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Low	Negligible		Negligible adverse significance
Change in water quality	All	Negligible	Negligible	None	Negligible adverse significance
Change in fish abundance/ distribution	All	Negligible	Low	None	Negligible adverse significance
Operation					
Barrier effects	All	Negligible	Negligible	None	Negligible adverse significance
Collision risk from vessels	All	Negligible	High	None beyond embedded mitigation (vessel codes of conduct)	Minor adverse significance
	HP	Low	Low		Minor adverse significance

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY	MITIGATION	RESIDUAL
Disturbance from vessels	BND	Low	Low	None beyond embedded mitigation (vessel codes of conduct)	Minor adverse significance
	CD	Low	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Low	Negligible		Negligible adverse significance
Change in water quality	All	No impact pathway			
Change in fish abundance/ distribution	All	Negligible	Low	None	Negligible adverse significance
Decommissioning					
PTS & disturbance	All	Assumed similar or lesser extent than piling			
Collision risk from vessels	All	Negligible	High	None beyond embedded mitigation (vessel codes of conduct)	Minor adverse significance
Disturbance from vessels	HP	Low	Low	None beyond embedded mitigation (vessel codes of conduct)	Minor adverse significance
	BND	Low	Low		Minor adverse significance
	CD	Low	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Low	Negligible		Negligible adverse significance
Change in water quality	All	Negligible	Negligible	None	Negligible adverse significance
Change in fish abundance/ distribution	All	Negligible	Low	None	Negligible adverse significance
Cumulative effects					
	HP	Low	Low		Minor adverse significance

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY	MITIGATION	RESIDUAL
Disturbance from underwater noise	BND	Medium	Low	None beyond embedded mitigation (piling MMMP)	Minor adverse significance
	CD	Medium	Low		Minor adverse significance
	RD	Low	Low		Minor adverse significance
	MW	Medium	Low		Minor adverse significance
	GS	Medium	Neg		Negligible adverse significance
Disturbance from vessels	HP	Negligible	Low	None beyond embedded mitigation (vessel codes of conduct)	Negligible adverse significance
	BND	Screened out			Screened out
	CD	Negligible	Low		Negligible adverse significance
	RD	Negligible	Low		Negligible adverse significance
	MW	Low	Low		Minor adverse significance
	GS	Negligible	Low		Negligible adverse significance

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Errata List

Incorrect figures

In their RR (RR-015), NRW noted that where a series of figures are presented in the revised Marine Mammal chapter (AS-026), either incorrect figures were presented, or data layers were missing from the figure.

The Applicant notes that the figures were presented correctly in the original Marine Mammals chapter (APP-053) and confirms that no revisions to the figures were intended to be made to those presented in the revised chapter (AS-026). The intention of the revised Marine Mammals chapter (AS-026) was purely related to correcting the contents page.

For completeness, the correct figures are appended to this document in Appendix A, duplicated from the figures presented in APP-053:

- Figure 1: Figure incorrectly displayed a black background and omitted base mapping. Corrected figure provided in Appendix A of this document. Note this figure is identical to Figure 1 presented in APP-053.
- Figure 2: Figure incorrectly displayed a black background and omitted base mapping. Corrected figure provided in Appendix A of this document. Note this figure is identical to Figure 2 presented in APP-053.
- Figure 18: Figure incorrectly displayed a partial black background and omitted base mapping. Corrected figure provided in Appendix A of this document. Note this figure is identical to Figure 18 presented in APP-053.
- Figure 19: Figure missing from AS-026 with Figure 21 incorrectly presented in its place. Corrected figure provided in Appendix A of this document. Note this figure is identical to Figure 19 presented in APP-053.
- Figure 21: Figure incorrectly displayed a partial black background and omitted base mapping. Figure was incorrectly presented in place of Figure 18. Corrected figure provided in Appendix A of this document. Note this figure is identical to Figure 21 presented in APP-053.

Assessment of Permanent Threshold Shift (PTS)

In ExQ1.2.15, the ExA noted an error in paragraph 132 where the assessment for Permanent Threshold Shift (PTS)-onset from unmitigated pile driving for Bottlenose dolphin, Common dolphin and Risso's dolphin concludes medium significance. This is an error.

