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Morlais Project
Environmental Statement

Chapter 12: Marine Mammals

Volume I

Applicant: Menter Môn Morlais Limited Document Reference: PB5034-ES-012 Chapter 12: Marine Mammals Author: Royal HaskoningDHV			
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TABLE OF ABBREVIATIONS

Acronym	Definition
AA	Appropriate Assessment
AC	Alternating Current
ADCP	Acoustic Doppler Current Profilers
ADD	Acoustic Deterrent Device
AIS	Automatic Identification System
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BND	Bottlenose Dolphin
BSI	British Standards Institution
CBD	Convention on Biological Diversity
CCW	Countryside Council for Wales
CD	Common Dolphin
CEDA	Central Dredging Association
Cefas	Centre for the Environment and Fisheries and Aquaculture Science
CES	Coastal East Scotland
CGNS	Celtic and Greater North Seas
CH	Carmel Head
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CIS	Celtic and Irish Sea
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CRM	Collision Risk Model
CRoW	The Countryside and Rights of Way Act
CSIP	Cetaceans Stranding's Investigation Programme
CV	Coefficient of Variation
CWC	Coastal West Channel
CWSH	Coastal West Scotland and the Hebrides`
dB	Decibel
DC	Direct Current
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DGU	Deep Green Utility units
DP	Dynamic Positioning
EC	European Commission
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment

EMEC	European Marine Energy Centre
EMF	Electromagnetic Fields
EMMP	Environmental Management and Monitoring Plan
EPS	European Protected Species
ERM	Encounter Risk Model
ES	Environmental Statement
EU	European Union
FCS	Favourable Conservation Status
FPSO	Floating Production, Storage and Offloading
GBS	Gravity Based Structures
GNS	Greater North Sea
GPS	Global Positioning System
GS	Grey Seal
HB	Holyhead Harbour
HD	High-definition
HF	High Frequency Cetaceans
HNP	Horizon Nuclear Power
HP	Harbour Porpoise
HRA	Habitats Regulations Assessment
HS	Harbour Seal
HVDC	High-Voltage Direct Current
HWDT	Hebridean Whale and Dolphin Trust
Hz	Hertz
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IPC	Infrastructure Planning Commission
IPPC	Integrated Pollution Prevention and Control
IS	Irish Sea
IWC	International Whaling Commission
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
kg	Kilogram
kHz	Kilohertz
km	Kilometre
km/h	Kilometre per hour
km^2	Kilometre square
kV	Kilovolt
kW	Kilowatt
LAT	Lowest Astronomical Tide
LCL	Lower 95% Confidence Limit
LF	Low Frequency Cetaceans
m	Metre
m/s	Metres per second

m^2	Metre squared
m^3	Metre cubed
MCA	Maritime and Coastguard Agency
MDZ	Morlais Development Zone
MF	Mid Frequency Cetaceans
MHWS	Mean High Water Spring tide
MM	Menter Môn
MMMP	Marine Mammal Mitigation Protocol
MMOs	Marine Mammal Observers
MPCP	Marine Pollution Contingency Plan
MU	Management Unit
MW	Mega Watt
nm	Nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Policy Statements
NRW	Natural Resource Wales
NS	North Sea
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and Maintenance
OCSW	Offshore Channel and South West England
ORJIP	Offshore Renewables Joint Industry Programme
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment 1992
OW	Oceanic Waters
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PCoD	Population Consequences of Disturbance
PDE	Project Design Envelope
PE	Parabolic Equation
PL	Port Lynas
pSAC	potential Special Protection Areas
PTEC	Perpetuus Tidal Energy Centre
PTS	Permanent Threshold Shift
PW	Phocid Pinnipeds (underwater)
RD	Risso's Dolphin
RMS	Root Mean Square
RNLI	Royal National Lifeboat Institute
SAC	Special Area of Conservation
SAMS	Scottish Association of Marine Sciences
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals

SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SL	Source Level
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SoCG	Statement of Common Ground
SoS	Secretary of State
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
SS	South Stack
SW	South West
TEC	Tidal Energy Converter
TGL	Tidal Generation Ltd
TPOD	Automatic Acoustic Data Loggers
TTS	Temporary Threshold Shift
TWG	Technical Working Group
UCL	Upper 95% Confidence Limits
UK	United Kingdom
VP	Vantage Point
WADZ	West Anglesey Demonstration Zone
WODA	World Organisation of Dredging Associations
WS	West Scotland

GLOSSARY OF TERMINOLOGY

Body width (m)	Body width of animal. Body width is usually around ¼ of the body length.
Dive profile	The variation of depth with elapsed time during a dive
Length (m)	Total length of animal (m) from tip to tail.

12. MARINE MAMMALS

12.1. INTRODUCTION

1. This chapter of the Environmental Statement (ES) describes the existing environment with regard to marine mammals which includes cetaceans (whales, dolphins and porpoises) and pinnipeds (seals) and assesses the potential impacts of the proposed Morlais Demonstration Zone (MDZ) and Export Cable Corridor (ECC) (hereafter referred to as 'the Project') during the construction, operation and maintenance (O&M), and decommissioning phases. Where appropriate, mitigation measures and residual impacts are presented.

2. This chapter of the ES was prepared by Royal HaskoningDHV and incorporates survey data collected by Natural Power and SEACAMS and density estimates analysed by SEACAMS.

3. This chapter also considers information from, and refers to, the following chapters within the ES:

- **Chapter 2**, Policy and Legislation;
- **Chapter 4**, Project Description;
- **Chapter 5**, Environmental Impact Assessment (EIA) Methodology;
- **Chapter 8**, Marine Water and Sediment Quality;
- **Chapter 9**, Benthic and Intertidal Ecology;
- **Chapter 10**, Fish and Shellfish Ecology; and
- **Chapter 15**, Shipping and Navigation.

4. This chapter is supported by the following Appendices:

- **Appendix 11.1**: Natural Power (2018) Morlais Demonstration Zone Bird and Marine Mammal Surveys 24-Month Technical Report;
- **Appendix 12.1**: SEACAMS (2019) Investigating methods to estimate harbour porpoise (*Phocoena phocoena*) density off West Anglesey;
- **Appendix 12.2**: Additional collision risk assessments;
- **Appendix 12.3**: Assessment of the potential for population level effects on marine mammals; and
- **Appendix 12.4**: Subacoustech (2019) Underwater noise technical note.

5. This chapter is also supported by the following documents:

- Marine Mammals - Statement of Common Ground – Menter Môn and Natural Resources Wales (**Document MOR/RHDHV/DOC/0070**);
- Information to Support Habitat Regulations Assessment (HRA) (**Document MOR/RHDHV/DOC/0067**); and
- Outline Environmental Management and Monitoring Plan (EMMP) (**Document MOR/RHDHV/DOC/0072**).

12.2. LEGISLATION, POLICY AND GUIDANCE

12.2.1. Legislation

12.2.1.1. The Habitats Directive

6. The European Union Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (hereafter called the Habitats Directive) gives regulation to the conservation and management of natural habitats, wild fauna (except birds) and flora in Europe. Its primary aim is to maintain or restore natural habitats and wild species at a favourable conservation status.

7. Annex II of the Habitats Directive lists species for which member states are expected to establish a "consistent network of special areas of conservation". This list includes harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus* along with the grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* all of which are relevant to the Project.

8. Although not legally binding, the European Commission's Guidance document on the strict protection of animal species of Community interest under the Habitats Directive (European Commission (EC) 2007) states that:

   "*In order to assess a disturbance, consideration must be given to its effect on the conservation status of the species at population level and biogeographic level in a Member State. For instance, any disturbing activity that affects the survival chances, the breeding success or the reproductive ability of a protected species or leads to a reduction in the occupied area should be regarded as a "disturbance" in terms of Article 12".*

9. The Habitats Directive protects all species of cetaceans under Annex IV as European Protected Species (EPS), being classed as endangered, vulnerable or rare, and grey and harbour seals are protected under Annex V which requires their exploitation or removal from the wild to be subject to management measures. Harbour porpoise, bottlenose dolphin and both seal species are additionally listed under Annex II, which requires member states to designate sites, identified as being key areas for their life and reproduction, as Special Areas of Conservation (SACs).

10. Article 12 of the Habitats Directive requires member states to establish stricter protection for species within their natural range; prohibiting all forms of deliberate capture or killing, deliberate disturbance (particularly during breeding and rearing periods, hibernations and migration) and the deterioration or destruction of breeding and resting sites.

12.2.1.2. The Habitats Regulations

11. The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (collectively referred to as 'the Habitats Regulations 2017') transpose the Habitats Directive into national law. The Habitats Regulations place an obligation on 'competent authorities' to carry out an Appropriate Assessment (AA) of any proposal likely to have a significant effect on a Natura 2000 site, to seek advice from Statutory Nature Conservation Bodies (SNCBs) and to reject an application that would have an adverse effect on the integrity of a Natura 2000 site except under very tightly constrained conditions.

12. All cetacean species are listed under Schedule 2 and defined as EPS and all seals are listed under Schedule 4 (animals which may not be captured or killed in certain ways).

- Under the Habitats Regulations 2017 a person is guilty of an offence if that person:
- Deliberately captures, injures or kills a wild animal belonging to a species with EPS status;
- Deliberately disturbs such animal; or
- Damages or destroys any resting or breeding place of such animal.

13. However, there is a provision to apply for an EPS licence where any of the above is expected to occur, provided there is no satisfactory alternative, and there will be no long-term detrimental effects. This is especially relevant to marine mammals and the likelihood of disturbance due to marine activities.

14. As in the Habitats Directive, there is a requirement to create SACs for species listed under Annex II (i.e. harbour porpoise, bottlenose dolphin, grey and harbour seals) and to advise on what marine operations may adversely affect the integrity of the site.

15. There are a number of provisions within the regulations that protect marine species from harmful activities. EPS, as listed under Annex IV of the Habitats Directive, are protected from:

- The deliberate capture, injury, killing;
- Any disturbance that is likely to result in a significant impact to the ability of any species group to survive, breed, rear or nurture their young, to disrupt a species' hibernation or migrations, or to affect significantly the local distributions or abundance of the species; and
- Damage or destroy any breeding or resting site.

12.2.1.3. Summary of relevant legislation

16. **Table 12-1** provides an overview of national and international legislation in relation to marine mammals.

Table 12-1 National and international legislation in relation to marine mammals

Legislation	Level of Protection	Species	Overview
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)	International	Odontocetes	Formulated in 1992, this agreement has been signed by 10 European countries bordering the Baltic and North Seas (including the English Channel) and includes the United Kingdom (UK). Under the Agreement, provision is made for the protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans.
The Berne Convention 1979	International	All cetaceans, grey seal and harbour seal	The Convention conveys special protection to those species that are

Legislation	Level of Protection	Species	Overview
			vulnerable or endangered. Appendix II (strictly protected fauna): 19 species of cetacean. Appendix III (protected fauna): all remaining cetaceans, grey and harbour seal. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981.
The Bonn Convention 1979	International	All cetaceans	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction. One of the measures identified is the adoption of legally binding agreements, including ASCOBANS.
Oslo and Paris Convention for the Protection of the Marine Environment 1992 (OSPAR)	International	Bowhead whale *Balaena mysticetus*, northern right whale *Eubalaena glacialis*, blue whale *Balaenoptera musculus*, and harbour porpoise	OSPAR has established a list of threatened and/or declining species in the North East Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the European Commission (EC) Habitats and Birds directives and measures under the Berne Convention and the Bonn Convention.
International Convention for the Regulation of Whaling 1956	International	All cetacean species	This Convention established the International Whaling Commission (IWC) who regulates the direct exploitation and conservation of large whales (in particular sperm whale and large baleen whales) as a resource and the impact of human activities on cetaceans. The regulation considered scientific matters related to small cetaceans, in particular the enforcing a moratorium on commercial whaling which came into force in 1986.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1975	International	All cetacean species	Prohibits the international trade in species listed in Appendix 1 (including sperm whales, northern right whales, and baleen whales) and allows for the controlled trade of all other cetacean species.
Convention on Biological Diversity (CBD) 1993	International	All marine mammal species	Requires signatories to identify processes and activities that are likely to have impacts on the conservation of and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.

Legislation	Level of Protection	Species	Overview
The Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017	National	All cetaceans, grey and harbour seal	'The Habitats Regulations 2017'. Provisions of The Habitats Regulations are described further above. It should be noted that the Habitats Regulations apply onshore, within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles (nm).
The Wildlife and Countryside Act 1981 (as amended)	National	All cetaceans	All cetaceans listed on Schedule 5 are fully protected within UK territorial waters. The Act protects them from killing or injury, sale, destruction of a particular habitat (which they use for protection or shelter) and disturbance. Short-beaked common dolphin *Delphinus delphis*, bottlenose dolphin and harbour porpoise are listed on Schedule 6 of the Act. Under the Act these species are prohibited from being used as a decoy to attract other animals. The Act also prohibits the use of vehicles in immediate pursuit to take, kill or drive them, it prevents nets, traps or electrical devices from being set in such a way that would injure them and prevents the use of nets or sounds to trap or snare them.
The Countryside and Rights of Way Act (CRoW) 2000	National	All cetaceans	Under the CRoW Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act.
Conservation of Seals Act 1970	England and Wales	Grey and harbour seal	Provides closed seasons, during which it is an offence to take or kill any seal, except under licence or in certain circumstances (grey seal: 1 September to 31 December; harbour seal: 1 June to 31 August).

12.2.2. Policy and Plans

17. An overview of the relevant policy and plans for the Project is provided in **Chapter 2, Policy and Legislation**, this includes:

- National Policy Statements;
- Marine Policy Statement;
- Welsh National Marine Plan;
- Planning Policy Wales; and
- Anglesey and Gwynedd Joint Local Development Plan.

18. **Table 11-2** in **Chapter 11 Marine Ornithology** outlines the National (UK and Wales) planning policy, plans and measures that are also relevant to marine mammals.

19. The assessment of potential impacts upon marine mammals has been made with specific reference to the relevant National Policy Statements (NPS)[1]. These are the principal decision-making documents for Nationally Significant Infrastructure Projects (NSIP).

20. The Overarching NPS for Energy (EN-1) sets out the UK Government's policy for delivery of major energy infrastructure, with generic considerations which are further considered in the technology-specific NPSs such as the NPS for Renewable Energy Infrastructure (EN-3). Although, NPS EN-3 states "*this NPS does not cover other types of renewable energy generation that are not at present technically viable over 50 MW onshore or over 100 MW offshore such as schemes that generate electricity from tidal stream or wave power*.", therefore relevant requirements have been referred to until a revision to this NPS or a separate NPS is provided for tidal range schemes greater than 100 MW.

21. The specific assessment requirements for marine mammals, as detailed in NPS EN-1 and EN-3, are summarised in **Table 12-2**, together with an indication of the paragraph numbers of the chapter where each is addressed.

Table 12-2 NPS EN-1 and EN-3 Assessment Requirements

NPS Requirement	NPS Reference	ES Reference
'Where the development is subject to EIA [Environmental Impact Assessment] the applicant should ensure that the ES [Environmental Statement] 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 Infrastructure Planning Commission (IPC) [now the Planning Inspectorate and the Secretary of State (SoS)] consider thoroughly the potential effects of a proposed project.'	**NPS EN-1 Section 5.3 Paragraph 5.3.3**	**Section 12.6**
'The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests.'	**NPS EN-1 Section 5.3 Paragraph 5.3.4**	**Section 12.6.2 and EMMP** (**Document MOR/RHDHV/DOC/0072**)
'When considering the application, the IPC will have regard to the Government's biodiversity strategy as (sic) set out in 'Working with the grain of nature', which aims to halt or reverse declines in priority habitats and species; accept the importance of biodiversity to quality of life. The IPC will consider this in relation to the context of climate change. As a general principle, and subject to the specific policies below, development should aim to avoid significant harm to	**NPS EN-1 Section 5.3 Paragraph 5.3.5-5.3.8**	**Section 12.6.2 and EMMP** (**Document MOR/RHDHV/DOC/0072**)

[1] https://www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure

NPS Requirement	NPS Reference	ES Reference
biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives (as set out in section 4.4 above); where significant harm cannot be avoided, then appropriate compensation measures should be sought. In taking decisions, the IPC should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment.'		
'The most important sites for biodiversity are those identified through international conventions and European Directives. The Habitats Regulations provide statutory protection for these sites but do not provide statutory protection for potential Special Protection Areas (pSPAs) before they have been classified as a Special Protection Area. For the purposes of considering development proposals affecting them, as a matter of policy the Government wishes pSPAs to be considered in the same way as if they had already been classified.'	**NPS EN-1 Section 5.3 Paragraph 5.3.9**	**Information to Support HRA (Document MOR/RHDHV/DOC/0067)**
The applicant should include appropriate mitigation measures as an integral part of the proposed development and 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; and • opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals.'	**NPS EN-1 Section 5.3 Paragraph 5.3.18**	**Section 12.6.2 and EMMP** (**Document MOR/RHDHV/DOC/0072**)
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 (PTS) and temporary threshold shift (TTS); and • operational noise.	**NPS EN-3 Paragraph 2.6.92**	**Section 12.5 and Section 12.6**

NPS Requirement	NPS Reference	ES Reference
The IPC [now SoS] 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 [now SoS] may refuse the application.	**NPS EN-3 Paragraph 2.6.94**	**Chapter 4; Section 12.6, including Section 12.6.2**
The conservation status of marine European Protected Species and seals are of relevance to the IPC [now SoS].	**NPS EN-3 Paragraph 2.6.95**	**Section 12.5 and Information to Support HRA (Document MOR/RHDHV/DOC/0067)**
Monitoring of the surrounding area before and during the piling procedure can be undertaken.	**NPS EN-3 Paragraph 2.6.97**	**Section 12.4.2 and EMMP** (**Document MOR/RHDHV/DOC/0072**)
During construction, 24-hour working practices may be employed so that the overall construction programme and the potential for impacts to marine mammal communities is reduced in time.	**NPS EN-3 Paragraph 2.6.98**	**Section 12.6, including Section 12.6.1**

22. **Table 12-3** sets out other national and regional policies which are particularly relevant to the Project.