Paragraph 132 should instead read as follows: *"The magnitude of the impact has been assessed as negligible adverse and the sensitivity of receptors as medium. Therefore, the significance of the effect of PTS-onset from unmitigated pile driving for bottlenose, common and Risso's dolphins is concluded to be of Minor adverse significance, which is not significant in terms of the EIA regulations."*.

Indicative Construction programme

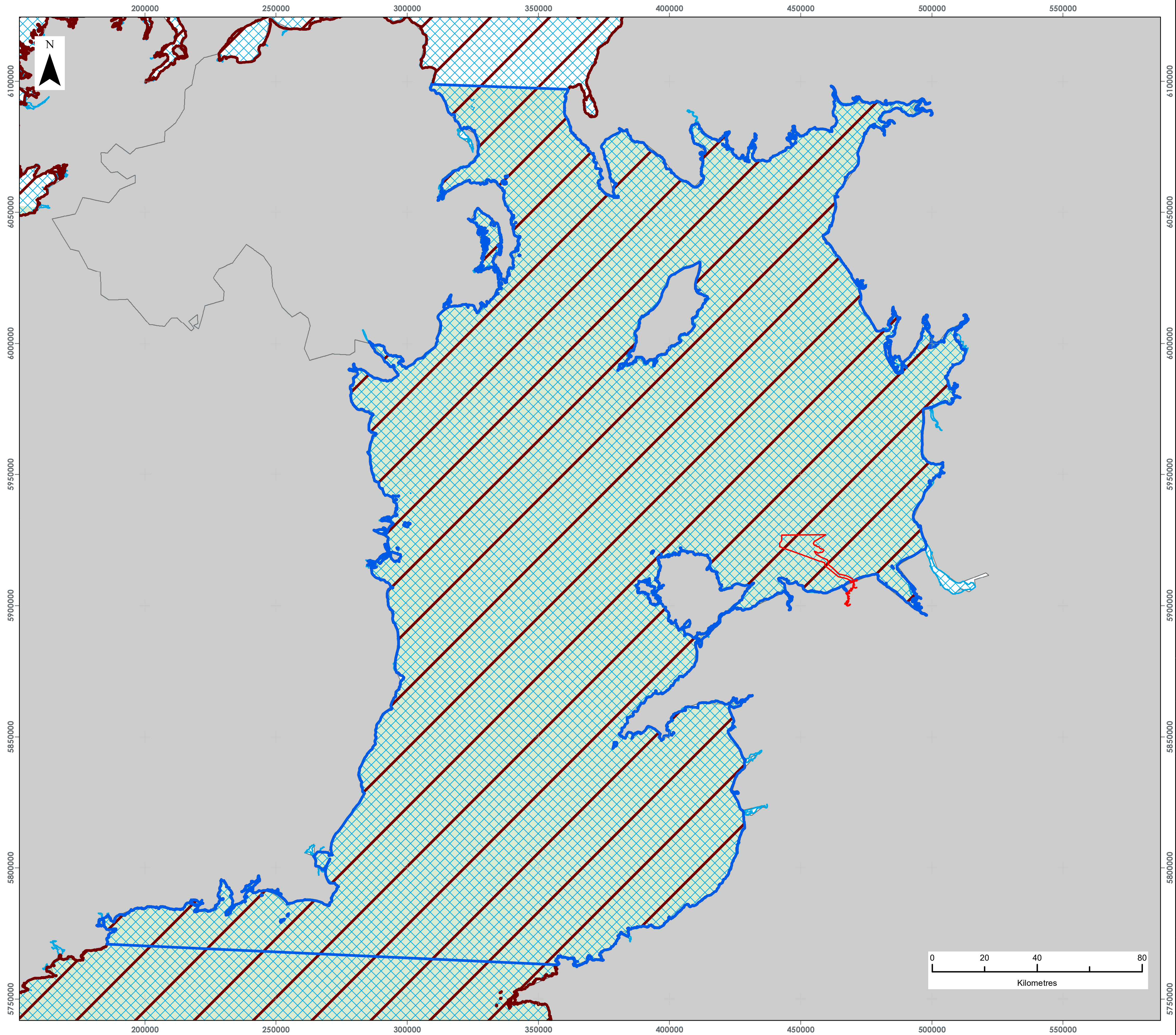
In ExQ1.4.3, the ExA noted that Table 18 indicates the offshore construction dates as January 2028 to March 2030, whilst the indicative construction programme in Figure 2 of ES Volume 2, Chapter 1 (APP-047) shows offshore clearance works from Year 1 to Year 4 Q2, and foundation installation Year 2 to Year 4.

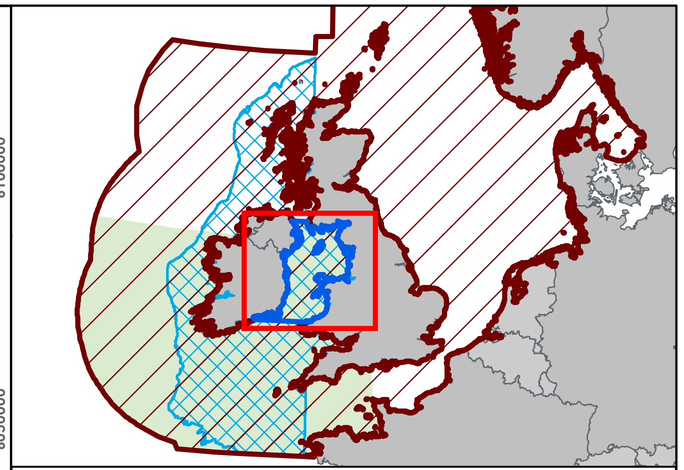
The Applicant can confirm that the two instances of "*January 2028 – March 2030*" in Table 18 are erroneous and should have read "*January 2026 – March 2030*" on which the assessment is based.

Correction of Table Heading

The Applicant has found an error in Table 22 within the revised Marine Mammal chapter (AS-026). The Table heading states: "CUMULATIVE PTS: 183 DB VHF WEIGHTED SELCUM" this should have read "CUMULATIVE PTS: 183 DB LF WEIGHTED SELCUM)". The Applicant can confirm that the underwater noise modelling was correct (LF weighted), and that the error was only in the table sub-heading.

Appendix A – Corrected Figures 1, 2, 18, 19 and 21





LEGEND

- Order Limits
- Irish Sea MU
- Celtic and Irish Seas MU
- Ospar Region III
- Celtic and Greater North Seas MU

Data Source:
IAMMWG (2015)

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Marine Mammal Regional Scale Study Area

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 1

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:1,500,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