Table 12-3 National and Regional Policy Requirements Relevant to Marine Mammals

Policy Description	Reference	ES Reference
MPS		
Noise resulting from a proposed activity or development in the marine area or in coastal and estuarine waters can have adverse effects on biodiversity although knowledge of the extent of impacts is limited and there are few systematic monitoring programmes to verify adverse effects. Man-made sound emitted within the marine environment can potentially affect marine organisms in various ways. It has the potential to mask biologically relevant signals; it can lead to a variety of behavioural reactions, affect hearing organs and injure or even kill marine life. Manmade sound sources of primary concern with regard to disturbance of marine life are explosions, shipping, seismic surveys, offshore construction and offshore industrial activities, for example dredging, drilling and piling, sonar of various types and acoustic deterrent devices.	Section 2.6.3.1	Underwater noise modelling has been undertaken to inform the impact assessment for construction and operation of the Project. Impact assessment is presented in **Sections 12.6.3.1** to **12.6.3.4**, and **12.6.4.1** to **12.6.4.3**.
Renewable energy developments can potentially have adverse impacts on marine fish and mammals, primarily through construction noise and may displace fishing activity and have direct or indirect impacts on other users of the sea, including mariners. Certain bird species may be displaced by offshore wind turbines, which also have the potential to form barriers to migration or present a collision risk for birds. Their foundation designs are likely to have an effect on hydrodynamics and consequent sediment movement. This includes potential scouring of	Section 3.3.24	See above

Policy Description	Reference	ES Reference
sediments around the bases of turbines. These and other potential adverse impacts, together with potential mitigation measures, are considered in the National Policy Statement for Renewable Energy Infrastructure (EN-3).		
Marine energy deployments, that is wave and tidal deployments, may pose potential risks to the environment if inappropriately sited. However, the level of risk and ecological significance is largely unknown since, in particular, tidal stream and wave technologies are at a relatively early stage of development. Studies of tidal range technologies, including barrages, have indicated that these structures can have adverse impacts on migratory fish and bird species and on the hydrodynamics of the estuarine environments in which they are situated. To underpin the marine planning process further research is needed to develop a better understanding of the potential impacts that marine technologies might have on potentially sensitive environmental features. For example, adaptation and mitigation methods for such impacts may be supported by detailed monitoring programmes and co-ordinated research initiatives, including post deployment of devices.	Section 3.3.25	Collision risk with tidal devices during operation of the Project is discussed in **Section 12.6.4.5.**
Draft WNMP		
Proposals should demonstrate how they: · 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 non-marine designated sites.	ENV_02: Marine Protected Areas	The conservation importance of marine mammal species in the vicinity of the MDZ is presented in **Section 12.5**. Information to support an HRA is presented in Document MOR/RHDHV/DOC/0067.
Proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference: a) avoid adverse impacts; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding	ENV_05: Underwater noise	Underwater noise modelling has been undertaken to inform the impact assessment for construction and operation of the Project. Impact assessment is presented in **Sections 12.6.3.1** to **12.6.3.4**, and **12.6.4.1** to **12.6.4.3**.
Proposals should demonstrate that they have assessed potential cumulative effects and, in order of preference: a) avoid adverse effects; and/or b) minimise effects where they cannot be avoided; and/or c) mitigate effects where they cannot be minimised. If significant adverse effects cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding. Proposals that contribute to positive cumulative effects are encouraged.	GOV_01: Cumulative effects	Cumulative impacts are assessed in **Section 12.6.6** and in **Chapter 26**
Anglesey and Gwynedd Joint Local Development Plan (JLDP)		
All impacts on landscape character, heritage assets and natural resources have been adequately mitigated,	Policy ADN 3: Other Renewable Energy	The impact assessment is included within **Section**

Policy Description	Reference	ES Reference
ensuring that the special qualities of all locally, nationally and internationally important landscape, biodiversity and heritage designations, including, where appropriate, their settings are conserved or enhanced	and Low Carbon Technologies	**12.6** and includes mitigation measures to reduce impact significance.

12.2.3. Guidance

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

- The Protection of Marine EPS from Injury and Disturbance: Draft Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area (Joint Nature Conservation Committee (JNCC) *et al*., 2010).
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal (Chartered Institute of Ecology and Environmental Management (CIEEM), 2016).
- Environmental Impact Assessment for offshore renewable energy projects – guide (British Standards Institution (BSI), 2015).
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report (Sea Mammal Research Unit Ltd (SMRU Ltd) on behalf of The Crown Estate, 2010).
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Centre for the Environment and Fisheries and Aquaculture Science (Cefas), 2012).
- Assessing collision risk between underwater turbines and marine wildlife. Scottish Natural Heritage (SNH) (2016) guidance note.
- Guidance to inform marine mammal site characterisation requirements at wave and tidal stream energy sites in Wales (Sparling *et al*., 2015).
- Defining Project Envelopes for Marine Energy Projects: Review and Tidal Energy Test Facility and Marine Mammals Case Study (Sparling and Smith, 2019, unpublished).

12.2.3.1. EPS Guidance

24. JNCC *et al*. (2010) provides draft guidance concerning the Regulations on the deliberate disturbance of marine EPS, provides an interpretation of the regulations in greater detail, including for pile driving operations (JNCC, 2010a), seismic surveys (JNCC, 2017a) and the use of explosives (JNCC, 2010b).

25. The draft guidance provides advice on activities at sea that could potentially cause deliberate injury or disturbance to marine mammals and summarises information and sensitivities of the species to which these regulations apply. The guidance refers to the European Commission's Guidance document (EC, 2007) stating that, there must be some ecological impact in order for significant disturbance to occur.

26. The draft guidance provides the following interpretations of deliberate injury and disturbance offences under both the Habitats Regulations and Offshore Regulations (now the Habitats Regulations 2017), as detailed in the paragraphs below:

“Deliberate actions are to be understood as actions by a person who knows, in light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action;

Certain activities that produce loud sounds in areas where EPS could be present have the potential to result in an injury offence, unless appropriate mitigation measures are implemented to prevent the exposure of animals to sound levels capable of causing injury.”

27. For the purposes of marine users, the draft guidance states that a disturbance which can cause offence should be interpreted as:

“Disturbance which is significant in that it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution.”

28. The draft guidelines further states that a disturbance offence is more likely where an activity causes persistent noise in an area for long periods of time, and a disturbance offence is more likely to occur when there is a risk of:

- Animals incurring sustained or chronic disruption of behaviour scoring five or more in the Southall *et al*. (2007) behavioural response severity scale; or
- Animals being displaced from the area, with redistribution significantly different from natural variation.

29. The JNCC *et al*. (2010) draft guidance highlights that sporadic “trivial disturbance” should not be considered as a disturbance offence under Article 12.

30. In order to assess whether a disturbance could be considered non-trivial in relation to the objectives of the Directive, JNCC *et al*. (2010) suggest that consideration should be given to the definition of the Favourable Conservation Status (FCS; see **Section 12.2.3.2**) of a species given in Article 1(i) of the Habitats Directive. There are three parameters that determine when the conservation status of a species can be taken as favourable:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its natural habitats.
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future.
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

31. Therefore, any action that could increase the risk of a long-term decline of the population, increase the risk of a reduction of the range of the species, and/or increase the risk of a reduction of the size of the habitat of the species can be regarded as a disturbance under the Regulations.

For a disturbance to be considered non-trivial, the disturbance to marine EPS would need to be likely to at least increase the risk of a certain negative impact on the species at FCS.

32. JNCC *et al*. (2010) do not provide guidance as to what would constitute a 'significant group' or proportion of the population, but provide some discussion on how to assess whether the numbers potentially affected could be of concern for a population's FCS.

33. JNCC *et al*. (2010) state that:

"In any population with a positive rate of growth, or a population remaining stable at what is assumed to be the environmental carrying capacity, a certain number of animals can potentially be removed as a consequence of anthropogenic activities (e.g. through killing, injury or permanent loss of reproductive ability), in addition to natural mortality, without causing the population to decrease in numbers, or preventing recovery, if the population is depleted. Beyond a certain threshold however, there could be a detrimental effect on the population".

34. Further discussion on the use of thresholds for significance and the permanent or temporary nature of any disturbance is considered by defining the magnitude of potential effect in this assessment (**Section 12.4.4**). Consideration of any potential essential habitat or geographical structuring of EPS is provided in the Existing Environment section (**Section 12.5**) of this chapter.

35. In order to assess the number of individuals from a species that could be removed from the regional population through injury or disturbance without compromising the FCS, the EIA considers:

- The numbers affected in relation to the best and most recent estimate of population size; and
- The threshold for potential impact on the FCS, which will depend on:
    - The species' / populations' life-history;
    - The species' FCS assessment in UK waters; and
    - Other pressures encountered by the population (cumulative effects).

36. One of the key parameters for consideration within this assessment is the population size. The EPS Guidance advises that the best available abundance estimates could be used as a baseline population size, taking account of any evidence of regional population structuring (JNCC *et al*., 2010).

37. An EPS licence is required if the risk of injury or disturbance to cetacean species is assessed as likely under the Habitats Regulations 2017.

38. If a licence is required, an application must be submitted, the assessment of which comprises three tests, namely:

- Whether the activity falls within one of the purposes specified in Regulation 55 of the Habitats Regulations. Only the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment" is of relevance to marine mammals in this context;

- That there are no satisfactory alternatives to the activity proposed (that would not incur the risk of offence); and
- That the licensing of the activity will not result in a negative impact on the species'/ population's FCS.

39. Under the definitions of 'deliberate disturbance' in the Habitats Regulations, chronic exposure and / or displacement of animals could be regarded as a disturbance offence.

40. If required, the EPS licence application will be submitted post-consent. At this time, the project design envelope will have been further refined, as well as full details of the mitigation and monitoring measures that will be in place.

12.2.3.2. Favourable Conservation Status (FCS)

41. Member states report back to the European Union (EU) every six years on the Conservation Status of marine EPS. Based on the most recent 2007-2012 reporting by the Joint Nature and Conservation Committee (JNCC, 2013), seven species of the 11 cetacean species were assessed as having a 'favourable' Conservation Status (**Table 12-4**).

42. Four of 11 cetacean species were assessed as having an 'unknown' Conservation Status (JNCC, 2013). This is a result of a lack of recent population estimates that encompassed their natural range in UK and adjacent waters and / or having no evidence to determine long-term trends in population abundance.

43. Another 17 species were considered to be uncommon, rare or very rare in occurrence, so it was not possible to ascertain their Conservation Status (JNCC, 2013).

Table 12-4 FCS assessment of cetacean species in Annex IV of the Habitats Directive occurring in UK and adjacent waters (JNCC, 2013)

Species	**FCS assessment**
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Favourable
Bottlenose dolphin *Tursiops truncatus*	Favourable
Common dolphin *Delphinus delphis*	Favourable
Fin whale *Balaenoptera physalus*	Favourable
Harbour porpoise *Phocoena phocoena*	Favourable
Killer whale *Orcinus orca*	Unknown
Long-finned pilot whale *Globicephala melas*	Unknown
Minke whale *Balaenoptera acutorostrata*	Favourable
Risso's dolphin *Grampus griseus*	Unknown
Sperm whale *Physeter macrocephalus*	Unknown
White-beaked dolphin *Lagenorhynchus albirostris*	Favourable

12.3. CONSULTATION

44. Details on the consultation for the Project are provided in **Chapter 6, Consultation**. Scoping and consultation have been on-going throughout the EIA and have supported the scope of the baseline characterisation work and ensuring that the requirements of the regulators and their

advisors are met. **Table 12-5** summarises relevant marine mammal consultation responses received prior to and during preparation of the ES and which were considered in this Chapter. A full list of consultation responses and how they have been taken into account in finalising the Project is presented in **Chapter 6, Consultation**.

45. A "statement of common ground" (SoCG) and technical working group (TWG) approach has been used for the management of key issues, with technical experts from Natural Resources Wales (NRW) and Royal HaskoningDHV on behalf of Menter Môn. **Table 12-5** includes the key points from the SoCG and marine mammal TWG meetings.

Table 12-5 Summary of marine mammal consultation responses

Consultee	Date/Document	Comment	Response
Planning Inspectorate	2018 Scoping comments	Study area: The Scoping Report has utilised an initial search area of up to 50 km. The Applicant is recommended to agree the study area with NRW, noting NRW's comments (see Appendix 1 of this Scoping Opinion) of the need to utilise the relevant marine mammal management units.	The relevant marine mammal management units have been used for each species as outlined in **Section 12.4.1**.
Planning Inspectorate	2018 Scoping comments	Underwater noise: The ES should set out the noise levels at which effects on marine mammals and basking sharks occur and explain how these levels have been derived.	The underwater noise assessment, including the thresholds and criteria are presented in **Section 12.6.3.1.1**.
Planning Inspectorate	2018 Scoping comments	Disturbance: Disturbance from the presence of construction and operational vessels should be assessed, where significant effects are likely.	The potential disturbance from the presence of vessels during construction has been assessed in **Section12.6.3.3** and for operational vessels in **Section 12.6.4.3**.
Planning Inspectorate	2018 Scoping comments	Displacement: The potential for displacement from underwater noise has been acknowledged in the Scoping Report; however, the resultant indirect effects have not been considered e.g. energy expenditure in avoiding the area. This should be assessed within the ES.	The potential for displacement from underwater noise has been assessed in **Section 12.6.3** and **12.6.4**.
Planning Inspectorate	2018 Scoping comments	EIA Baseline Characterisation: The Scoping Report has not proposed any site specific surveys to inform the baseline and it is unclear whether the marine mammal surveys which have been undertaken alongside the offshore ornithological surveys cover the application site. The Applicant should consider the applicability of existing data to the Proposed Works and application site. It is recommended that the sufficiency of any existing data, and the need for any site specific surveys, is discussed with NRW.	The baseline characterisation takes into account the site specific marine mammal surveys undertaken by Natural Power and SEACAMS, as outlined in **Section 12.4.2**.

Consultee	Date/Document	Comment	Response
Planning Inspectorate	2018 Scoping comments	Collision Risk: The Scoping Report states that collision risk would be determined through a literature review of similar studies and the results taken from SeaGen and the MeyGen projects. Therefore, it is assumed that site specific collision risk modelling will not be undertaken. However, the Scoping Report fails to provide the information necessary to obviate the need for collision risk modelling taking into account the chosen device(s) and the location of the Proposed Works. The ES should ensure that impacts which may result in likely significant effects to these species are assessed, including those from collision risk. The Applicant should make effort to discuss and agree the approach to the assessment with NRW. If reliance is placed on existing information to demonstrate an absence of likely significant effect, the ES should explain why the studies referenced are applicable to the Proposed Works.	In **Section 12.6.4.4.1**, site specific collision risk modelling has been undertaken for a range of different devices based on the SNH (2016) ERM and CRM models.
Planning Inspectorate	2018 Scoping comments	Underwater baseline noise: The Applicant's attention is drawn to the existence of the Defra Marine Noise Registry which could inform the baseline noise environment.	The marine noise registry data was checked, however no ambient underwater noise levels were available for the MDZ area. Therefore, information from other studies has been included, as outlined in **Section 12.6.3.1.1**.
Planning Inspectorate	2018 Scoping comments	EMF: The Scoping Report has identified the potential for EMF to affect benthic ecology and migratory fish; however, no reference has been made to potential impacts from EMF on marine mammals. Any likely significant effects to marine mammals from EMF should be assessed within the ES.	The potential effects of EMF have been assessed in **Section 12.6.4.9**.
Planning Inspectorate	2018 Scoping comments	Changes to prey resource: Potential impacts from a decrease in water quality has been identified as a potential impact for fish and shellfish. The resultant indirect impacts for marine mammals, basking sharks and reptiles should be assessed.	The potential changes to prey resources during construction have been assessed in **Section 12.6.3.8** and during operation in **Section 12.6.4.12**.
NRW	2018 Scoping comments	In section 8.1.1.2 it states that "due to the wide ranging nature of offshore ecological receptors such as … marine mammal receptors, an initial search of up to 50 km has been used for these receptors". We advise that with regard to marine mammals, rather than the 50 km search area proposed, the relevant marine mammal management units provide the appropriate spatial extent for screening in marine mammal protected sites (including	The relevant marine mammal management units have been used for each species as outlined in **Section 12.4.1**.

Consultee	Date/Document	Comment	Response
		SSSIs where appropriate) (see IAMMWG, 2015).	
NRW	2018 Scoping comments	For Annex II marine mammal species, the Welsh SACs within the relevant management units are as follows: Harbour porpoise Management Unit: Celtic & Irish Sea Welsh SACs with harbour porpoise as a feature within the Management Unit: North Anglesey Marine West Wales Marine Bristol Channel Approaches Bottlenose dolphin Management Unit: Irish Sea Welsh SACs with bottlenose dolphin as a feature within the Management Unit: Pen Llyn a'r Sarnau Cardigan Bay Grey Seal Management Unit: South and West England and Wales Welsh SACs with grey seal as a feature within the Management Unit: Pen Llyn a'r Sarnau Cardigan Bay Pembrokeshire Marine	As outlined in **Section 12.5.8**, these sites have been assessed in the information for the HRA (**Document MOR/RHDHV/DOC/0067**).
NRW	2018 Scoping comments	Please note that that the series of Harbour Porpoise SACs in the UK are now officially adopted by Europe and must be formally considered in HRA. Sites outside of Welsh waters (e.g. in Irish, English, Northern Irish, Scottish waters) should also be screened in based on their presence in the relevant management unit.	All designated sites within the relevant MUs, including harbour porpoise SACs, have been considered in the HRA screening (**Document MOR/RHDHV/DOC/0067**).
NRW	2018 Scoping comments	The nearshore and inshore waters of the Anglesey coast are important for cetaceans and seals. We advise that the scope of the ES assessment must consider the impacts of all stages of the development (construction, operation and decommissioning) on the following marine mammal species: harbour porpoise, common dolphin, Risso's dolphin, grey seal, minke whale and bottlenose dolphin.	As outlined in **Section 12.5** and agreed with NRW at the second marine mammal TWG meeting in February 2019, the ES assessment considers the impacts of all stages of the development (construction, operation and decommissioning) on the following marine mammal species: harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale and grey seal.
NRW	2018 Scoping comments	Some species might present a high risk and require a more quantitative approach to assessment than others, for example bottlenose dolphin, grey seal, harbour	Where possible, all assessments in the ES have been based on a quantitative approach.

Consultee	Date/Document	Comment	Response
		porpoise, which are all SAC species from nearby sites.	This has been put into the context of the SAC sites in the information for the HRA (**Document MOR/RHDHV/DOC/0067**).
NRW	2018 Scoping comments	Please note that bottlenose dolphin in the demonstration zone area are likely to be from Cardigan Bay SAC and Pen Llyn ar Sarnau SACs in the Irish Sea Management Unit (not just Cardigan Bay SAC).	This has been taken into account in the assessments for the ES (see **Section 12.5.2**) and in the information for the HRA (**Document MOR/RHDHV/DOC/0067**).
NRW	2018 Scoping comments	There are regionally important grey seal pupping sites on Anglesey, including on Holy Island (see Westcott and Stringell 2003). An NRW commissioned census of grey seal pupping abundance and distribution has recently been completed and indicates at least a doubling of pup production in North Wales (Banga *et al*. 2018 in prep – this paper might be available in time for consideration within the ES).	Grey seal pupping sites on Anglesey have been taken into account (as outlined in **Section 12.5.6**), based on Clarke *et al*. (2018). Grey Seal Pup Production and Distribution in North Wales.
NRW	2018 Scoping comments	The use of the demonstration zone and surrounding area by marine mammals will need to be assessed both spatially and temporally. The spatial extent of activities and operations and marine mammal protected sites should be guided by the relevant marine mammal management units (IAMMWG, 2015).	**Section 12.5**, outlines the distribution and occurrence for each species, including the relevant MUs. Where relevant, the potential impacts in **Section12.6** have been assessed both spatially and temporally.
NRW	2018 Scoping comments	Table 8.5 currently presents very broad appraisal of the potential impacts to be assessed; we consider that a more detailed list of possible impact pathways needs to be considered and presented in the ES. Where a particular impact is ruled out as being not significant, it is important that the decision is based on clear evidence. The impact pathways identified in the ES should also be considered in the cumulative impact assessment and HRA, where appropriate. We recommend that the ORJIP Ocean Energy Forward Look provides a useful start for prioritising impact pathways and evidence needs (see http://www.orjip.org.uk/documents).	**Section 12.6.1** provides details on the potential impacts and possible pathways assessed in the ES and **Section 12.4.4** outlines the EIA methodology. The impact pathways have also considered, where appropriate, in the cumulative impact assessment (**Section 12.6.6**) and in the information for the HRA (**Document MOR/RHDHV/DOC/0067**). Determining the potential impacts and pathways took into account numerous information sources, including ORJIP (2017) Ocean Energy Forward Look.

Consultee	Date/Document	Comment	Response
NRW	2018 Scoping comments	At this stage, the key issues would appear to relate to displacement, disturbance and collision during operation and noise impacts during construction, operation and decommissioning. There, however, be will be other impacts to consider, including indirect effects on prey species and cumulative effects.	**Section 12.6.1** provides an overview of the potential impacts that have been assessed for marine mammals, including potential changes in prey availability (**Section 12.6.3.8** and **12.6.4.12**) and cumulative impacts (**Section 12.6.6**).
NRW	2018 Scoping comments	We advise that it is likely that the key issue of collision risk during operation will need to be considered in quantitative detail. The potential for population level effects on marine mammals will need to be considered where significant impact pathways have been identified. For the assessment of marine mammal collision risk, we advise that the use of modelling frameworks such as the Population Consequences of Disturbance (PCoD) or toll quotas such as Potential Biological Removal should be considered.	In **Section 12.6.4.4.1**, site specific collision risk modelling has been undertaken for a range of different devices based on the SNH (2016) ERM and CRM models. The potential for population level effects on marine mammals have been assessed, where significant impact pathways have been identified, in **Appendix 12.3**.
NRW	2018 Scoping comments	We advise that the Sparling et al 2015 publication “Guidance to inform marine mammal site characterisation requirements at wave and tidal stream energy sites in Wales” should be followed to assist in determining the level of baseline characterisation required to inform the ES.	Sparling *et al*. (2015) and other guidance and information sources have been taken into consideration in **Sections 12.5** and **12.6**.
NRW	2018 Scoping comments	Note that although a literature review and results of collision risk analysis from similar studies (e.g. SeaGen and the MeyGen projects) will be informative, we advise that there will likely be a need to adapt present models to fit the chosen device(s) and unique location characteristics (open tidal site).	In **Section 12.6.4.4.1**, site specific collision risk modelling has been undertaken for a range of different devices based on the SNH (2016) ERM and CRM models.
NRW	2018 Scoping comments	The proposed baseline underwater noise monitoring survey should be undertaken in line with the latest relevant guidelines.	Noise data were collected by SEACAMS for the MDZ and have been used in the characterisation of the site.
NRW	2018 Scoping comments	No information is provided in the scoping report on the proposed approach to assessing potential underwater noise effects. This should follow the latest guiding principles for the assessment of the impacts of underwater noise. This includes applying an appropriate acoustic model, published exposure criteria or acoustic thresholds and relevant noise sources and model input data. The limitations and constraints of any approach should be set out.	The underwater noise assessment, including the thresholds and criteria are presented in **Section 12.6.3.1.1**. The underwater noise assessments also include, where possible, a general review of the latest available scientific

Consultee	Date/Document	Comment	Response
		The noise assessment should also include a general review of the latest available scientific evidence of the observed responses of marine mammals to different types of underwater sound for context.	evidence of the observed responses of marine mammals to different types of underwater sound for context.

NRW	1st Marine Mammal TWG meeting 27th November 2018
	
	and
	
	2nd Marine Mammal TWG meeting 19th February 2019
		▪ Species to be considered in baseline environment;
		▪ Data sources;
		▪ Density estimates and reference populations;
		▪ Construction and installation impacts to be assessed;
		▪ Operation and Maintenance (O&M) impacts to be assessed;
		▪ Decommissioning impacts to be assessed;
		▪ Potential cumulative impacts and in-combination effects impacts to be assessed;
		▪ Impact assessment methodology; and
		▪ Assessment approach for:
		  ▪ Underwater noise;
		  ▪ Vessel collision risk;
		  ▪ Disturbance at seal haul-out site;
		  ▪ Changes to water quality;
		  ▪ EMF effects;
		  ▪ Changes in prey availability;
		  ▪ Risk of entanglement;
		  ▪ Barrier effects;
		  ▪ Collision risk assessment, including use of ERM and CRM, approach to determining parameters in models; avoidance rates and thresholds.
		  ▪ Population modelling
			Full details of the key discussions undertaken within the first and second TWG meetings are provided within the Statements of Common Ground (SoCG) (**Document MOR/RHDHV/DOC/0070**)

NRW	3rd Marine Mammal TWG meeting 10th May 2019	▪ Density estimates and reference populations. ▪ Marine Mammal SACs and Reference Populations. ▪ Sensitivity of marine mammal populations in Welsh waters based on Sparling et al. (2015). ▪ List of potential impacts assessed for construction, operation and decommissioning. ▪ Overview of approach to assessments and presentation of results. ▪ PCoD update	Full details of the key discussions undertaken within the first and second TWG meetings are provided within the Statements of Common Ground (SoCG) (**Document MOR/RHDHV/DOC/0070**)

Consultee	Date/Document	Comment	Response
NRW	NRW Response 22.05.19 (CAS-84017-M9P0)	We have a particular concern about the collision risk figures presented for cetaceans (all of which are European Protected Species) and seals. Note that harbour porpoise, bottlenose dolphin and grey seal are qualifying features of several Special Areas of Conservation in Welsh waters. It is important to note that the evidence for the potential impacts of marine mammal collision with tidal devices with the potential to cause injury or fatalities is severely limited. We note that mitigation for collision risk is proposed by the use of monitoring systems (such as active sonar; passive acoustics; cameras) and deterrents such as Acoustic Deterrent Devices as part of an adaptive management plan. However, based on the information that we have seen so far and the evidence currently available to us regarding these methods, we cannot be fully confident that the proposed mitigation will be effective. As such we may not be able to conclude that significant adverse effects on the integrity of European protected sites could be ruled out without reasonable scientific doubt or that the project would not be detrimental to the favourable conservation status of European Protected Species. We may need to consider further measures as a fail-safe if the above mitigation fails, such as a shutdown of operations when a certain number of collisions occur, as part of the consent conditions. We note the ‘one dolphin scenarios’ presented on slide 38 of the Morlais Marine Mammal TWG 3rd Meeting presentation document and recommend that further consideration is given to an initial test phase of deployment of the scale given in the lower table, subject to us being satisfied with the predicted collision risk figures for the other cetacean and seal species with this approach. We acknowledge that this would generate up to 17.65MW, which is much less than the intended first phase of 40MW. A smaller test phase with reduced collision risk for cetacean and seal species could potentially offer a solution to allow progress if sufficient monitoring was put in place via an adaptive management plan to inform whether relevant Marine Licence conditions could be discharged before further devices were deployed. In addition, we wish to reiterate the advice from our EIA Scoping Opinion (paragraph 0.6 of Scoping opinion SC1804, issued on 11/07/18) that, without wishing to prejudice the HRA or consenting processes, should it not be possible to identify a package of measures that would avoid or mitigate the effects of the proposal and avoid adverse effects on the	Taking into account NRW’s comments, the collision risk assessments in the ES (**Section 12.6.4.4.1**) and information for the HRA (**Document MOR/RHDHV/DOC/0067**) are based on the less than one bottlenose dolphin collision risk scenarios. The assessments are based on indicative scenarios for the combination of different types of devices where the collision risk is predicted to be less than one bottlenose dolphin (based on the scenarios with the current maximum MW). Each stage of deployment would only progress based on these scenarios and that the regular reviewing of the monitoring and mitigation indicated that there was no increased collision risk. The approach will be to deploy to a level where the risk is less than one bottlenose dolphin. This deployment will then be monitored with mitigation, such as the use of ADDs if animals come too close to the tidal devices and arrays. The next phase of deployment would only proceed when a review of the monitoring and requirements for mitigation (e.g. how often ADDs were activated), indicates that there is no increased collisions risk. This would be done through the adaptive management and mitigation plan (EMMP) and in consultation with NRW. Therefore, the assessments, including the in-combination

Consultee	Date/Document	Comment	Response
		integrity of European protected sites it may be necessary to consider the proposal under Regulation 64 of the Conservation of Habitats and Species Regulations (“IROPI”).	assessment, is based on the scenarios for less than one bottlenose dolphin, as this would be the worst-case scenario. It is important to note that the output of the devices (MW) used in the assessments have been based on the current minimum rating, as a worst-case scenario and prior to deployment it is expected that the rating (MW) for the devices deployed could be higher for devices of the same or similar parameters. Further assessments will be conducted prior to deployment as part of the adaptive management and mitigation plan (EMMP). For information, indicative assessments for additional collision risk scenarios are presented in **Appendix 12.2** (**Volume III**).

12.4. METHODOLOGY

12.4.1. Study Area

46. Marine mammals are highly mobile and transitory in nature; therefore, it is necessary to examine species occurrence not only within the proposed MDZ, but also over the wider region. For each species of marine mammal, the following study areas have been defined based on the relevant Management Units (MUs), current knowledge and understanding of the biology of each species; taking into account the feedback received during consultation.

- Harbour porpoise Celtic and Irish Seas (CIS) MU;
- Bottlenose dolphin Irish Sea (IS) MU;
- Minke whale Celtic and Greater North Seas (CGNS) MU;
- Risso’s dolphin Celtic and Greater North Seas (CGNS) MU;
- Common dolphin Celtic and Greater North Seas (CGNS) MU;
- Grey seal South and West England and Wales MU and the OSPAR region; and
- Harbour seal in Wales and the OSPAR region.

47. MUs provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (Inter-Agency Marine Mammal Working Group (IAMMWG), 2015). The study areas, MUs and reference populations used in the assessment have been determined based on the most relevant information and scale at which potential impacts from the proposed Project alone and cumulatively with other plans and projects.

48. The status and activity of marine mammals known to occur within or adjacent to the MDZ is considered in the context of regional population dynamics at the relevant scale, depending on the data available for each species and the extent of the agreed reference population.

12.4.2. Data Sources – Site-Specific Surveys and Reports

49. Marine mammal data for the MDZ have been collected by:

- Morlais Natural Power boat surveys data (visual surveys, shared platform with bird surveys): 24 boat surveys from November 2016 to October 2018 (**Appendix 11.1, Volume III**); and
- SEACAMS boat surveys data (visual and acoustic): 18 boat surveys from January 2015 to December 2016 (**Appendix 12.1, Volume III**).

12.4.2.1. Natural Power Surveys

50. Twenty-four surveys were conducted during two years of baseline marine mammal surveys of the Morlais Demonstration Zone (MDZ) between November 2016 and October 2018.

12.4.2.1.1. Survey Vessel

51. The surveys were all undertaken using the vessel Seekat C. The vessel is operated by SeeKat Marine Charters of Amlwch, north Anglesey. The SeeKat C is a Maritime and Coastguard Agency (MCA) Category 2 survey boat and has the following attributes:

- A forward-facing viewing platform with an unobstructed view;
- An observer eye height of greater than 5 m above sea level; and
- Capable of completing surveys at a speed of 5-15 knots (undertaken at 8-12 knots).

12.4.2.1.2. Survey Area

52. The surveyed area was designed to cover the whole of the MDZ (‘the Site’) plus a buffer area around the Site of 2 km (1.08nm) (the ‘survey area’). Note, however, that parts of the buffer on the east side actually encompass land.

53. The survey area was surveyed using 13 parallel transects, of varying length, orientated in a west-east direction. This transect orientation, being approximately perpendicular to the coast, ensured that each transect comprised a similar depth profile. Transects were spaced 0.92 km (0.5nm) apart, which is the minimum transect separation distance specified by boat-based survey guidelines (e.g. Camphuysen *et al*., 2004).

54. Whilst slightly under the recommended 15 transects for robust Distance analysis (Buckland *et al*., 2004), this spacing maximised survey coverage across the MDZ and 2 km buffer. The total length of all transects was 101.94 km (55.04nm). The location of the Site, together with the survey transects are illustrated in **Plate 12-1**.

12.4.2.1.3. Survey Timing

55. The surveys were scheduled to be undertaken on a monthly basis: i.e. one survey per calendar month for two years. On occasion, there were months where a survey was not possible due to poor weather or logistical constraints. Surveys were not undertaken in February, June or October 2017, or in September 2018. These surveys were completed as soon as possible in subsequent months to ensure that the full suite of 24 surveys were carried out within the two year period.

56. Each survey was carried out on a single day and took between five and six hours to complete. The direction along which transects were surveyed was alternated from north to south (Transect 1 to 13) and from south to north (Transect 13 to 1), to build temporal variation into the baseline dataset collected.

57. Surveys were largely undertaken during appropriate weather conditions, considered to be sea state three of less, swell height of <0.5m or less, and visibility of more than 500m.

58. For further details on survey effort, survey methods, data analysis and survey results see **Appendix 11.1** (**Volume III**).

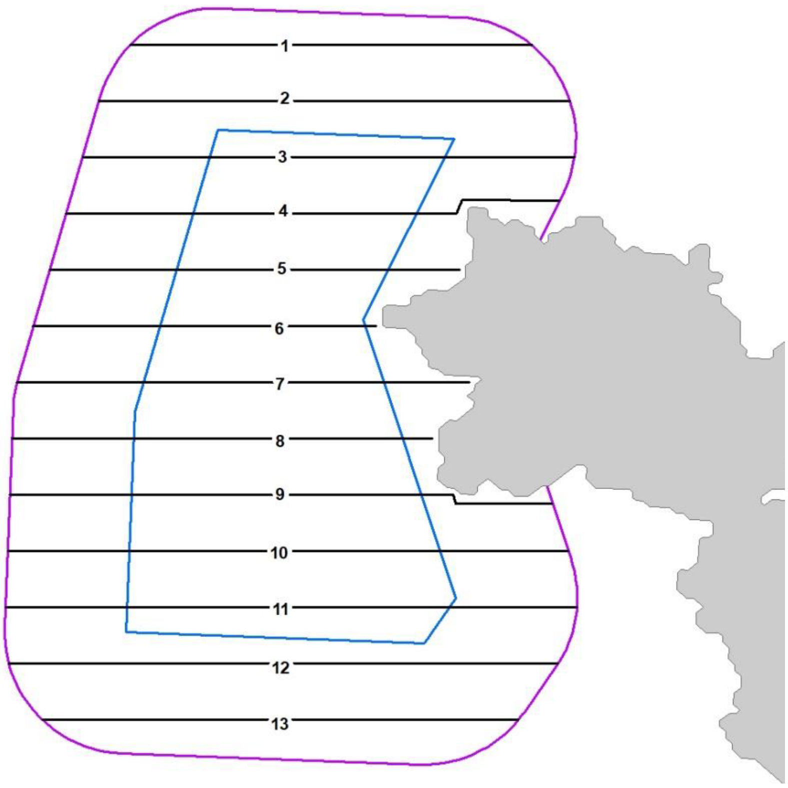

Plate 12-1 Location of Morlais Demonstration Zone (MDZ), the 2 km buffer survey area and transect layout used for Natural Power surveys (Source: Natural Power, 2018)

12.4.2.2. SEACAMS Surveys

59. Eighteen surveys were conducted between January 2015 and December 2016.

12.4.2.2.1. Survey Area and Design

60. The survey site (**Plate 12-2**) covers an area that includes the West Anglesey Demonstration Zone (WADZ) boundary, now the MDZ, as well as a buffer zone. A series of 10 zig zag transect lines were designed to provide even and maximum coverage of the survey area (**Plate 12-2**). Spacing between transect lines is approximately one kilometre. The orientation of the lines were designed so that transects cut across the predominant current direction as shown by a SEACAMS hydrodynamic model in order to minimise fluctuations in speed over ground caused by strong current speeds.

61. Surveys were conducted on days where predominantly Beaufort Sea state was force two or less. These are known to be favourable conditions to collect visual data on harbour porpoise, the target species. The aimed intensity of surveys was one per month, where 1-2 transects were completed at an average speed of 10 knots. Surveys were conducted in all seasons.

12.4.2.2.2. Survey Vessel

62. The surveys were also all undertaken using the 11 metre catamaran ‘Seekat C’, equipped with twin 280hp diesel engines was chartered for surveys. On the roof of the vessel are two purpose-built platforms for up to four observers (two primary and two independent observers). The primary observer platform reaches an eye height of approximately 4.5 metres with slight fluctuations depending on observer height. The eye height of the independent observer platform is approximately 5.5 metres. A wind breaker between the two platforms is used during surveys allowing independence between observers.

63. For further details on survey effort, visual and acoustic survey methods, data analysis and survey results see **Appendix 12.1**.

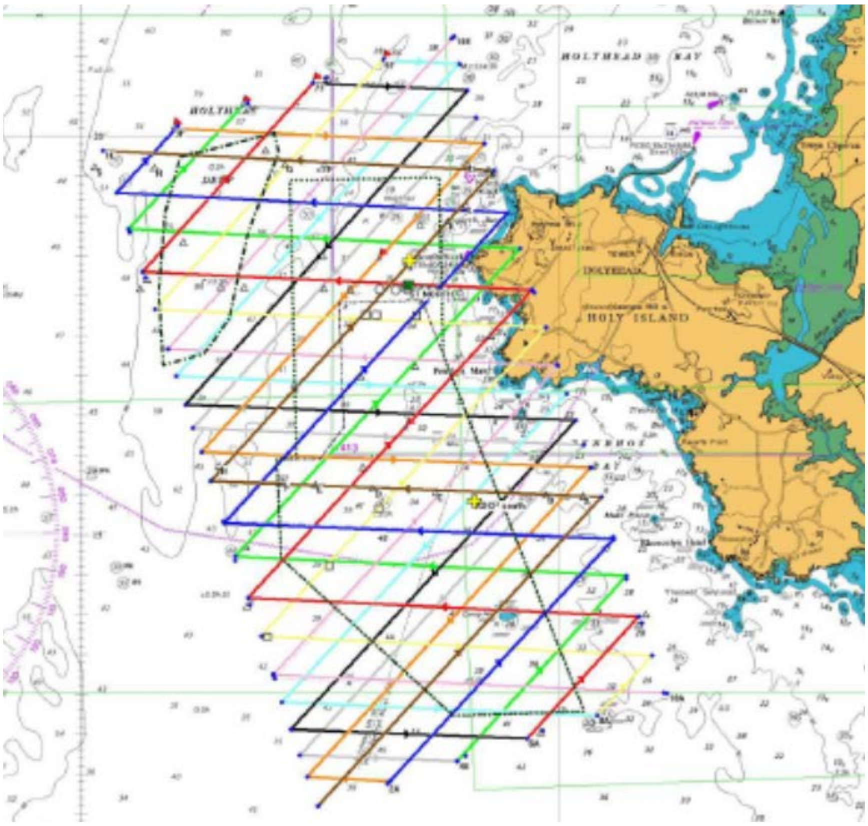

Plate 12-2 SEACAMS survey area and transect lines. One zig zag transect is represented by each colour

12.4.3. Data Sources – Desk Study

64. In addition to the site-specific surveys, a range of other relevant data sources and information has been reviewed to provide information on the marine mammal species that could be present in and around the proposed Morlais site, this includes, but is not limited to:

- Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond *et al*., 2017).
- ObSERVE aerial surveys (Rogan *et al*., 2018);
- Sea Watch Foundation sightings (Sea Watch Foundation, 2019);
- Management Units (MUs) for cetaceans in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG), 2015).
- The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov, 2015).
- Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (Paxton *et al*., 2016).
- UK seal at sea density estimates and usage maps (Russell *et al*., 2017).
- Special Committee on Seals (SCOS) annual reporting of scientific advice on matters related to the management of seal populations (SCOS, 2017).
- All relevant NRW reports, for example, Clarke *et al*. (2018). Grey Seal (*Halichoerus grypus*) Pup Production and Distribution in North Wales.

- Atlas of the Marine Mammals of Wales. Countryside Council for Wales (CCW) Monitoring Report No. 68 (Baines and Evans, 2012).
- UK Offshore Energy Strategic Environmental Assessment. OWESEA3 March 2016 (Department of Energy and Climate Change (DECC), 2016).
- Minesto Deep Green Holyhead Deep Project Environmental Statement and Habitats Regulations Assessment Report (Minesto, 2016).
- Horizon Wylfa Newydd Power Station baseline information, Environmental Statement and information for Habitats Regulations Assessment (Horizon Nuclear Power (HNP), 2018a, b).

12.4.4. Impact Assessment Methodology

65. The general EIA methodology is set out within **Chapter 5, EIA Methodology**. In principle, a matrix approach has been used to assess impacts following best practice and EIA guidance. Each potential impact has been identified using expert judgement and through consultation with NRW. An assessment of the significance has then made based on the sensitivity, value and magnitude of effect.

12.4.4.1. Sensitivity

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

- Adaptability – The degree to which a receptor can avoid or adapt to an effect;
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect;
- Recoverability – The temporal scale over and extent to which a receptor will recover following an effect; and
- Value – A measure of the receptor’s importance and rarity (as reflected in the species conservation status and legislative importance, see **section 12.4.4.2**).