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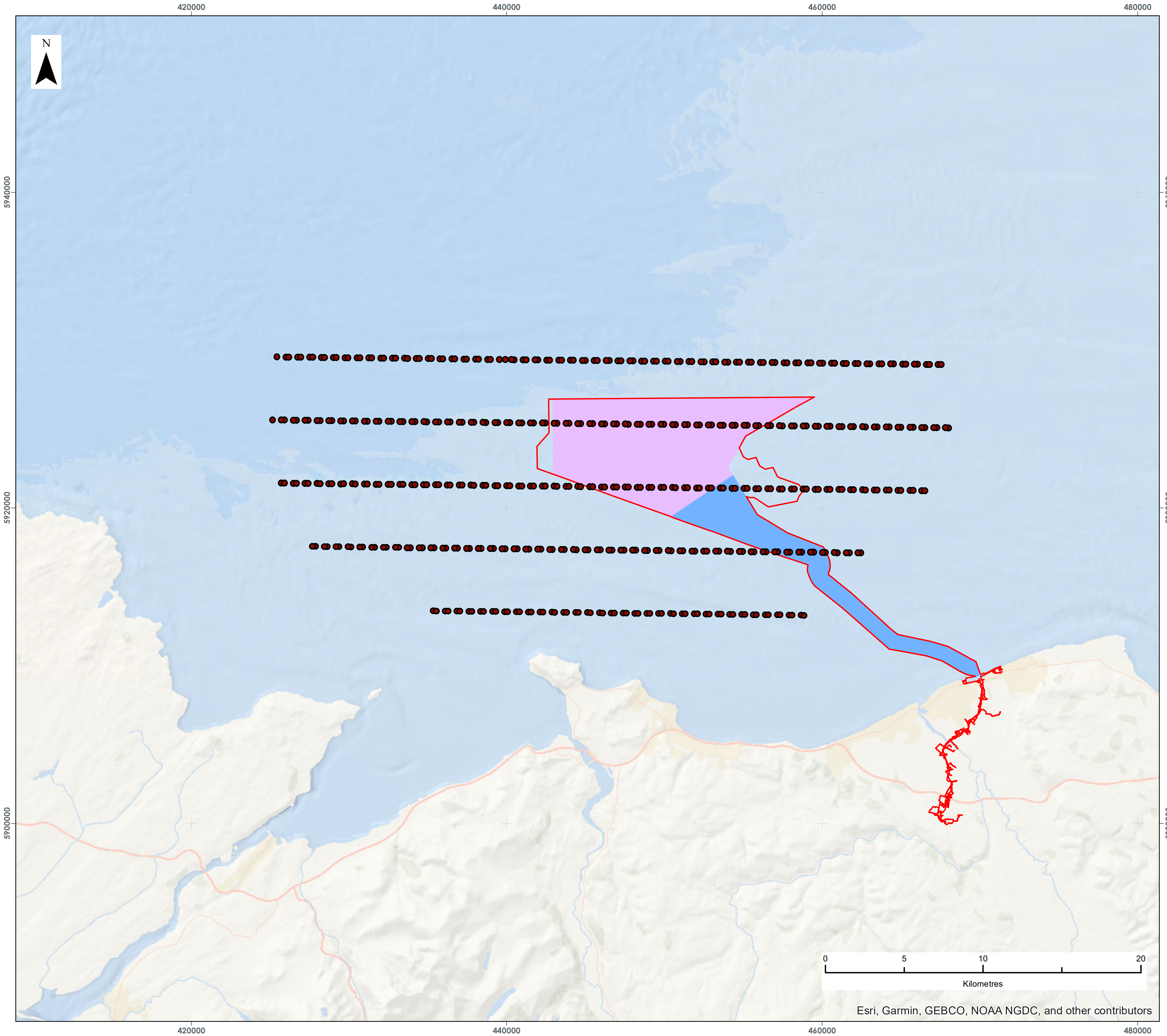

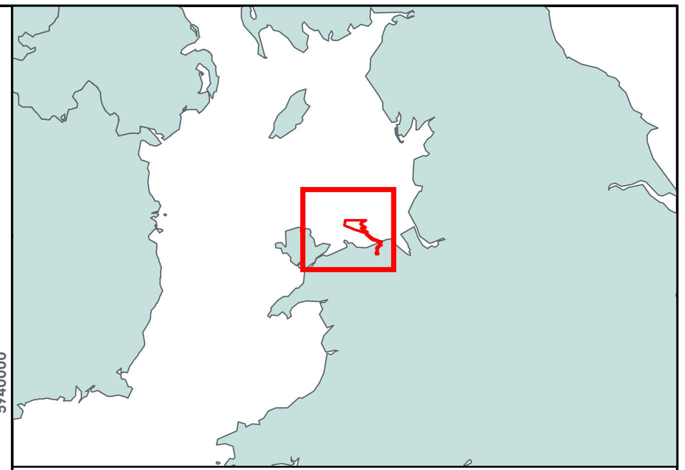

LEGEND

- Order Limits
- Array Area
- Offshore Export Cable Corridor
- Site Specific Surey Area - GPS Positions

Data Source:
APEM

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Marine Mammal Site Specific Survey Area

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 2

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:250,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