67. The sensitivity to potential impacts of lethality, physical injury, auditory injury or hearing impairment, as well as behavioural disturbance or auditory masking will be considered for each species, using available evidence including published data sources. **Table 12-6** defines the levels of sensitivity and what they mean for the receptor.

Table 12-6 Definitions of sensitivity levels for marine mammals

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

Sensitivity	Definition
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.

12.4.4.2. Value

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

69. In the case of marine mammals, a large number of species fall within legislative policy; all cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin, grey seal and harbour seals are also afforded international protection through the designation of Natura 2000 sites. As such, all species of marine mammal can be considered to be of high value.

70. The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement. **Table 12-7** provides definitions for the value afforded to a receptor based on its legislative importance.

Table 12-7 Definitions of value levels for marine mammals

Value	Definition
High	Internationally or nationally important
Medium	Regionally important or internationally rare
Low	Locally important or nationally rare
Negligible	Not considered to be or particular important or rare

12.4.4.3. Magnitude

71. The significance of the potential impacts is also based on the intensity or degree of impact to the baseline conditions and is categorised into four levels of magnitude: high; medium; low; or negligible, as defined in **Table 12-8**.

72. The thresholds defining each level of magnitude of effect for each impact have been determined using expert judgement, current scientific understanding of marine mammal population biology and JNCC *et al*. (2010) draft guidance on disturbance to EPS species. The magnitude of each effect is calculated or described in a quantitative or qualitative way within the assessment.

73. The number of animals that can be 'removed' from a population through injury or disturbance will vary between species, but is largely dependent on the growth rate of the population; populations with low growth rates can sustain the removal of a smaller proportion of the population. The JNCC *et al*. (2010) draft guidance provides some indication on how many animals may be removed from a population without causing detrimental effects to the population at FCS. The JNCC *et al*. (2010) draft guidance also provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement. As such this guidance has been considered in defining the thresholds for magnitude of effects.

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

75. Permanent effects to greater than 1% of the reference population being affected within a year are considered to be high magnitude in this assessment. The assignment of this level is informed by the JNCC *et al*. (2010) draft guidance (suggesting 4% as the 'default maximum growth rate for cetaceans) but also reflects the large amount of uncertainty in the potential individual and population level consequences of permanent effects.

Table 12-8 Definitions of magnitude levels for marine mammals

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

Value	Definition
	Assessment indicates that between 0.01% and 1% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (limited to phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to effect.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that 0.001% or less of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more (but not permanent, e.g. limited to lifetime of the project). Assessment indicates that 0.01% or less of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (limited to phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that 1% or less of the reference population anticipated to be exposed to effect.

12.4.4.4. Impact Significance

76. Following the identification of receptor sensitivity and the magnitude of the effect, the impact significance is determined using expert judgement. The probability of the impact occurring is also considered in the assessment process. If doubt exists concerning the likelihood of occurrence or the prediction of an impact, a precautionary approach is taken to assign a higher level of probability to adverse effects.

77. The matrix (provided in **Table 12-9**) is used as a framework to aid determination of the impact assessment. Definitions of impact significance are provided in **Table 12-10**. For the purposes of this assessment and specifically the marine mammal assessment, major and moderate impacts are considered to be significant. However, whilst minor impacts would not be considered significant in their own right, they may contribute to significant impacts cumulatively or through inter-relationships.

Table 12-9 Impact significance matrix

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

Table 12-10 Definitions of impact significance for marine mammals

Value	Definition
High	Very large or large changes (either adverse or beneficial) to a receptor (or receptor group), which is important at a population (national or international) level because of the contribution to achieving national or regional objectives, or, a change expected to result in exceedance of statutory objectives and / or breaches of legislation.
Medium	Intermediate or large changes (either adverse or beneficial) to a receptor (or receptor group), which may be an important consideration at national or regional population level. Potential to result in exceedance of statutory objectives and / or breaches of legislation.
Low	Small changes (either adverse or beneficial) to a receptor (or receptor group), which may be raised as local issues but is unlikely to be important at a regional population level.
Negligible	No discernible change in receptor (or receptor group).

78. If mitigation is required or proposed, the assessment will also take into the mitigation to provide the post-mitigation residual impact. If the impact does not require mitigation (or none is possible) the residual impact will remain the same.

12.4.5. Cumulative Impact Assessment

79. The cumulative impact assessment (CIA) identifies areas where the predicted impacts of the construction, operation, maintenance and decommissioning of the proposed Project could interact with impacts from different plans or projects within the same region and impact sensitive receptors.

80. For this assessment, the stages of project development have been considered within the cumulative impact assessment. This was based on guidance issued by JNCC and Natural England in September 2013 and the Planning Inspectorate (2015) Advice Note 17. The assessment therefore takes into consideration: built and operational projects; projects under construction; projects that have been consented (but construction has not yet commenced); projects that have an application submitted to the appropriate regulatory body that have not yet been determined; projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects); and projects that have been identified in relevant strategic plans or programmes.

81. The types of plans and projects taken into consideration, where relevant, include:

- Other marine renewable (wave and tidal) developments;
- Offshore windfarms;
- Aggregate extraction and dredging;
- Licenced disposal sites;
- Shipping and navigation;
- Sub-sea cables and pipelines;
- Port and harbour developments;
- Coastal developments; and
- Oil and gas development and operation, including seismic surveys.

82. The CIA is a two-part process in which an initial list of potential projects is identified with the potential to interact with the proposed Project based on the mechanism of interaction and spatial

extent of the reference population for each marine mammal receptor. The list of projects is then refined based on the level of information available for this list of projects to enable further assessment.

83. The plans and projects screened in to the CIA are:

- Located in the relevant marine mammal population reference area (defined for individual species in the assessment sections); and
- Have potential construction, operational and decommissioning activities which could result in potential cumulative impacts with the construction, operation and decommissioning of the proposed Morlais project.

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

85. Commercial fisheries have the potential to cause a cumulative impact on marine mammals, through both the direct impact of by-catch, the indirect impact through the loss of marine mammal prey species (from commercial fisheries) and the disturbance from underwater noise (from vessel presence). However, by-catch by commercial fisheries is recognised as a historic and continuing cause of marine mammal mortality and will therefore be a factor in shaping the size of the current Management Unit (MU) populations. The available prey has also been influenced by historic and continuing commercial fishing.

86. Noise and disturbance from vessels associated with established activities such as ferry routes, commercial shipping routes and commercial fisheries, are also considered to be part of the baseline conditions.

87. This approach is in accordance with the Planning Inspectorate Advice Note 17 Cumulative Effects Assessment, which states that:

"Where other projects are expected to be completed before construction of the proposed NSIP and the effects of those projects are fully determined, effects arising from them should be considered as part of the baseline".

12.4.6. Transboundary Impact Assessment

88. The potential for transboundary impacts has been addressed by considering the reference populations, MUs, seal telemetry and potential linkages to non-UK sites.

89. The assessment of the effect on the integrity of the transboundary European sites as a result of impacts on the designated marine mammal populations will be undertaken and presented in the Report to inform the HRA.

12.5. EXISTING ENVIRONMENT

90. A review of the Atlas of Marine Mammals of Wales indicates that nineteen marine mammal species have been recorded in Welsh waters since 1990 (Baines and Evans, 2012). The most

regular visitors are harbour porpoise, bottlenose dolphin, grey seal, common dolphin, Risso's dolphin and minke whale. Species recorded more rarely include fin whale, sei whale and humpback whale. Grey seal are also regularly recorded around Wales (Baines and Evans, 2012; SCOS, 2017).

91. The Sea Watch Foundation collate volunteer cetacean sightings from around the UK's coastline. The most recent sightings between October 2018 and February 2019 from around the Welsh coastline have recorded predominantly bottlenose dolphin and harbour porpoise, while other cetacean species that have been sighted included Risso's dolphin and common dolphin (Sea Watch Foundation, 2019). Around Anglesey, the majority of sightings have been of harbour porpoise, bottlenose dolphin, Risso's dolphin and common dolphin (Sea Watch Foundation, 2019).

92. A large-scale survey for cetaceans in European Atlantic waters was conducted in summer 2016 (SCANS-III) in all European shelf waters (Hammond *et al*., 2017). The survey was split into survey areas, or blocks, with the MDZ being located within the SCANS-III survey block E, which recorded harbour porpoise, bottlenose dolphin, Risso's dolphin and minke whale to be present (Hammond *et al*., 2017).

93. The available data from the site specific survey (**Section 12.4.2**) and other data sources (**Section 12.4.3**), indicates that marine mammal species that could be present in and around the MDZ are:

- Harbour porpoise;
- Bottlenose dolphin;
- Risso's dolphin;
- Common dolphin;
- Minke whale;
- Grey seal; and
- Harbour seal.

94. The marine mammal species included in the assessment were agreed with NRW at the second marine mammal technical working group (TWG) meeting in February 2019. **Section 12.5.10** provides a summary of the relevant density estimates and reference populations used in the assessments.

12.5.1. Harbour porpoise

12.5.1.1. Distribution and Occurrence

95. Harbour porpoise distribution is generally restricted to the temperate and sub-arctic waters of the Northern Hemisphere, mainly on the continental shelf at depths of 20-200m and primarily within water temperatures ranging from 11 to 14^{o}C (DECC, 2016; Reid *et al*., 2003).

96. Harbour porpoise are widely distributed throughout the Celtic and Irish Seas during most months of the year (Reid *et al*., 2003; Mackey *et al*., 2004; Baines and Evans, 2012; Hammond *et al*., 2013, 2017; Rogan *et al*., 2018). Their occurrence is not evenly distributed in Welsh waters with

apparent hotspots at the south-west coast of the Lleyn Peninsula, southern Cardigan Bay, in the vicinity of Strumble Head and the west and north Pembrokeshire Coast and Islands (Skomer and Ramsey) and in the Bristol Channel off the south coast of Wales around the Gower Peninsula and in Swansea Bay (Baines and Evans, 2012).

97. Harbour porpoise are typically widely distributed throughout Cardigan Bay, with detections in both inshore and offshore waters. Harbour porpoise clusters were observed in the southern part of Cardigan Bay SAC around Cemaes Head, Pembrokeshire, and harbour porpoise are regularly spotted offshore in both Cardigan Bay and Pen Llŷn a'r Sarnau SACs (Feingold and Evans, 2014b).

98. Localised hotspots also appear to exist off the north and north-west coast of Anglesey, in particular around Point Lynas and South Stack, including Holyhead Deep (Baines and Evans, 2012; Evans *et al*., 2015). Harbour porpoise are likely to be present at these locations throughout the year, with little seasonal variation (Baines and Evans, 2012; Evans *et al*., 2015).

99. During the site-specific surveys for the Wylfa Newydd Development Area, harbour porpoise were the most frequently reported cetacean (HNP, 2018a). The sightings were generally concentrated to the east of the Wylfa Newydd Development Area, in areas in the vicinity of Middle Mouseand Point Lynas. The Vantage Point (VP) surveys indicated that the survey area covered from Wylfa Head, had the highest number of individuals recorded.

100. Heinänen and Skov (2015) provided detailed analyses of 18 years of Joint Cetacean Protocol (JCP) survey data. The model results for the Celtic and Irish Seas indicate that most important factors for probability of presence of harbour porpoise in this MU during summer are increasing current speeds up to 0.4m/s and with increasing eddy activity. In winter, the same response to current speed is observed, although there are lower probabilities with high current speeds (Heinänen and Skov, 2015). The responses to water depth indicate that high densities of harbour porpoise are associated with the shallowest areas (areas shallower than 40m) in summer and high probability of presence in the same areas in winter. During summer, high densities are often associated with sandy-gravelly sediments, with rather low densities in muddy areas (Heinänen and Skov, 2015).

101. The Heinänen and Skov (2015) study identified several persistent high density areas off Wales. Three coastal areas off west Wales (Pembrokeshire and Cardigan Bay), and north-west Wales (Anglesey, Lleyn Peninsula), and part of the Bristol Channel (Camarthen Bay). The distribution of harbour porpoise during the site-specific surveys of the MDZ and 2 km buffer conducted by Natural Power (**Appendix 11.1**), as calculated by the Distance analysis, indicates that the greatest abundance of porpoise occurred in the north of the survey area (**Plate 12-3**).

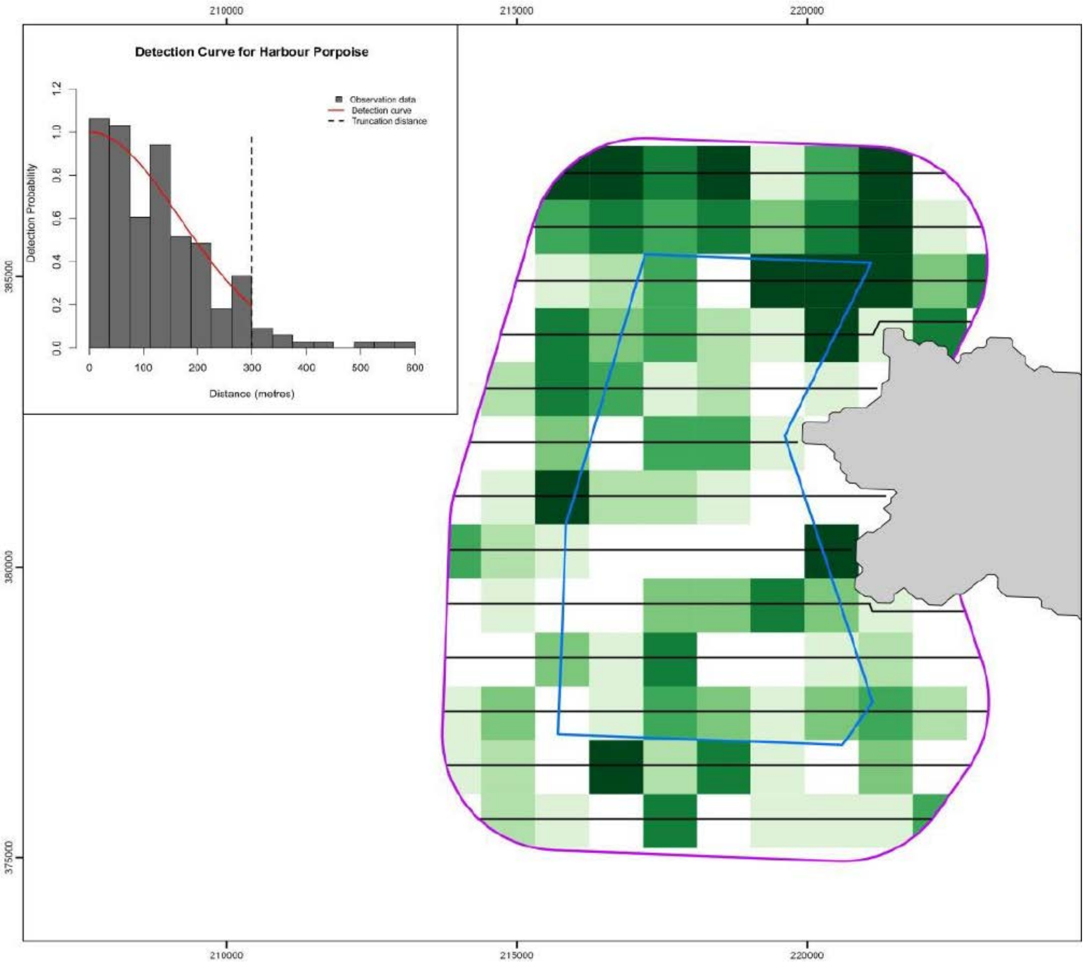

Plate 12-3 Density of harbour porpoise calculated using Distance analysis (and associated detection curve) from Natural Power site specific surveys

12.5.1.2. Abundance and Density Estimates

12.5.1.2.1. Celtic and Irish Seas Management Unit

102. Harbour porpoise within the eastern North Atlantic are generally considered to be part of a continuous biological population that extends from the French coastline of the Bay of Biscay to northern Norway and Iceland (Tolley and Rosel, 2006; Fontaine *et al*., 2007, 2014; IAMMWG, 2015). However, for conservation and management purposes, it is necessary to consider this population as smaller Management Units (MUs). MUs provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (IAMMWG, 2015).

103. The Inter-Agency Marine Mammal Working Group (IAMMWG) defined three MUs for harbour porpoise: The North Sea (NS); West Scotland (WS) and the Celtic and Irish Sea (CIS) (comprising ICES area VI and VII, except VIId). The MDZ is located in the Celtic and Irish Seas MU (**Plate 12-4**), which has an estimated harbour porpoise abundance of 104,695 (CV = 0.32; 95% CI = 56,774-193,065; IAMMWG, 2015), this was based on the SCANS-II survey (Hammond *et al*., 2013) and CODA surveys (Macleod *et al*., 2009).

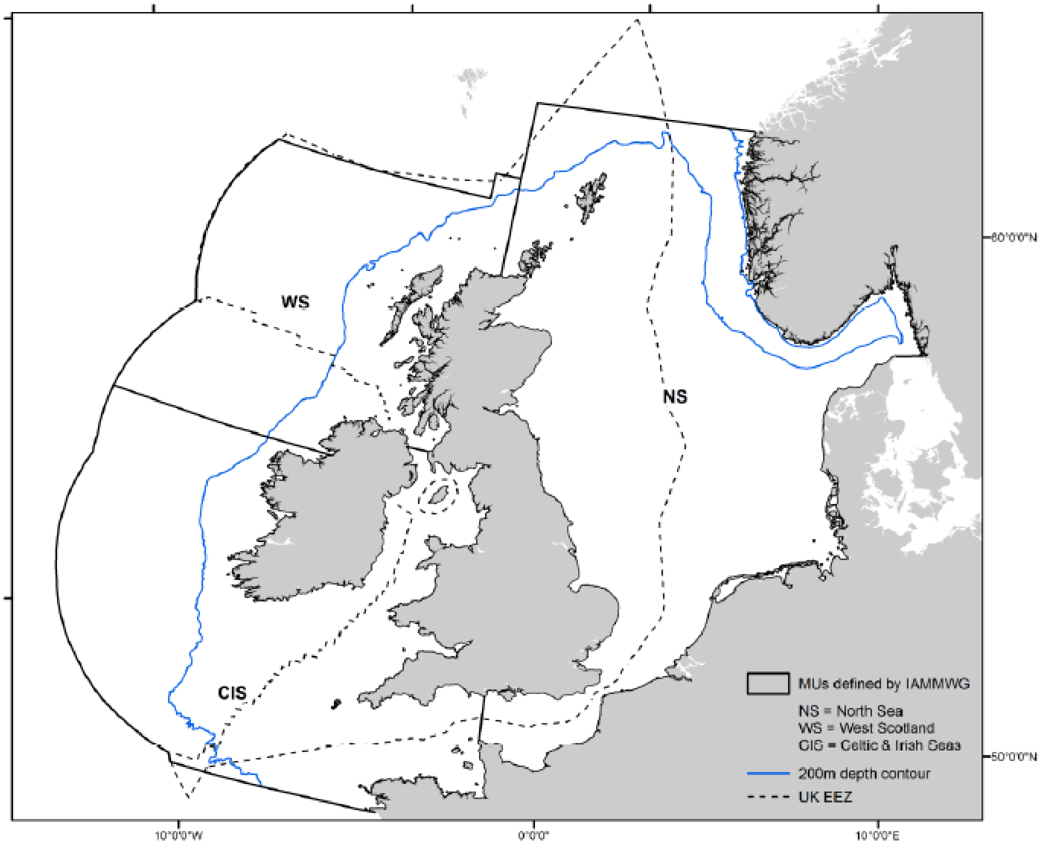

Plate 12-4 Harbour Porpoise Management Units (Source: IAMMWG, 2015)

104. Information provided by NRW (NRW comments on 1st marine mammal TWG meeting), indicates that the abundance estimate for the Celtic and Irish Seas MU based on the original SCANS-II (2005) data was 107,384 (CV = 0.30) and the abundance estimate based on the revised SCANS-II (2005) data was 98,807 (CV = 0.30; 95% CI = 57,315-170,336). The abundance estimate for the Celtic and Irish Seas MU based on the SCANS-III and ObSERVE survey was not available at the time of writing. It was therefore agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019, that the published IAMMWG (2015) abundance estimate for the Celtic and Irish Seas MU was the most appropriate to use in the assessments.

105. For the assessments, the CIS MU has been used as the reference population. This is appropriate to take into account the wide range and distances covered by harbour porpoise. As stated in the North Anglesey Marine / Gogledd Môn Forol SAC Selection Assessment Document "*as a wide-ranging species, the animals within the North Anglesey Marine / Gogledd Môn Forol site cannot be considered isolated in relation to the rest of the population. Animals within the site are part of the wider MU population*" (JNCC and NRW, 2017).

12.5.1.2.2. Joint Cetacean Protocol (JCP) Data

106. The Revised Phase-III Data Analysis of the Joint Cetacean Protocol (JCP) (Paxton *et al*., 2016) and The Identification of Discrete and Persistent Areas of Relatively High Harbour Porpoise Density in the Wider UK Marine Area (Heinänen and Skov, 2015) analyse harbour porpoise abundance and distributions in UK waters. Both projects used numerous data sources collated by the JCP.

107. The two projects, through the use of complex modelling produced distribution maps and estimates of density for harbour porpoise in UK waters. The JCP report specifically aimed to examine abundance and changes in abundance which can be used to assist in environmental impact assessments (Paxton *et al*., 2016). The analyses helped identify discrete and persistent areas of high harbour porpoise density in the UK marine area using habitat mapping; the aim of this project was to assist in the identification of potential harbour porpoise SACs (Heinänen and Skov, 2015).

108. The results of the two projects produced broadly similar modelled densities of harbour porpoise; however, derivation of the results using different modelling approaches resulted in some key differences (JNCC, 2016). For example, the Heinänen and Skov (2015) report uses associations between observed numbers and habitat characteristics and is therefore more likely to provide a realistic picture of harbour porpoise density where effort is low (Paxton *et al*., 2016).

109. As such, JNCC have provided some advice on the use of the outputs in analyses for environmental impact assessments. JNCC (2016) concluded that the Heinänen and Skov (2015) density surfaces better represent the expected distribution and abundance of harbour porpoise for any given area of interest and should, therefore, be used preferentially. The densities from the Heinänen and Skov (2015) report are not currently available for wider use and, in the interim, JNCC advice that the JCP Phase-III density surfaces for harbour porpoise may be used.

110. The revised JCP Report (2016) defines a set of Developer Areas of which are important areas for the development of offshore renewable energy. The closest developer area for harbour porpoise is the Irish Sea Developer Area (with an estimate of 2.2-5.9% of CIS reference population). Other Developer Areas included within the MU are Isle of Wight (0.2-0.8% of CIS MU), Atlantic Array (7.9-18.6% of CIS MU), Strangford Loch (0.2-0.7% of CIS MU) and Solway Firth (0.8-2.2% of CIS MU) (Paxton *et al*., 2016).

12.5.1.2.3. SCANS Data

111. In July 2005, SCANS-II surveyed the entire European Atlantic continental shelf to generate robust estimates of abundance for harbour porpoise and other cetacean species (shown on **Plate 12-5**). For the entire SCANS-II survey area, harbour porpoise abundance in the summer of 2005 was estimated to be 375,358 (CV = 0.197; Hammond *et al*., 2013). The SCANS-II survey estimated that the abundance of harbour porpoise in survey block O (an area of 45,417 km^2), which is located in the Irish Sea and includes the MDZ, was 15,230 individuals (CV = 0.35) and the density was estimated to be 0.335 harbour porpoise per km2 (CV = 0.35) (Hammond *et al*., 2013).

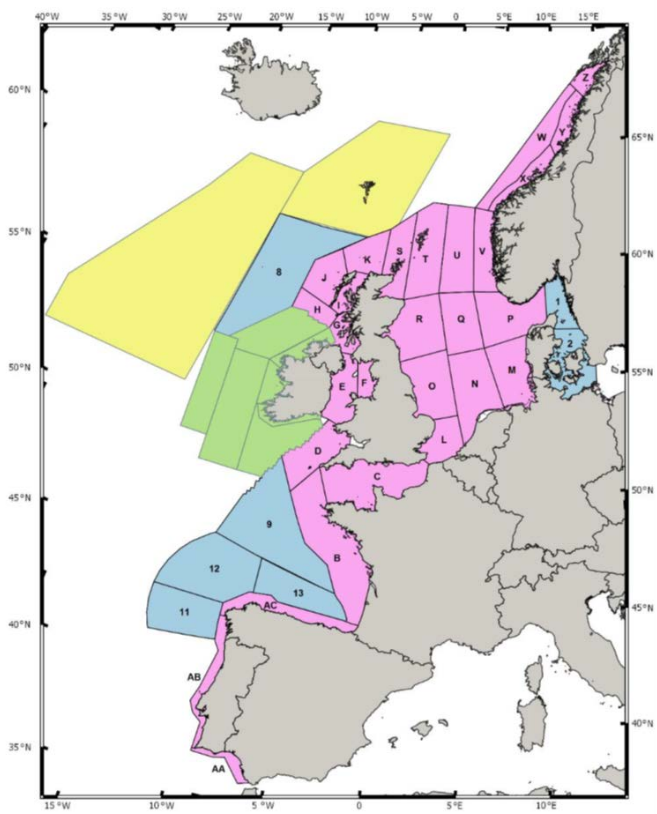

Plate 12-5 Area covered by SCANS-III and adjacent surveys[2] (Source: Hammond *et al*., 2017)

112. SCANS-III in the summer of 2016 surveyed all European Atlantic waters from the Strait of Gibraltar in the south to 62°N in the north and extending west to the 200 nautical miles (nm) limits of all EU Member States (Hammond *et al*., 2017). The survey area was not the same as for SCANS-II. For the entire SCANS-III survey area, harbour porpoise abundance in the summer of 2016 was estimated to be 466,569 with an overall estimated density of 0.381/ km^2 (CV = 0.154; 95% CI = 345,306-630,417; Hammond *et al*., 2017).

113. Estimates for harbour porpoise in the Celtic and Irish Seas ICES Assessment Unit (partial coverage only) during the SCANS-III survey was an abundance of 26,700 and density of 0.11/ km^2 (CV = 0.25; 95% CI = 16,055 – 42,128; Hammond *et al*., 2017).

114. The SCANS-III survey estimated that the abundance of harbour porpoise in survey block E (**Plate 12-5**; surface area of 34,870 km^2), which is located in the Irish Sea and includes the MDZ, was 8,320 individuals and the density was estimated to be 0.239 harbour porpoise per km^2, with a mean group size of 1.31 (CV = 0.28; 95% CI = 4,643 – 14,354; Hammond *et al*., 2017).

[2] SCANS-III areas = pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Adjacent survey = blocks coloured green to the south, west and north of Ireland which were surveyed by the Irish ObSERVE project and blocks coloured yellow which were surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015

In the adjacent area, survey block F (**Plate 12-5**; surface area of 12,322 km^2), the estimated abundance was 1,056 harbour porpoise, with an estimated density of 0.086/ km^2 and mean group size of 1.00 (CV = 0.38; 95% CI = 342-2,010; Hammond *et al*., 2017).

12.5.1.2.4. ObSERVE Data

115. Extensive aerial surveys of Ireland's offshore waters (ObSERVE surveys) were conducted in the summer and winter of 2015 and 2016, with additional surveys conducted in inshore/coastal areas in the summer and winter of 2016. The study area covered waters overlying and beyond Ireland's continental shelf and was divided into five survey strata in 2015, with three smaller inshore strata added in 2016 (**Plate 12-6**). Within each stratum, two zig-zag transects were surveyed, designed to provide equal coverage probability (Rogan *et al*., 2018).

116. During the surveys, harbour porpoises were recorded over a large spatial area during the summer months, but a more coastal distribution was indicated in winter. Harbour porpoises were more commonly sighted in summer, with overall harbour porpoise abundance estimates of 35,975 individuals in summer (CV: 0.09) and 20,571 in winter (CV: 0.23) (Rogan *et al*., 2018).

117. The ObSERVE aerial surveys provide density estimates for the Irish Sea off the Irish Coast (Rogan *et al*., 2018). For stratum 5 (**Plate 12-6**), which covered the east coast of Ireland, the density estimates were 0.696 and 1.046 harbour porpoise per km^2 during the summer 2015 and 2016 periods, respectively; and during the winter periods were 0.867 and 0.924 harbour porpoise per km^2 in 2015 and 2016, respectively (as provided in **Section 12.5.1.2.7**).

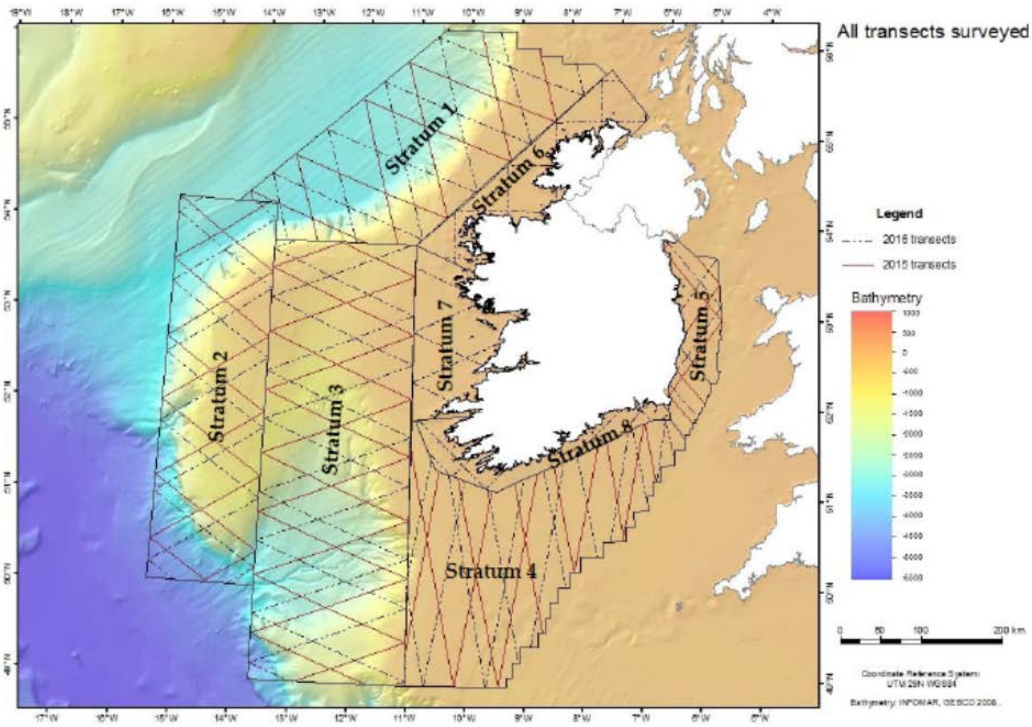

Plate 12-6 ObSERVE aerial transect lines flown in summer and winter 2015 and 2016 in relation to bathymetry (Source: Rogan *et al*., 2018)

12.5.1.2.5. Cardigan Bay

118. Harbour porpoise abundance estimates for the whole of Cardigan Bay between 2011 and 2013 have more than halved over the three years with an estimated 1074 in 2011, 565 in 2012 and 410 individuals in 2013 (Feingold and Evans, 2014b).

119. However, within Cardigan Bay SAC, harbour porpoise abundance estimates have changed little over the years, the only exception being in 2011 (**Plate 12-7**). The relatively high estimate in 2011 (340), reflects the very high CV due to low effort coverage, and the number of actual observations was low (n=20) whereas the estimates for 2012-13 are similar to those obtained in earlier years (2005-07).

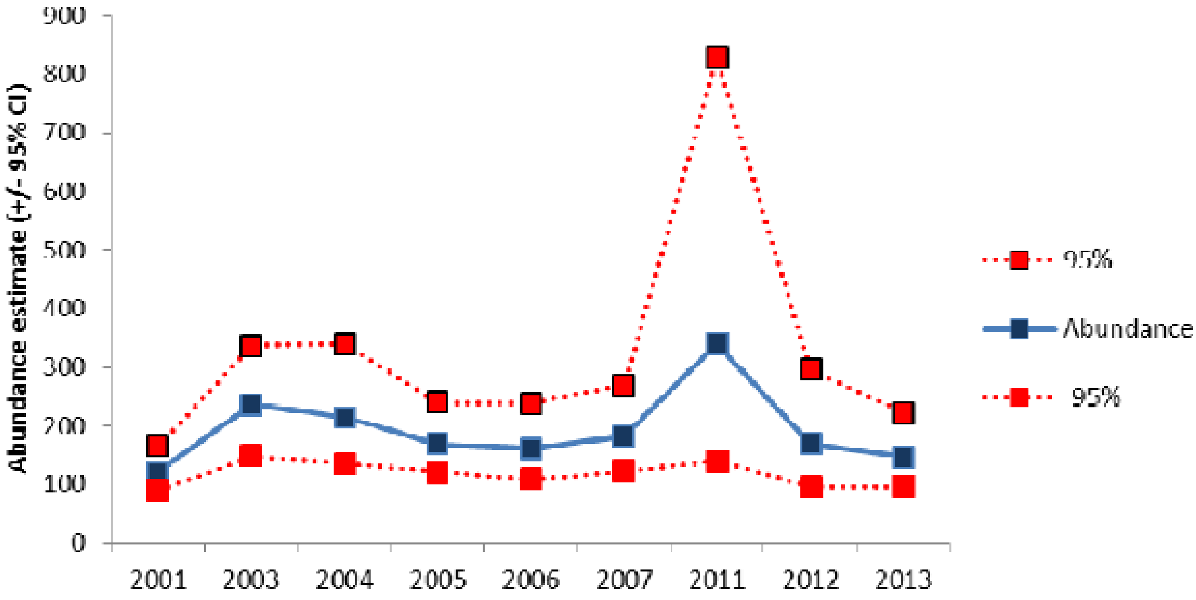

Plate 12-7 Abundance estimates of harbour porpoise in Cardigan Bay SAC, 2001-13 (Source: Feingold and Evans, 2014b)

12.5.1.2.6. North Anglesey Survey Data

120. Two dedicated studies of the harbour porpoise population around the north coast of Anglesey have been undertaken that cover some of the MDZ.

121. Shucksmith *et al*. (2009) conducted dedicated harbour porpoise surveys between 2002 and 2004 covering an area of approximately 489 km^2 extending from the east of Point Lynas to the west of South Stack on the north coast of Anglesey. In the three year study, visual and acoustic methods were used to detect the animals along 31 transects extending out from the shore between May and September. Shucksmith *et al*. (2009) assumed a g(0) of 1, where g(0) is the probability of detecting an animal on track line during the survey. If all animals were detected then g(0) would be 1, if half the animals were missed (e.g. they were under the water and not surfacing) then g(0) would be 0.5. In reality the g(0) for harbour porpoise is never as high as 1, so the Shucksmith *et al*. (2009) data likely represents an underestimate for this species. Shucksmith *et al*. (2009) estimated that the minimum number of harbour porpoise off the north

coast of Anglesey was 309 individuals (CV = 0.20), with an estimated density of 0.63 individuals per km^2. When g(0) is 0.5 is applied to the data, based on a precautionary scenario that half of the harbour porpoise were submerged, the estimated maximum abundance is 618 individuals, with a density estimate of 1.26 individuals per km^2.

122. The harbour porpoise study area used by Shucksmith *et al*. (2009) was split in to five sectors: South Stack (SS); Holyhead Harbour (HB); Carmel Head (CH); Middle Mouse (MM); and Point Lynas (PL). The Morlais Development Zone is located in the South Stack sector, where the estimated abundance was 207 harbour porpoise with an estimated density of 2.54/ km^2, based on g(0) is 0.5. However, it is important to note that 75% of all detections were made within 5 km of the shoreline in this sector and that harbour porpoise in the SS area were more randomly distributed compared to other areas, such as Point Lynas, where they tend to concentrate around specific features (Shucksmith *et al*., 2009).

123. Gordon *et al*. (2011) undertook cetacean surveys off the north-west coast of Anglesey at two locations, Carmel Head and South Stack. The visual and towed hydrophone acoustic surveys, passive acoustic monitoring from static acoustic loggers and visual observations from shore authors were conducted in July and August 2009. Based on acoustic detection rates and assuming a group size of 1.5 (mean of primary and tracker observers mean group sizes), an effective survey strip width of 186m and using no g(0) correction (i.e. they assumed they had seen all of the animals), they estimated that the overall density of harbour porpoise in the two survey areas (Carmel Head and South Stack) to be 0.38 individuals km^2. After applying their expected g(0) of 0.68, the density estimate was 0.56 individuals km^2.

124. Gordon *et al*. (2011) also deployed five automated acoustic data loggers (TPODS) to the north of the Holyhead Deep site around the Skerries and Carmel Head in summer 2009. They confirmed relatively high detection rates of harbour porpoise in the area, with detections every day (and night) of the study. Activity levels were reported to be highest at night, probably due to diurnal patterns in prey availability (Gordon *et al*., 2011).

12.5.1.2.7. Site-Specific Survey Data

125. During the Natural Power boat surveys of the MDZ and 2 km buffer, harbour porpoise was the most frequently sighted cetacean species and comprised 93% of all marine mammals recorded. The total number of observations of harbour porpoise from the 24 months of surveys was 233 individuals (range 0-76 per survey). January 2017 and April 2018 resulted in the highest encounter rates (number of on-effort marine mammal encounters per km survey effort) for harbour porpoise, with 0.255 and 0.177 encounters per km survey effort, respectively (**Appendix 11.1**, **Volume III**).

126. There were sufficient records of harbour porpoise (170) to allow Distance analysis to be undertaken. Within the Site, harbour porpoise peaked at an estimated 1.00 animals/ km^2 during the January 2017 survey (35 individuals). However, it should be noted that although detectability of animals available for detection is accounted for in this analysis, these figures still represent a minimum estimate since the assumption of g(0) = 1 (i.e. all animals were observed and recorded) will provide an underestimate (**Appendix 11.1**, **Volume III**). The harbour porpoise abundance and density estimates for the Natural Power surveys are provided in **Table 12-11**.

127. Over the course of the 24 Natural Power surveys all tidal conditions were encountered within the survey area. The data indicates that the greatest number of porpoises were present mid-tide, when then the tide was rising (**Appendix 11.1**, **Volume III**).

Table 12-11 Harbour porpoise abundance and density estimates (animals/ km^2), lower 95% (confidence limits (LCL) - upper 95% confidence limits (UCL); coefficient of variation (%CV)) derived from distance sampling (Appendix 11.1; Natural Power, 2018).