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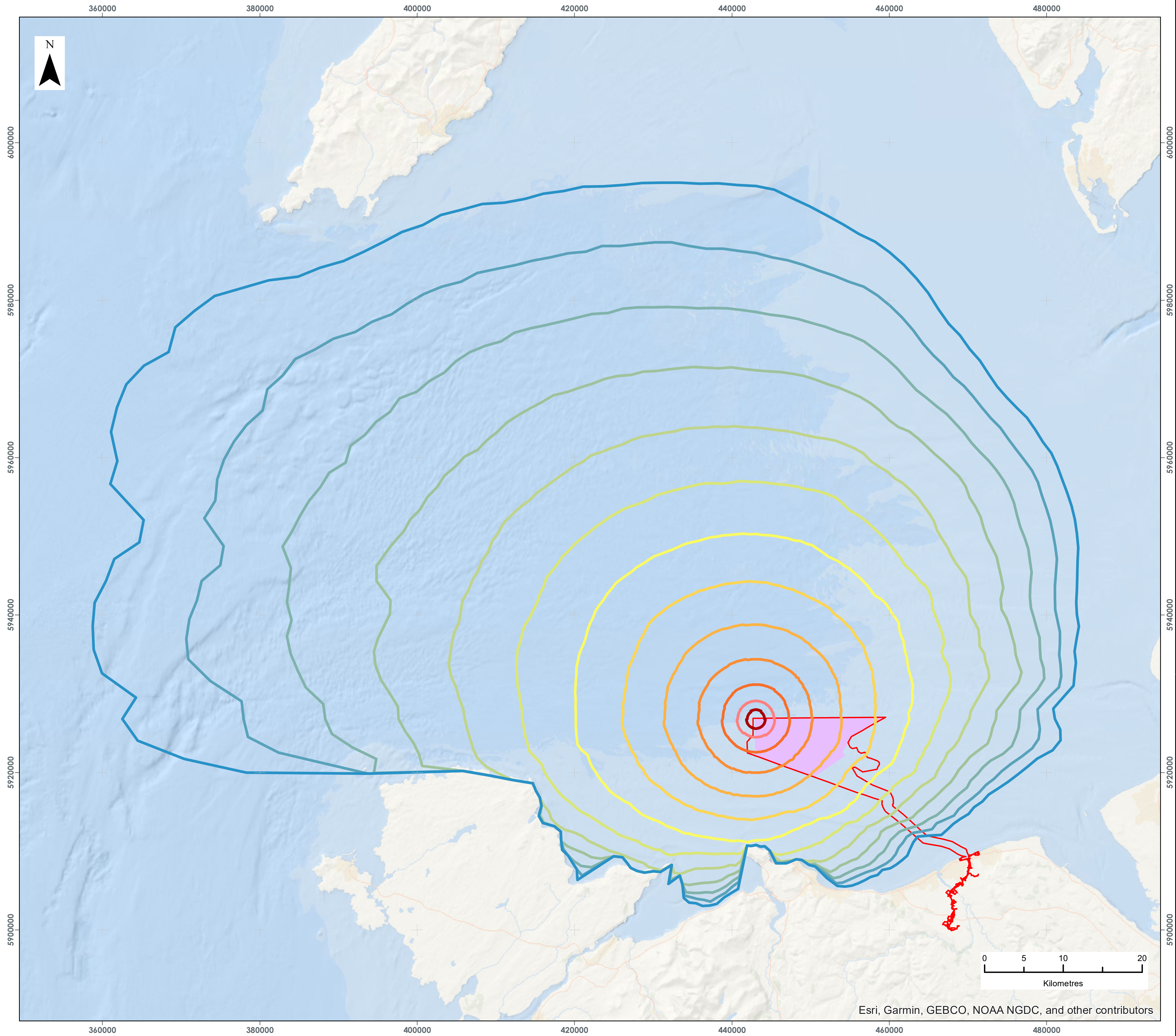

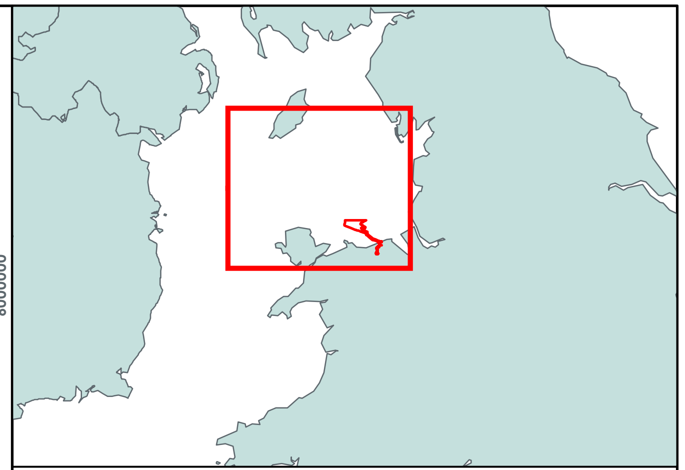

LEGEND

- Order Limits
- Array Area

NW Monopile Disturbance Dose-Response Contours

- 120 SELss dB re 1 μPa²s
- 125 SELss dB re 1 μPa²s
- 130 SELss dB re 1 μPa²s
- 135 SELss dB re 1 μPa²s
- 140 SELss dB re 1 μPa²s
- 145 SELss dB re 1 μPa²s
- 150 SELss dB re 1 μPa²s
- 155 SELss dB re 1 μPa²s
- 160 SELss dB re 1 μPa²s
- 165 SELss dB re 1 μPa²s
- 170 SELss dB re 1 μPa²s
- 175 SELss dB re 1 μPa²s
- 180 SELss dB re 1 μPa²s