Survey Month	Abundance (LCL- UCL)	Density (LCL – UCL;%CV)
November 2016	Site = 6 (1 - 39) Buffer = 26 (11 - 63)	Site = 0.17 (0.02 – 1.11; 98.78) Buffer = 0.40 (0.16 – 0.96; 42.71)
December 2016	Site = 0 Buffer = 10 (4 - 27)	Site = 0 Buffer = 0.15 (0.05 – 0.41; 49.09)
January 2017	Site = 35 (13 - 97) Buffer = 3 (1 - 21)	Site = 1.00 (0.36 – 2.76; 46.6) Buffer = 0.64 (0.26 – 1.57; 42.98)
February 2017	Site = 18 (6 - 51) Buffer = 3 (1 - 21)	Site = 0.50 (0.17 – 1.46; 49.37) Buffer = 0.05 (0.01 – 0.32; 103.75)
March 2017	Site = 9 (3 - 28) Buffer = 0	Site = 0 Buffer = 0.25 (0.08 – 0.79; 53.54)
April 2017	Site = 3 (0 - 19) Buffer = 32 (15 - 68)	Site = 0.08 (0.01 – 0.54; 97.19) Buffer = 0.50 (0.23 – 1.05; 35.7)
May 2017	Site = 0 Buffer = 0	Site = 0 Buffer = 0
June 2017	Site = 9 (3 - 26) Buffer = 35 (19 - 67)	Site = 0.25 (0.08 – 0.75; 50.63) Buffer = 0.54 (0.29 – 1.03; 30.35)
July 2017	Site = 9 (3 - 26) Buffer = 13 (4 - 39)	Site = 0.25 (0.08 – 0.75; 50.82) Buffer = 0.20 (0.07 – 0.60; 54.12)
August 2017	Site = 3 (0 - 21) Buffer = 3 (1 - 21)	Site = 0.08 (0.01 – 0.59; 102.84) Buffer = 0.05 (0.01 – 0.32; 103.39)
October 2017	Site = 6 (1 - 25) Buffer = 3 (1 - 20)	Site = 0.05 (0.01 – 0.31; 102.17) Buffer = 0.17 (0.04 – 0.71; 69.52)
November 2017	Site = 6 (1 - 25) Buffer = 16 (5 - 53)	Site = 0.04 (0.04 – 0.71; 69.52) Buffer = 0.25 (0.08 – 0.81; 58.94)
December 2017	Site = 0 Buffer = 13 (4 - 41)	Site = 0 Buffer = 0.20 (0.06 – 0.63; 57.5)
January 2018	Site = 0 Buffer = 10 (2 - 41)	Site = 0 Buffer = 0.15 (0.03 – 0.63; 74.72)
February 2018	Site = 3 (0 - 19) Buffer = 19 (10 - 36)	Site = 0.08 (0.01 – 0.54; 97.19) Buffer = 0.30 (0.16 – 0.56; 29.83)
March 2018	Site = 23 (11 - 50) Buffer = 32 (11 - 95)	Site = 0.67 (0.31 – 1.42; 34.11) Buffer = 0.50 (0.17 – 1.46; 53.22)
April 2018	Site = 3 (0 - 19) Buffer = 10 (2 - 39)	Site = 0.08 (0.01 – 0.54; 97.19) Buffer = 0.15 (0.04 – 0.60; 71.01)
May 2018	Site = 6 (1 - 23) Buffer = 10 (4 - 25)	Site = 0.15 (0.06 – 0.39; 46.25) Buffer = 0.15 (0.06 – 0.39; 46.25)

Survey Month	Abundance (LCL- UCL)	Density (LCL – UCL;%CV)
June 2018	Site = 15 (6 - 37) Buffer = 10 (3 - 29)	Site = 0.42 (0.16 – 1.06; 42.65) Buffer = 0.05 (0.05 – 0.45; 54.32)
July 2018	Site = 6 (1 - 24) Buffer = 10 (3 - 29)	Site = 0.17 (0.04 – 0.67; 66.74) Buffer = 0.05 (0.05 – 0.45; 54.92)
August 2018	Site = 3 (0 - 21) Buffer = 16 (7 - 39)	Site = 0.08 (0.01 – 0.59; 102.55) Buffer = 0.25 (0.10 – 0.59; 41.9)
September 2018	Site = 9 (3 - 25) Buffer = 13 (4 - 42)	Site = 0.25 (0.09 – 0.73; 49.26) Buffer = 0.20 (0.06 – 0.64; 58.6)
October 2018	Site = 12 (5 - 28) Buffer = 6 (2 - 25)	Site = 0.33 (0.14 – 0.81; 40.18) Buffer = 0.10 (0.03 – 0.38; 68.86)

128. Dedicated harbour porpoise surveys have been conducted off West Anglesey as part of the SEACAMS project which includes the Morlais site (**Plate 12-2**). The boat surveys collected visual and acoustic data. Eighteen surveys were completed between January 2015 and December 2016, totalling 25 transects, 884 km of effort on transects covering an area of 707 km^2.

129. The SEACAMS data (**Appendix 12.1**, **Volume III**), provides a range of relative and absolute density estimates calculated for harbour porpoise off Holy Island, Anglesey. The relative density of individuals is estimated to be 0.43 animals per km^2 (CV=0.18). Correcting for incomplete detection on the track line to compensate for under-estimation, density ranges from 0.714 (CV=0.33) to 0.852 (CV=0.33) individuals per km^2, with a mid-point of 0.783 harbour porpoise per km^2 (**Table 12-12**).

130. The SEACAMS density estimate is consistent with the density estimate range from the Natural Power Morlais site surveys of 0.5-1/ km^2 (Natural Power, 2018; **Appendix 11.1**, **Volume III**).

131. The SEACAMS density estimate is higher than the SCANS-III density estimate of 0.239/ km^2 (CV = 0.28) for the Irish Sea area covered by SCANS-III survey block E (Hammond *et al*., 2017). The SEACAMS survey was conducted close to the coast and in high energy waters, both of which are known to be preferred by harbour porpoise (e.g. Shucksmith *et al*., 2005). The increased number of harbour porpoise closer to shore is reflected in the higher density estimates from the shore based surveys conducted by Shucksmith *et al*. (2009) on the North Anglesey Coast and South Stack (**Table 12-12**).

132. For the assessments, the density estimate of 0.783 harbour porpoise per km^2 has been used, based on the SEACAMS data. This was agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

Table 12-12 Harbour porpoise density estimates

Area	Density Estimate	Source
West Anglesey (**Plate 12-2**)	0.714/ km^2 to 0.852/ km^2 (CV=0.33) mid-point = **0.783/ km^2**	SEACAMS (Veneruso *et al*., 2019)
Morlais site surveys* **(Plate 12-1**)	0.5-1/ km^2	Natural Power (2018)

Area	Density Estimate	Source
SCANS-III Block E (**Plate 12-5**)	0.239/ km^2 (CV = 0.28)	Hammond *et al*. (2017)
North Anglesey Coast	1.26/ km^2 (CV = 0.25)	Shucksmith *et al*. (2009)
North Anglesey Coast (South Stack)	2.534/ km^2 (CV = 0.23)	Shucksmith *et al*. (2009)
ObSERVE aerial surveys – stratum 5 Summer 2015 (**Plate 12-6**)	0.696/ km^2 (CV=0.35)	Rogan *et al*. (2018)
ObSERVE aerial surveys – stratum 5 Winter 2015/16 (**Plate 12-6**)	0.867/ km^2 (CV=0.46)	Rogan *et al*. (2018)
ObSERVE aerial surveys – stratum 5 Summer 2016 (**Plate 12-6**)	1.046/ km^2 (CV=0.46)	Rogan *et al*. (2018)
ObSERVE aerial surveys – stratum 5 Winter 2016/17 (**Plate 12-6**)	0.924/ km^2 (CV=0.3)	Rogan *et al*. (2018)
Celtic and Irish Seas (CIS) MU (**Plate 12-4**)	0.858/ km^2 (entire CIS MU) 0.758/ km^2 (UK portion of CIS MU)	IAMMWG (2015)

*Natural Power Morlais site surveys: The precautionary estimate would be 1/ km^2 = the maximum calculated on site, but the mode and median are both 0.17 – which is considerably lower (19 of the 24 samples are below 0.25; 22 of the 24 samples are below 0.5). Therefore, a value of 0.5/ km^2, is a precautionary estimate for 22 of the 24 months.

Table 12-13 Harbour porpoise abundance estimates

Area	Abundance Estimate	Source
Celtic and Irish Seas (CIS) MU (**Plate 12-4**)	**104,695** (95% CI = 56,774-193,065)	IAMMWG (2015)
UK portion of Celtic and Irish Seas (CIS) MU (**Plate 12-4**)	47,229 (95% CI = 25,611-87,094)	IAMMWG (2015)
Celtic/Irish Seas (partial coverage only; **Plate 12-5**)	26,700 (95% CI =16,055-42,128)	Hammond *et al*. (2017)
SCANS-III Block E (**Plate 12-5**)	8,320 (95% CI = 4,643-14,354)	Hammond *et al*. (2017)
North Anglesey Coast	618 (95% CI = 406-909)	Shucksmith *et al*. (2009)
North Anglesey Coast (South Stack)	207 (95% CI = 140-329)	Shucksmith *et al*. (2009)
ObSERVE aerial surveys – stratum 5 Summer 2015 (**Plate 12-6**)	7,734 (95% CI = 5,248 – 11,398)	Rogan *et al*. (2018)

Area	Abundance Estimate	Source
ObSERVE aerial surveys – stratum 5 Winter 2015/16 (**Plate 12-6**)	9,636 (95% CI = 5,634 – 16,483)	Rogan *et al*. (2018)
ObSERVE aerial surveys – stratum 5 Summer 2016 (**Plate 12-6**)	11,625 (95% CI = 8,726 – 15,486)	Rogan *et al*. (2018)
ObSERVE aerial surveys – stratum 5 Winter 2016/17 (**Plate 12-6**)	10,264 (95% CI = 7,555 – 13,943)	Rogan *et al*. (2018)
JCP estimate for Celtic and Irish Seas Management Unit	21,714 (95% CI = 20,639.97 23,914.07)	JCP data (Paxton *et al*., 2016)

12.5.1.3. Habitat

133. In coastal waters, aggregations of harbour porpoise are often associated at local sites with strong tidal features, such as headlands, sounds between islands, areas with upwelling, tidal races and rips, often close to reefs and small islands, where prey are probably concentrated into patches providing favourable foraging conditions (Gaskin, 1992; Read and Westgate, 1997; Pierpoint, 2001, 2008; Marubini *et al*., 2009; Shucksmith *et al*., 2009). By-catch data from Ireland suggests that harbour porpoise occur regularly offshore, with records from up to 220 km from land (Rogan and Berrow, 1996) and they have also been sighted in deep water areas beyond the shelf edge (Northridge *et al*., 1995; MacLeod *et al*., 2003).

134. The north coast of Anglesey is characterised by many overlaying rocks and a broken, uneven seabed comprising pinnacles and gullies leading to rapid changes in seabed relief (Gordon *et al.,* 2011). This type of topography, in combination with the area's strong currents, precipitates a range of fine-scale oceanic tidal features with which harbour porpoises are commonly associated (Shucksmith *et al.,* 2009).

135. As outlined in **Chapter 7, Metocean Conditions and Coastal Processes**, most of the sea bed in the MDZ comprises large areas of outcropping bedrock with minimal relief above surrounding bed levels. Secondary bathymetric features include a large, generally symmetric, sand ridge north of South Stack which extends to the northwest for approximately 1 km (within the offshore cable corridor). Within Abraham's Bosom (a bay towards the landfall), the bathymetry is smoother, representing the surface of an area of sediment on top of the bedrock, bounded by rock outcrops to the north and south.

12.5.1.4. Diet

136. The diet of the harbour porpoise consists of a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and Ammodytes. Other prey species such as cephalopods, other molluscs, crustaceans and polychaetes have also been recorded. The diet varies geographically, seasonally, annually, overtime and differences in diet between sexes or age classes may also exist, reflecting changes in available food resources (Berrow and Rogan, 1995; Kastelein *et al*., 1997; Börjesson *et al*. 2003; Santos and Pierce 2003; Santos *et al*., 2004).

137. The main prey fish species of harbour porpoise typically include sandeels Ammodytidae, whiting *Merlangius merlangus*, herring *Clupea harengus*, sprat *Sprattus sprattus*, cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, saithe *Pollachius virens*, pollack *Pollachius pollachius*, Norway pout *Trisopterus esmarkii* as well as flat fish such as flounder *Platichthys flesus* and sole *Solea solea* (Rogan and Berrow, 1996; Reid *et al*., 2003; Santos and Pierce, 2003; Santos *et al*., 2004).

138. Taking into account the fish species recorded in the area in **Chapter 10, Fish and Shellfish Ecology**, prey species of harbour porpoise in and around the MDZ is likely to include: sandeel, whiting, cod, mullet species, pollack, herring, sprat, Atlantic mackerel *Scomber scombrus*, horse mackerel *Trachurus Trachurus*, flounder and sole

139. Harbour porpoise tend to concentrate their movements in small focal regions (Johnston *et al*., 2005), which often approximate to particular topographic and oceanographic features and are associated with prey aggregations (Raum-Suryan and Harvey, 1998; Johnston *et al*., 2005; Keiper *et al*., 2005; Tynan *et al*., 2005). Consequently, habitat use is highly correlated with prey density rather than any particular habitat type. However, JNCC (2017a) states that for the Gogledd Môn Forol/North Anglesey Marine SAC, it is unknown which features of the habitat are the most important drivers of the association with prey or what the main prey species of harbour porpoise within the site are.

140. Harbour porpoise have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein *et al*., 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it has been estimated that it can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997).

141. A study by Wisnlewska *et al*. (2016) using high-resolution movement and prey echo recording tags on five wild harbour porpoise has shown that porpoises forage nearly continuously day and night, attempting to meet their metabolic demands foraging on small prey.

12.5.1.5. Movements and Seasonal Occurrence

142. The seasonal movements and migratory patterns of harbour porpoise are not well understood. Harbour porpoise may reside within an area for an extended period of time, although onshore / offshore migrations and movements parallel to the shore are also thought to occur (Northridge *et al*., 1995; Bjørge and Tolley, 2002). Seasonal movements are thought to coincide with prey availability and the calving and mating seasons.

143. Harbour porpoise are highly mobile and satellite telemetry work in Danish waters has shown an individual moving more than 1,000 km from Danish waters to east of the Shetland Islands (Teilmann *et al*., 2004). In Danish waters, harbour porpoise have been shown to concentrate their movements in relatively large areas, ranging from approximately 400 to 1,600 km^2 (Teilmann *et al*., 2004). In the western North Atlantic, individuals are known to range over quite large areas, covering as much as 11,289 km^2 within a single month (Johnston *et al*., 2005).

144. Although harbour porpoise are highly mobile and utilise extensive areas over which they range, they tend to occupy small core areas or focal regions for short periods and then make rapid

movements over periods of hours to days across larger scales to other restricted areas (Johnston *et al.,* 2005; Fontaine *et al.,* 2007), which often correspond with reliable feeding opportunities (Marubini *et al*., 2009).

145. In many coastal localities, there can be distinct seasonal peaks in harbour porpoise sightings. The sightings of harbour porpoise in the Irish Sea typically peak during the summer months (in particular June to August) (Evans *et al*., 2015).

146. A study into the temporal and seasonal changes in the distribution of harbour porpoise off the North Cornwall coast revealed the highest peaks in harbour porpoise detections occurred from late December to early March. This trend was shown to be a negative correlation with Sea Surface Temperatures (SST), i.e. as sea temperatures decreased, harbour porpoise detection rates increased. Harbour porpoise detection also varied significantly with the spring-neap tidal cycle, with a significantly increase in detection during neap tides (Cox *et al*., 2017).

147. The seasonal movements and temporal changes in distributional patterns observed are likely to reflect the changes in preferred prey availability and patterns (Skov and Thomsen, 2008; Simon *et al.*, 2010; Sveegaard *et al.*, 2011, 2012).

148. Site-specific surveys indicate that harbour porpoise are present in and around the MDZ year round. As outlined in **Table 12-11**, harbour porpoise were recorded within the site and / or buffer in every month during the Natural Power surveys between November 2016 and October 2018 (**Appendix 11.1**).

12.5.1.6. Life History

149. The calving period for harbour porpoise is primarily between May and July, when sea temperatures are increasing (Read 1990; Sørensen and Kinze 1994; Lockyer, 1995; Bandomir-Krischack 1996; Börjesson and Read 2003; Learmonth *et al*., 2014).

150. At present, not enough is known about harbour porpoise to determine whether some parts of their range are more important for breeding than others. Potential calving grounds have been identified in the German North Sea (Sonntag *et al*., 1999), but there is currently no evidence of specific habitat requirements for mating and calving in UK waters (JNCC, 2002, 2019).

151. Harbour porpoises typically occur in groups of 1-3 animals; larger aggregations have been reported, probably where many smaller groups are concentrated in the same area rather than coordinated schools (Reid *et al*., 2003).

152. During the Natural Power boat surveys of the MDZ and 2 km buffer, most harbour porpoise records were of single animals (73% of sightings) but groups of up to three animals were observed. There were 61 records of two individuals and 11 groups of three individuals recorded. Most of the porpoises recorded were given a behaviour of 'slow swimming'; with eight records (14 animals) recorded as 'foraging', although such behaviour is likely to have been under-recorded (**Appendix 11.1**, **Volume III**).

153. During the SEACAMS surveys, harbour porpoise group size ranged between 1 and 5 animals with a mean estimated group size of 1.53 (CV=0.07; **Appendix 12.1**, **Volume III**).

12.5.1.7. Conservation Status

154. The current conservation status of the harbour porpoise, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2013), is ‘Favourable’ (JNCC, 2013).

12.5.2. Bottlenose dolphin

12.5.2.1. Distribution and Occurrence

155. The bottlenose dolphin has a worldwide distribution across tropical and temperate seas of both hemispheres and can be found in coastal and continental shelf waters (Reid *et al*., 2003; DECC, 2016). In most regions, including the UKCS, inshore and offshore ‘sub-populations’ tend to be distinct (DECC, 2016; Oudejans *et al*., 2015; IAMMWG, 2015). In UK waters, inshore individuals are frequently reported off north-east and south-west Scotland, in the Irish Sea, and in the western English Channel (DECC, 2016; IAMMWG, 2015).

156. There are two main areas of UK territorial waters where there are semi-resident groups of bottlenose dolphin: Cardigan Bay in Wales and the Moray Firth on the north-east coast of Scotland. Both of these areas have been designated SAC for bottlenose dolphin. There are also smaller populations of bottlenose dolphin off south Dorset and around Cornwall (Williams *et al.,* 1996; Wither *et al.,* 2012; JNCC, 2019).

157. Bottlenose dolphin are recorded in the western Channel off the coast of Cornwall throughout most of the year (DECC, 2016). A small, possibly resident, population of bottlenose dolphin may also occur in the waters around the Inner Hebrides and sightings are also reported off the west coast of the Outer Hebrides, in the Sound of Barra and in the northern entrance to the Minch (Grellier and Wilson, 2003; Mandleberg, 2006; DECC, 2016; JNCC, 2019). Transient groups are not infrequent almost anywhere around the British coast except the southern North Sea and south-east England (JNCC, 2019).

158. In the Irish Sea, bottlenose dolphin have a predominantly coastal distribution, with higher concentrations off west Wales (particularly Cardigan Bay) and off the coast of Co. Wexford in southeast Ireland. They are also regularly sighted in summer off the Galloway coast of southwest Scotland and around the Isle of Man (Hammond *et al*., 2005, Baines and Evans, 2012; DECC, 2016). During the ObSERVE aerial surveys, only one sighting of five individuals in winter 2016 was made in stratum 5 (**Plate 12-6**), which covered western Irish Sea and east coast of Ireland (Rogan *et al*., 2018).

159. In Welsh waters, the inshore population is centred on Cardigan Bay, although bottlenose dolphin are also regularly observed in the coastal waters between Cardigan Bay and Anglesey (Pesante *et al*., 2008a,b), with concentrations in south Cardigan Bay, south of the Lleyn Peninsula and off Anglesey (Baines and Evans, 2012). There are also regular sightings in the coastal waters to the east of Anglesey around Bull Bay and towards the Llandudno coast (Evans *et al*., 2015). Bottlenose dolphin are most commonly seen in Cardigan Bay within 10 miles of the coast and particularly within two miles; sightings are greatest in the southern portion of the bay (Feingold and Evans, 2014b).

160. During the site-specific boat surveys for the Wylfa Newydd Development Area, two sightings totalling 14 individuals of bottlenose dolphin (a pod of four and 10 individuals respectively). The first sighting occurred in May 2016 to the east of the Wylfa Newydd Development Area, approximately 3 km off Cemaes Bay. The second sighting (consisting of adults and one calf) was recorded in January 2017 to the west of Cemlyn Bay, approximately 4 km offshore (HNP, 2018a). During the Wylfa Newydd Development Area VP surveys between 2011 and 2014, bottlenose dolphin were sighted in Cemlyn Bay and off Cerrig Brith (HNP, 2018a).