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Harbour Porpoise Disturbance Contours

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 18

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

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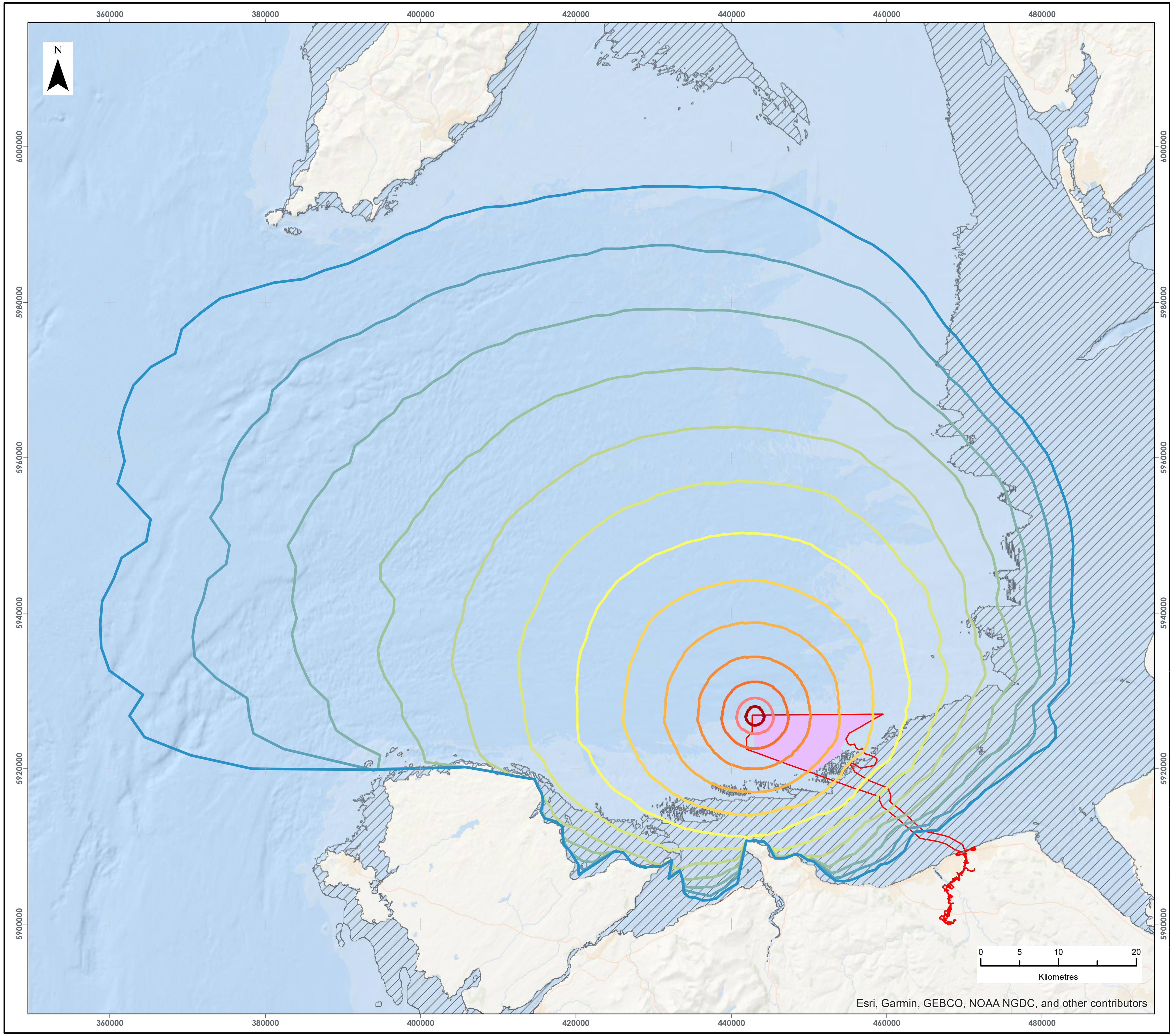