161. During the Natural Power surveys between November 2016 and October 2018 (**Appendix 11.1**, **Volume III**), one group of 12 bottlenose dolphin were recorded during the February 2018 survey.

162. Three sightings of bottlenose dolphin were recorded during the SEACAMS surveys (**Appendix 12.1**, **Volume III**).

12.5.2.2. Abundance and Density Estimates

12.5.2.2.1. Irish Sea Management Unit

163. A number of inshore groups of bottlenose dolphin have been identified in UK and Irish waters and there appears to be limited interchange between these groups Robinson *et al*., 2012; Cheney *et al*., 2013; ICES, 2014; IAMMWG, 2015).

164. IAMMWG (2015) currently recognise seven MUs for bottlenose dolphin in UK waters:

(1) Coastal West Scotland and the Hebrides (CWSH, to 12nm);

(2) Coastal East Scotland (CES, to 12nm);

(3) Greater North Sea (GNS);

(4) Offshore Channel and SW England (OCSW);

(5) Coastal West Channel (CWC, to 12nm);

(6) Irish Sea (IS); and

(7) Oceanic Waters (OW).

165. The MDZ is located in the Irish Sea MU (**Plate 12-8**), which has an estimated bottlenose dolphin abundance of 397 (CV = 0.23; 95% CI = 362-414; IAMMWG, 2015; **Table 12-15**). This reference population was agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

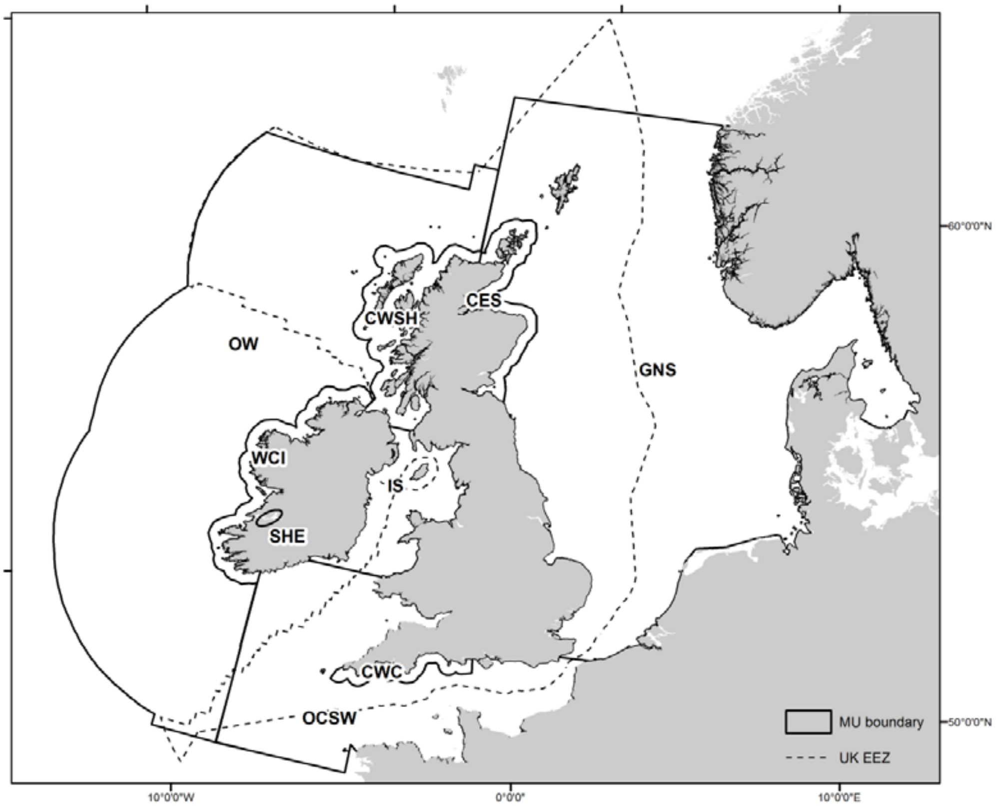

Plate 12-8 Bottlenose Dolphin MUs (source: IAMMWG, 2015)

12.5.2.2.2. SCANS data

166. For the entire SCANS-II survey area, bottlenose dolphin abundance in the summer of 2005 was estimated to be 16,485 (CV = 0.422; Hammond *et al*., 2013). The SCANS-II survey estimated the abundance of bottlenose dolphin in survey block O, which is located in the Irish Sea and includes the MDZ, to be 235 individuals (CV=0.75) and the density was estimated to be 0.0052 bottlenose dolphin per km^2 (CV=0.75) (Hammond *et al*., 2013).

167. For the entire SCANS-III survey area (not the same as SCANS-II area), bottlenose dolphin abundance in the summer of 2016 was estimated to be 27,697 with an overall estimated density of 0.015/ km^2 (CV = 0.233; 95% CI = 17,662 – 43,432; Hammond *et al*., 2017).

168. The SCANS-III survey estimated that the abundance of bottlenose dolphin in survey block E (**Plate 12-5**; surface area of 34,870 km^2), which is located in the Irish Sea and includes the MDZ, was 288 individuals and the density was estimated to be 0.008 bottlenose dolphin per km^2, with a mean group size of 1.50 (CV = 0.57; 95% CI = 0-664; Hammond *et al*., 2017). In the adjacent area, survey block F (**Plate 12-5**; surface area of 12,322 km^2), no bottlenose dolphin were recorded (Hammond *et al*., 2017).

12.5.2.2.3. Cardigan Bay

169. Cardigan Bay is the largest population in the UK with annual estimates for the wider area varying between 254 and 330 animals (CV = 0.25 – 0.28) for the years 2011 and 2013 inclusive (Feingold and Evans, 2013, 2014a, b).

170. Maximum density estimate based on area of Cardigan Bay Special Area of Conservation (SAC) (approx. 959 km^2) and maximum number of dolphins in the population (330 individuals), is 0.344 bottlenose dolphin per km^2.

171. The population is not closed as individuals may join up for periods of time from elsewhere (Reid *et al*., 2003) and sightings of individuals initially reported off the south-west coast of England, have been observed in Welsh waters (Wood, 1998; Hammond *et al*., 2008).

172. Photo identification studies completed by the Sea Watch Foundation (Veneruso and Evans, 2012a,b) have revealed that of 221 bottlenose dolphin recorded between 2007 and 2012 off the north coast of Anglesey, 141 (64%) had been previously recorded within the Bae Ceredigion/ Cardigan Bay SAC, as well as north of the Llyn Peninsula, and many had additionally been recorded within the Pen Llyn a'r Sarnau/Llyn Peninsula and the Sarnau SAC (Veneruso and Evans, 2012a,b). This indicates that the majority of the Cardigan Bay population of bottlenose dolphin move between the two sites.

173. Within the same study, bottlenose dolphin encountered from the north coast of Anglesey (n=28) were investigated to determine the seasonal movements of bottlenose dolphin. It was revealed that of the dolphins recorded in the winter surveys (December to February), 95% had previously been recorded within Cardigan Bay, supporting the theory that there is a seasonal movement of dolphins from Cardigan Bay to the north coast of Anglesey within the winter months (Veneruso and Evans, 2012a,b). During spring (March to May), 62% of the individuals recorded along the north coast of Anglesey had previously been recorded in Cardigan Bay, 38% were recorded in the summer (June to August) and 98% in the autumn (September to November). This pattern gives a clear indication of the movement of bottlenose dolphins from Cardigan Bay in summer to the north coast of Anglesey and the Llyn Peninsula in the autumn and winter (Veneruso and Evans, 2012a,b).

174. A review of the field research (2011-13) conducted by the Sea Watch Foundation for bottlenose dolphin in the Cardigan Bay and Pen Llŷn a’r Sarnau SACs (Feingold and Evans, 2014b), indicates that the entire coastal area from Aberaeron to Cardigan appears to be of particular significance. Bottlenose dolphin sightings have also been regularly reported in North Wales, particularly around the Isle of Anglesey but extending east into Liverpool Bay and north to at least the Isle of Man (Feingold and Evans, 2014b).

175. Photo-identification surveys off the coast of Anglesey, along with data provided from the Isle of Man and Liverpool Bay, indicate that individuals from Cardigan Bay extend their home ranges, particularly in winter, to the northern Irish Sea at least as far as the Isle of Man (Feingold and Evans, 2014b).

176. In addition to winter sightings of the species in the northern Irish Sea, bottlenose dolphin have also been recorded off the North Wales coast and across to Liverpool Bay in summer (Feingold and Evans, 2014b; Veneruso and Evans, 2011a,b).

12.5.2.2.4. Site-Specific Survey Data

177. There is currently insufficient data from the site-specific surveys to provide any estimates for abundance or density (**Appendix 11.1** and **12.1**, **Volume III**).

178. To take into account the range of bottlenose dolphin from Anglesey to Cardigan Bay, including the Cardigan Bay SAC and Lleyn Peninsula SAC (**Figure 12-1, Volume II**), the density estimate has been based on 330 dolphins in an area of 16,098 km^2 (**Table 12-14**). For the assessments, the density estimate of 0.02 bottlenose dolphin per km^2 has been used. This was agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

Table 12-14 Bottlenose dolphin density estimates

Area	Density	Source	Notes
Area from Anglesey to Cardigan Bay (**Figure 12-1, Volume II**)	**0.02/ km^2**	Feingold and Evans (2013)	Density estimate is based on area of 16,098 km^2 and maximum number of 330 individuals.
Cardigan Bay SAC and Lleyn Peninsula SAC	0.136/ km^2	Feingold and Evans (2013)	Density estimate is based on area of Cardigan Bay SAC & Lleyn Peninsula and the Sarnau SAC (approx. 2,419 km^2) and maximum number of 330 individuals.
Cardigan Bay SAC	0.344/ km^2	Feingold and Evans (2013)	Density estimate is based on area of Cardigan Bay SAC (approx. 959 km^2) and maximum number of 330 individuals.
Lleyn Peninsula SAC	0.226/ km^2	Feingold and Evans (2013)	Density estimate based on area of Lleyn Peninsula and the Sarnau SAC (approx. 1460 km^2) and maximum number of BND (330 individuals).
SCANS-III Block E (**Plate 12-5**)	0.008/ km^2 (CV = 0.57)	Hammond *et al*. (2017)	For context of the density estimate for the wider area.
Irish Sea (IS) MU (**Plate 12-8**)	0.009/ km^2 (Whole IS) 0.009/ km^2 (UK IS)	IAMMWG (2015)	For context of the density estimate for the wider area.
ObSERVE aerial surveys – stratum 5 Winter 2016/17 (**Plate 12-6**)	0.036/ km^2 (CV=0.94)	Rogan *et al*. (2018)	No bottlenose dolphin estimates available for stratum 5 for other seasons

Table 12-15 Bottlenose dolphin abundance estimates

Area	Abundance Estimate	Source
Irish Sea (IS) (**Plate 12-8**)	**397** (CV = 0.23; 95% CI = 362–414)	IAMMWG (2015)
SCANS-III Block E (**Plate 12-5**)	288 (95% CI = 0-664)	Hammond *et al*. (2017)
Cardigan Bay SAC	330 (CV = 0.24; 95% = CI 203-534)	Feingold and Evans (2013)
Lleyn Peninsula SAC	Up to 330 (CV = 0.24; 95% CI 203-534)	Feingold and Evans (2013)
ObSERVE aerial surveys – stratum 5 Winter 2016/17 (**Plate 12-6**)	401 (95% CI = 76 – 2015)	Rogan *et al*. (2018)
JCP estimate for Irish Seas Management Unit	1,863 (95% CI = 1,827 – 1,890)	JCP data (Paxton *et al*.,2016)

12.5.2.3. Habitat

179. Throughout its range, the bottlenose dolphin occurs in a diverse range of habitats, from shallow estuaries and bays, coastal waters, continental shelf edge and deep open offshore ocean waters. However, it is primarily an inshore species, with most sightings within 10 km of land, but they can also occur offshore, often in association with other cetaceans (JNCC, 2019).

180. In coastal waters, bottlenose dolphin are often associated with river estuaries, headlands or sandbanks, where there is uneven bottom relief and/or strong tidal currents (e.g. Lewis and Evans, 1993; Wilson *et al*., 1997; Liret *et al*., 1998; Liret, 2001; Ingram and Rogan 2002; Reid *et al*., 2003).

181. Within Cardigan Bay, bottlenose dolphins appear to use specific habitats consistently. Areas within 3.2 km of the shoreline, with strong currents, in proximity to rocky headlands and near small embayments and estuaries, are the habitats most frequented by the bottlenose dolphin (Lewis and Evans, 1993; Arnold and Mayer, 1995).

182. Within Cardigan Bay, bottlenose dolphin appear to use specific habitats. For example, areas within 3.2 km of the shoreline, with strong currents, in proximity to rocky headlands and near small embayments and estuaries, are the habitats most frequented by the bottlenose dolphin (Lewis and Evans, 1993; Arnold and Mayer, 1995). Habitat analysis shows preference for areas between 5m and 10m in depth, although areas of between 25m and 30m depth have seen an increase in sightings since 2005 with the majority of the sightings in this region occurring over the slope range of Cardigan Bay (Pesante *et al.,* 2008b).

183. The predominant bottlenose dolphin behaviour noted within the Cardigan Bay SAC was travelling or foraging, while in Pen Llyn the behaviours noted included consistently higher levels of socialising behaviours (Norrman *et al*., 2015). This suggests that the northern sector of Cardigan Bay may be a socialising and mating ground whereas the southern areas are key foraging and nursery areas (Norrman *et al*., 2015).

184. A photo-monitoring study researching connectivity of bottlenose dolphin in Wales (Pesante *et al*., 2008a), suggests that their preference for Cardigan Bay is a result of the shallow bathymetry and diverse benthic habitats, in addition to the fact that significant numbers of salmonids pass through the bay during migration.

12.5.2.4. Diet

185. Bottlenose dolphin are opportunistic feeders and take a wide variety of fish and invertebrate species. Benthic and pelagic fish (both solitary and schooling species), including haddock, saithe, pollock, cod, whiting, hake *Merluccius merluccius*, blue whiting *Micromesistius poutassou*, bass *Dicentrarchus labrax*, mullet Mugilidae, mackerel Scombridae, salmon *Salmo salar*, sea trout *Salmo trutta trutta*, flounder, sprat and sandeels, as well as octopus and other cephalopods have all been recorded in the diet of bottlenose dolphin (Santos *et al*., 2001; Santos *et al*., 2004; Reid *et al*., 2003).

186. In Irish waters, haddock, saithe and pollock are the dominant prey species, followed by whiting, blue whiting, Atlantic mackerel and horse mackerel; cephalopods are also important (Hernandez-Milian *et al*., 2015). The stomach contents analysis of three individuals in the Irish

Sea indicated a highly variable diet comprising horse mackerel, hake, mackerel, poor cod, pollock, whiting and saithe (Couperus, 1995; O'Brien and Berrow, 2006).

187. Diet analysis suggests that bottlenose dolphin are selective opportunists and although they may have preference for a type of prey, their diet seems to be determined largely by prey availability. Research in Australia has shown that when presented with a choice, they will preferentially feed on certain types of prey, particularly those with a high fat content (Corkeron *et al*., 1990).

188. Taking into account the fish species recorded in the area, as outlined in **Chapter 10, Fish and Shellfish Ecology**, the main prey species of bottlenose dolphin in and around the MDZ is likely to include a wide range of prey species such as salmon, sea trout, bass, mullet, whiting, mackerel, sandeels and flat fish.

12.5.2.5. Movements and Seasonal Occurrence

189. Greatest numbers are thought to occur in UK waters between July and October with a secondary peak in some localities in March-April (Reid *et al.,* 2003; Evans *et al.,* 2003) although animals are present all year round in some areas (Wilson *et al.,* 1997; Veneruso and Evans, 2012a, b; Cheney *et al.,* 2013). Analyses of photo-identification data from multiple studies have also shown that bottlenose dolphin can make long-distance movements (Robinson *et al.,* 2012).

190. In Cardigan Bay, the population ranges over an area wider than the SAC, which likely includes all of the west and north Wales coasts and a wide area of the Irish Sea (DECC, 2016). The distribution of bottlenose dolphin is variable with main concentrations in the summer being around Tremadog Bay and southern Cardigan Bay (Evans *et al.,* 2015; Feingold and Evans, 2014b). Sightings of bottlenose dolphin occurring around the coast of north Wales, primarily Anglesey, differed considerably to those in Cardigan Bay, with the most frequent sightings occurring during winter (Pesante *et al.,* 2008b), suggesting possible seasonal movements in the area (Norman *et al.,* 2015). Although there are a higher number of bottlenose dolphin off north Anglesey in the winter months, bottlenose dolphin are present off north Anglesey throughout the year (Veneruso and Evans, 2012a, b).

191. During photo-identification studies of bottlenose dolphin in Scotland, one individual was identified south of Aberdeen and then re-identified off Burghead 52 hours later, representing a distance of 218 km and a minimum swimming speed of 4.2 km/h (Wilson *et al.,* 2004). For consecutive sightings five or less days apart, the median rate of travel for dolphins identified primarily within the inner Moray was 0.071 km/h, whereas for dolphins observed using areas outwith the inner Moray Firth it was significantly greater at 0.22 km/h. Similarly, during sightings in the outer Moray Firth and along the coasts south of Fraserburgh the median rate of progress was 7.6 km/h, which was twice as fast as in the inner Moray Firth (3.9 km/h) (Wilson *et al.,* 2004).

12.5.2.6. Life History

192. Indications suggest that bottlenose dolphin in UK waters may have two calving peaks in the year (Evans, 1980) or an extended breeding season, meaning that calves can often be observed throughout the year. Calves stay with their mothers for at least four years (Smolker *et al*., 1992), but have been reported to stay together until the calf is eight years old (Grellier *et al*., 2003).

193. Cardigan Bay SAC is an important calving area for bottlenose dolphin. There are also two other important calving areas in north wales: the Pen Llyn Sarnau and the Isle of Anglesey (Feingold and Evans, 2013, 2014a). Peak calving times within the Cardigan Bay SAC are generally between July and September (when approximately 76% of all calves are born), although calving may occur at any time (Norrman *et al*., 2015).

194. There is currently not enough information to determine what, if any, the habitat requirements are for any breeding areas or calving areas for bottlenose dolphins in UK waters.

12.5.2.7. Conservation Status

195. The current conservation status, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), of the bottlenose dolphin is ‘favourable’ (JNCC, 2013).

12.5.3. Risso’s dolphin

12.5.3.1. Distribution and Occurrence

196. Risso’s dolphin are seasonally recorded in the Celtic and Irish Seas (IAMMWG, 2015). There distribution is thought to be a relatively localised, running in a wide band running southwest to northwest Wales, encompassing west Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey (Evans *et al.,* 2015). Risso’s dolphin are also found on the southeast coast of Ireland and around the Isle of Man (Baines and Evans, 2012).

197. During the ObSERVE aerial surveys, sightings of Risso’s dolphins were recorded in summer 2015 and 2016 in stratum 5 (**Plate 12-6**), which covered western Irish Sea and east coast of Ireland. These coastal sightings in the western Irish Sea likely represent a frequently sighted community that regularly appears near the Saltee Islands off Co. Wexford (Rogan *et al*., 2018).

198. Risso’s dolphin are sighted regularly around the northern and western part of the Lleyn Peninsula, with a hot spot around Bardsey Island, and are rarely sighted in Cardigan Bay (Baines and Evans, 2012). Risso’s dolphin are thought to present along the north coast of Anglesey all year round. Although abundance increases during the summer and autumn months (July to October) however sightings vary every year (Baines and Evans, 2012).