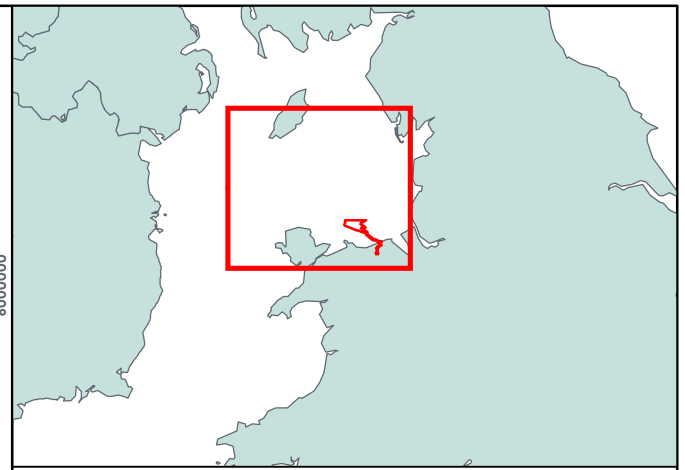

LEGEND

- Order Limits
- Array Area
- 20 m Depth Contour

NW Monopile Disturbance Dose-Response Contours

- 120 SELss dB re 1 μPa²s
- 125 SELss dB re 1 μPa²s
- 130 SELss dB re 1 μPa²s
- 135 SELss dB re 1 μPa²s
- 140 SELss dB re 1 μPa²s
- 145 SELss dB re 1 μPa²s
- 150 SELss dB re 1 μPa²s
- 155 SELss dB re 1 μPa²s
- 160 SELss dB re 1 μPa²s
- 165 SELss dB re 1 μPa²s
- 170 SELss dB re 1 μPa²s
- 175 SELss dB re 1 μPa²s
- 180 SELss dB re 1 μPa²s

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Bottlenose Dolphin Disturbance Contours

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 19

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

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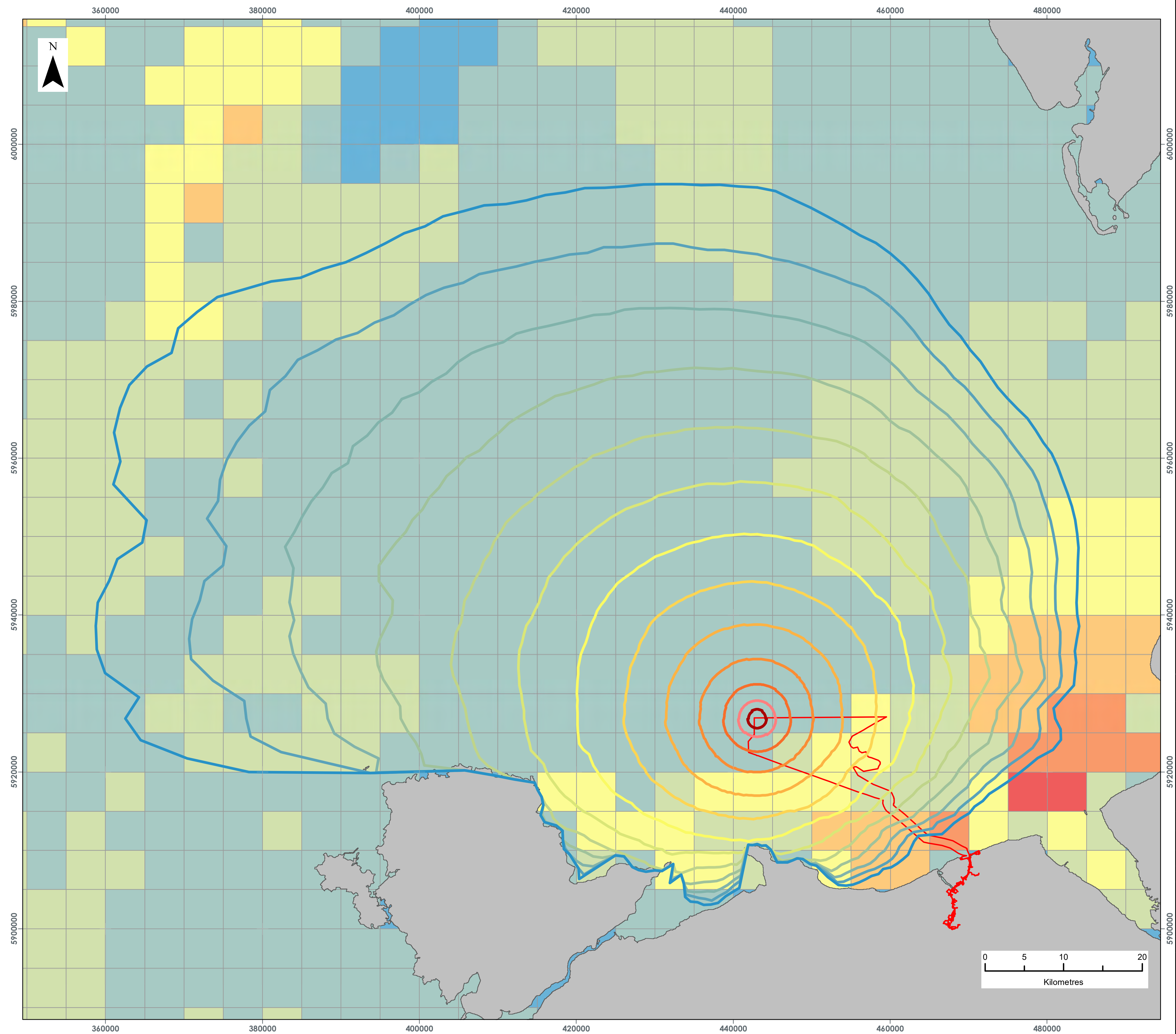

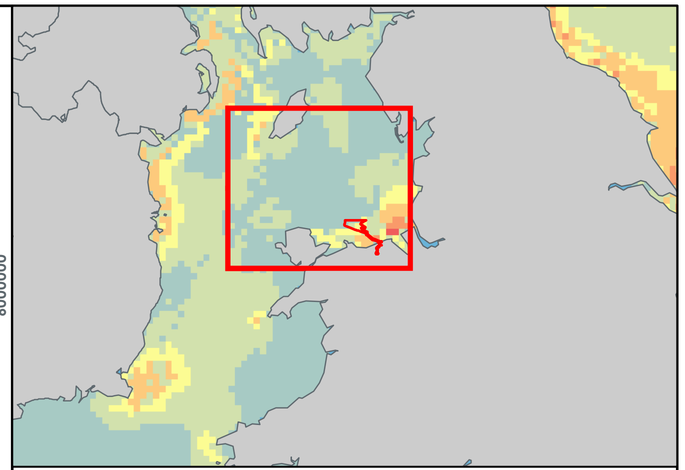

LEGEND

Order Limits

NW Monopile Disturbance Dose-Response Contours

- 120 SELss dB re 1 μPa²s
- 125 SELss dB re 1 μPa²s
- 130 SELss dB re 1 μPa²s
- 135 SELss dB re 1 μPa²s
- 140 SELss dB re 1 μPa²s
- 145 SELss dB re 1 μPa²s
- 150 SELss dB re 1 μPa²s
- 155 SELss dB re 1 μPa²s
- 160 SELss dB re 1 μPa²s
- 165 SELss dB re 1 μPa²s
- 170 SELss dB re 1 μPa²s
- 175 SELss dB re 1 μPa²s
- 180 SELss dB re 1 μPa²s

% British Isles At-Sea Population per 25 km² cell

- 0.00
- 0.00 - 0.001
- 0.001 - 0.005
- 0.005 - 0.01
- 0.01 - 0.025
- 0.025 - 0.05
- >0.05

Data Source:
Subacoustech Enviromental Ltd

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Grey Seal Disturbance Contours

VER	DATE	REMARKS	Drawn	Checked
1	10/03/2022	For Issue	RRS	RM

FIGURE NUMBER:

Figure 21

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

Fferm Wynt Alltraeth

AWEL Y MÔR

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