199. There were no sightings of Risso’s dolphin along the north coast of Anglesey during land-based surveys undertaken for the Wylfa Newydd project during 2011 to 2014 (HNP, 2018) and only one sighting of a single individual was recorded during transit for the dedicated vessel transect surveys. The dedicated vessel transect surveys yielded three sightings of Risso’s dolphin with an average pod size of two individuals (HNP, 2018a).

200. During the Natural Power surveys between November 2016 and October 2018, Risso’s dolphin were encountered during three surveys (September 2017, May and October 2018; **Appendix 11.1**, **Volume III**). The two sightings of 8 individuals during the September 2017 survey was outwith the MDZ and buffer area. During the May 2018 survey there were two observations of 11 individuals and during the October 2018 survey there were three observations of 20 individuals. Most of these observations were in the buffer area rather than the MDZ (**Plate 12-9**).

201. Four sightings of Risso's dolphin were recorded during the SEACAMS surveys and these were all outside of the MDZ (**Appendix 12.1**, **Volume III**).

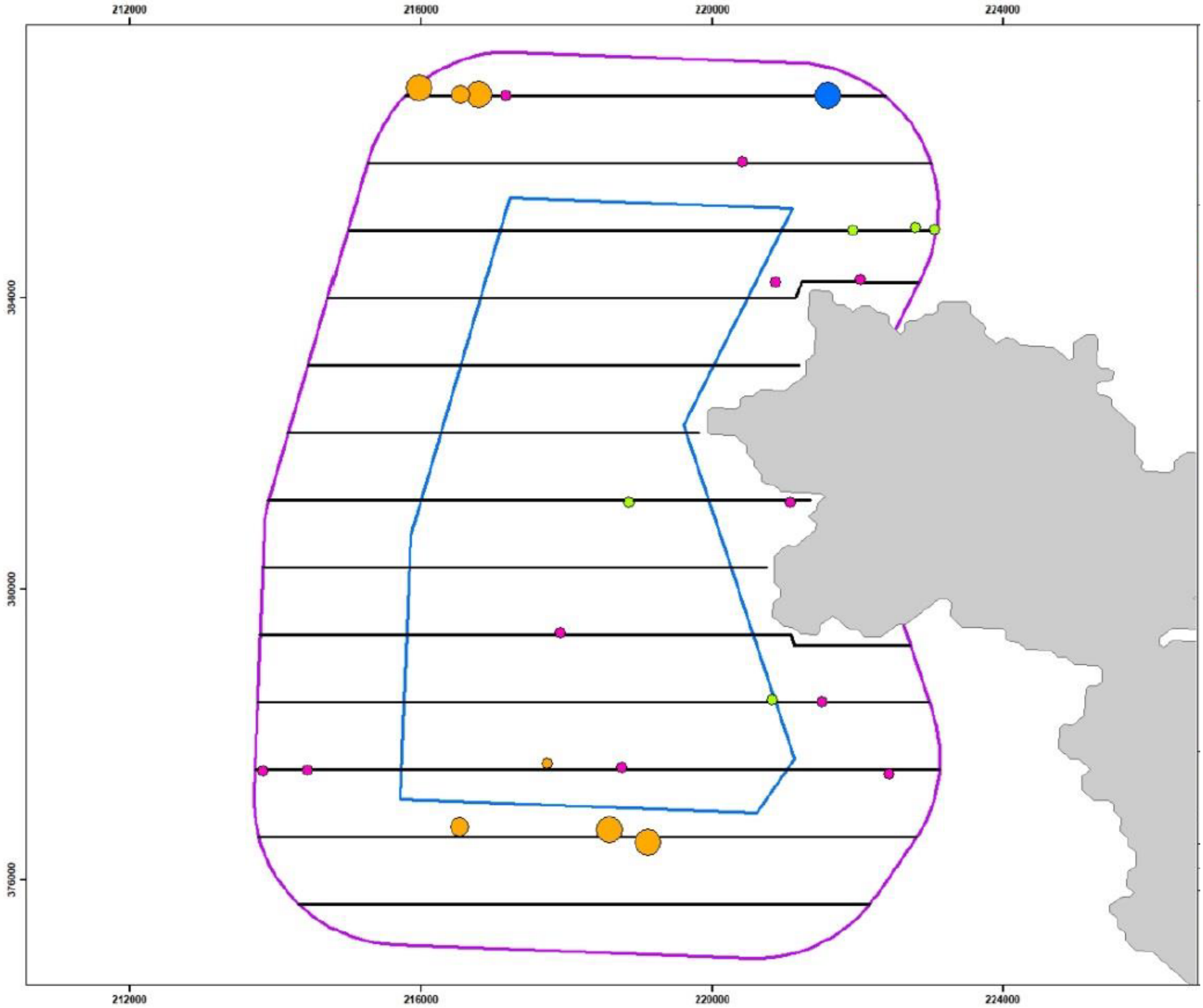

Plate 12-9 Distribution of marine mammal (excluding harbour porpoise) sightings (on-effort, off-effort and incidental) survey during Natural Power surveys (November 2016 to October 2018; Appendix 11.1)

12.5.3.2. Abundance and Density Estimates

202. The IAMMWG (2015), recommends a single MU, the Celtic and Greater North Seas (CGNS) MU comprising all UK waters and extending to the seaward boundary used by the European Commission for Habitats Directive reporting, with the eastern boundary determined by OSPAR's Regional Seas boundary (**Plate 12-10**).

203. The JCP abundance estimate for Risso's dolphin in the Celtic and Greater North Sea Management Unit is 8,794 (95% CI = 8,695 – 8,848) (Paxton *et al.,* 2016; **Table 12-16**). The JCP abundance estimates of Risso's dolphin in the Irish Sea Development Area were highest in spring with an abundance estimate of 70 individuals (CI = 0 – 280) and summer abundance estimate of 30 individuals (CI = 0 – 160) (Paxton *et al*., 2015).

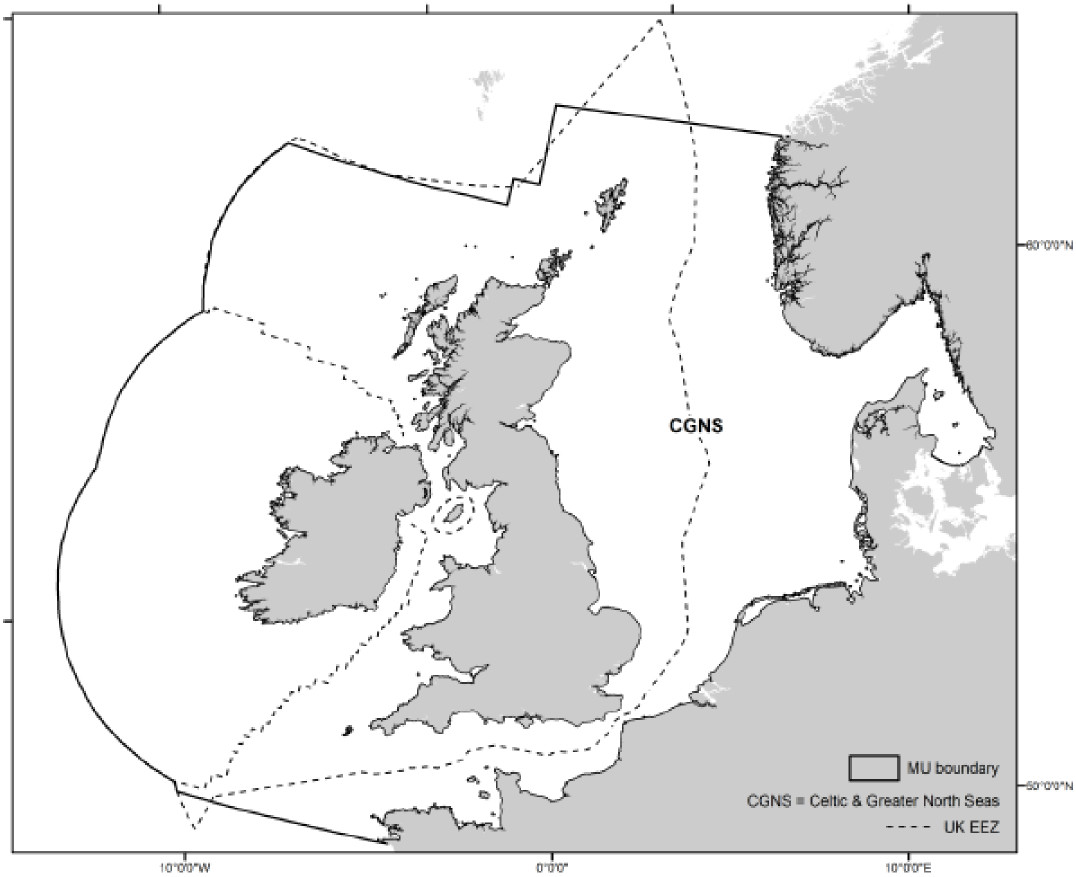

Plate 12-10 Celtic and Greater North Seas (CGNS) MU (source: IAMMWG, 2015)

204. The SCANS-III survey estimated that the abundance of Risso's dolphin in survey block E, which is located in the Irish Sea and includes the MDZ (**Plate 12-5**), was 1,090 individuals and the density was estimated to be 0.031 Risso's dolphin per km^2, with a mean group size of 7.50 (CV = 0.69; 95% CI = 0-2,843; Hammond *et al*., 2017; **Table 12-16**). In the adjacent area, survey block F, no Risso's dolphin were recorded (Hammond *et al*., 2017).

Table 12-16 Risso's dolphin abundance and density estimates

Area	Abundance Estimate	Density Estimate	Source
SCANS-III Block E (**Plate 12-5**)	1,090 (95% CI = 0-2,843)	**0.031/ km^2** (CV = 0.69)	Hammond *et al.* (2017)
JCP estimate for Celtic and Greater North Sea Management Unit (**Plate 12-10**)	**8,794** (95% CI = 8,695 – 8,848)	N/A	JCP data
ObSERVE aerial surveys – stratum 5 (Summer 2015) (**Plate 12-6**)	35.1 (95% CI =7-188)	0.0032/ km^2 (CV=0.96)	Rogan *et al.* (2018)

12.5.3.3. Diet

205. Risso's dolphin feed mostly on cephalopods including octopus, cuttlefish, and small squid (Santos *et al*. 1994). They also feed on pelagic and benthic fish species (Kruse *et al*. 1999; Bloch *et al*. 2012).

12.5.3.4. Conservation Status

206. The current conservation status, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), of the Risso's dolphin is 'unknown' (JNCC, 2013).

12.5.4. Common dolphin

12.5.4.1. Distribution and Occurrence

207. The common dolphin is the most numerous offshore cetacean species in the north east Atlantic, most often sighted off the western coast of the UK, in the Celtic Sea, and western approaches to the Channel (Reid *et al*., 2003).

208. The MU for common dolphin encompasses the whole of the Celtic and Greater North Seas (**Plate 12-10**), with the majority of sightings having been reported south of 60˚N (Murphy *et al*. 2013; IAMMWG, 2015). The distribution of common dolphins in the Irish Sea is typically concentrated in the south, in an area offshore of Pembrokeshire called Celtic Deep, just within the 12nm territorial limit of Wales (Baines and Evans, 2012). In the northern Irish Sea, the densities of common dolphin are relatively low with another hotspot for common dolphin off the Isle of Man (Baines and Evans, 2012).

209. No common dolphin were recorded in stratum 5 of the Irish Sea (**Plate 12-6**) during the ObSERVE aerial surveys in summer and winter 2015 and 2016 (Rogan *et al*., 2018).

210. Sightings in Welsh waters are mainly in the summer with fewer individuals recorded in the winter, however it should be noted that survey effort in the winter months is low (Baines and Evans, 2012). However, the Phase-III Joint Cetacean Protocol reported the highest abundance estimate of 310 common dolphin (CI = 110 – 860) in autumn, which is significantly higher than summer estimate of 80 common dolphin (CI = 30 – 260) (Paxton *et al*., 2017).

211. One sighting was recorded for common dolphin by the Sea Watch Foundation (2019) which was for a group of 10 at Point Lynas, Anglesey on the 17th November 2018 (Sea Watch Foundation, 2019).

212. No common dolphin were sighted during the site-specific surveys for the Wylfa Newydd Development Area (HNP, 2018a).

213. No common dolphin were sighted during the MDZ site specific surveys conducted by Natural Power (**Appendix 11.1, Volume III**) and SEACAMS (**Appendix 12.1, Volume III**).

12.5.4.2. Abundance and Density Estimates

214. The abundance of common dolphin in the CGNS MU is 56,556 (CV = 0.28; 95% CI = 33,014-96,920; **Table 12-17**) and the UK component (abundance within the UK EEZ) is 13,607 (CV = 0.23; 95% CI = 8,720-21,234). These estimates were derived from SCANS-II (Hammond *et al*., 2013) and Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA; Macleod *et al*., 2009) and are likely to be biased low due to perception bias that could not be corrected for in the aerial surveys (IAMMWG, 2015).

215. The SCANS-III survey did not record any common dolphin in survey block E (surface area of 34,870 km²). SCANS-III survey block D, which is also located in the south-west (**Plate 12-5**) had an abundance of 18, 458 and the density was estimated to be 0.374/ km², with a mean group size of 10.06 (CV = 0.41, 95% CL = 4,394 – 33,077; Hammond *et al*., 2017).

216. A density estimate has been derived based on the density estimate of SCANS-III survey block D, which assumes the animals in block D could also be distributed in block E. A density of 0.22 common dolphin per km² was estimated based on 18,458 common dolphin in the total area (83,460 km²) of survey blocks D and E (**Plate 12-5 Table 12-17**). This approach was agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

Table 12-17 Common dolphin abundance and density estimates

Area	Abundance Estimate	Density Estimate	Source
Celtic and Greater North Sea (CGNS) MU (**Plate 12-10**)	**56,556** (95% CI = 3,989-39,572) for CGNS MU 13,607 (95% CI=7,176-21,066) for UK portion of CGNS	N/A	IAMMWG (2015)
SCANS-III Block E (**Plate 12-5**)	0	0	Hammond *et al*. (2017)
SCANS-III Block D (**Plate 12-5**)	18, 458 (CV = 0.41, 95% CL = 4,394 – 33,077)	0.374/ km² (CV = 0.41, 95% CL = 4,394 – 33,077)	Hammond *et al*. (2017)
SCANS-III Block E and D (**Plate 12-5**)	18, 458	**0.22/ km²**	Estimate based on 18,458 common dolphin in the total area (83,460 km²) of survey blocks D and E

12.5.4.3. Diet

217. Common dolphins have a varied diet and are opportunistic feeders that often use cooperative feeding techniques to herd schools of fish (Sea Watch Foundation, 2012). Their diet depends on local prey availability and may include small schooling fish including hake, cod, sardine, mackerel, horse mackerel, scad, sprat, herring, sandeel, whiting, blue whiting, and squid (Sea Watch Foundation, 2012).

12.5.4.4. Conservation Status

218. The current conservation status of common dolphin, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), is ‘favourable’ (JNCC, 2013).

12.5.5. Minke whale

12.5.5.1. Distribution and Occurrence

219. Minke whale are widely distributed along the Atlantic seaboard of Britain and Ireland (Reid *et al*., 2003). Within UK waters, minke whale are most commonly sighted in the western central North Sea and the west of Scotland around the Hebrides (DECC, 2016).

220. Minke whale are predominantly a seasonal visitor to UK waters, with sightings increasing from May to October, with sightings rare outside of this period. However, there are some individuals that are known to be resident in UK waters year-round (Evans, 2008). The annual movement patterns and migrations of minke whale are not well understood, but it is thought that they make a migration between tropical breeding grounds in the winter to colder feeding grounds in the summer (HWDT, 2019).

12.5.5.2. Abundance and Density Estimates

12.5.5.2.1. Celtic and Greater North Seas Management Unit

221. Genetic evidence suggests that the minke whales of the North Atlantic are likely to be a single genetic population (Anderwald *et al*., 2012). Therefore, IAMMWG (2015) considers a single MU is appropriate for minke whales in European waters.

222. The abundance of minke whales in the CGNS MU (**Plate 12-10**) is 23,528 animals (CV = 0.27; 95% CI = 13,989-39,572; IAMMWG 2015; **Table 12-18**). The estimate was derived from SCANS-II (Hammond *et al*., 2013) and CODA (Macleod *et al*., 2009) and is likely to be underestimated. The IAMMWG (2015) note the abundance of minke whales is highly seasonal, with abundance peaking during migration south into waters around the UK for summer.

12.5.5.2.2. JCP Data

223. The JCP estimated densities of minke whale across UK waters in summer are 0.02-0.04 individuals per km^2 (97.5% CI = 0-0.02 – 0.1-0.2 per km^2; Paxton *et al*., 2016).

224. The JCP abundance estimates for the Irish Sea Development area are highest in summer, with an estimated abundance of 190 individuals (97.5% CI = 80 – 620) and for winter months the estimated abundance is 60 individuals (97.5% CI = 0-100; Paxton *et al*., 2016).

12.5.5.2.3. SCANS and ObSERVE Data

225. SCANS-I in July 1994 estimated 8,445 minke whale (95% CI = 5,000-13,500) (Hammond *et al*., 2002). The SCANS-II survey gave an overall estimate of 18,958 minke whale (CV = 0.347); and 13,734 minke whale (CV = 0.41; 95%CI = 9,800 – 36,700) within an area comparable to the 1994 survey (Hammond *et a*l., 2013). Although these estimates were not significantly different, there were noticeable changes in distribution between the two surveys which is most likely to be linked to changes in prey availability.

226. For the entire SCANS-III survey area (not the same area as SCANS-II), minke whale in the summer of 2016 was estimated to be 14,759 with an overall estimated density of 0.008/ km^2 (CV = 0.327; 95% CI = 7,908-27,544; Hammond *et al*., 2017).

227. For the SCANS-III survey block E (**Plate 12-5**), the abundance of minke whale in the summer of 2016 was estimated as 603 individuals (CV = 0.62, 95% CI 134 – 1,573) with an estimated density of 0.017 individuals per km^2 (Hammond *et al*., 2017; **Table 12-18**).

228. ObSERVE aerial surveys estimated minke whale density in stratum 5 to be 0.045/ km^2 in Summer 2015 and 0.016/ km^2 in summer 2016 (Rogan *et al*., 2018).

Table 12-18 Minke whale abundance and density estimates

Area	Abundance Estimate	Density Estimate	Source
Celtic and Greater North Seas (CGNS) MU (**Plate 12-10**)	**23,528** (95% CI = 3,989-39,572) for CGNS MU 12,295 (95% CI=7,176-21,066) for UK portion of CGNS	N/A	IAMMWG (2015)
SCANS-III Block E (**Plate 12-5**)	603 (95% CI = 134-1,753)	**0.017/ km^2** (CV = 0.62)	Hammond *et al*. (2017)
ObSERVE aerial surveys – stratum 5 Summer 2015 (**Plate 12-6**)	494.7 (95% CI = 221.5 – 1105)	0.045/ km^2 (CV=0.69)	Rogan *et al*. (2018)
ObSERVE aerial surveys – stratum 5 – Summer 2016 (**Plate 12-6**)	180.1 (95% CI = 58.6 – 552.9)	0.016/ km^2 (CV=1.06)	Rogan *et al*. (2018)

12.5.5.3. Diet

229. Minke whales feed on a variety of fish species, including herring, cod and haddock. Minke whale feed by engulfing large volumes of prey and water, which they then 'sieve' out of through their baleen plates and swallow their prey whole.

230. A study into the diet of minke whale in the north-eastern Atlantic sampled a total of 210 minke whale forestomach contents from 2000 to 2004, with a total of 37 minke whale samples analysed within the northern North Sea. Within this area, minke whale were found to prey upon a number of different species at the population level, however, 84% of individuals were found to prey upon only one species. Sandeels (56% of total prey by biomass) and mackerel (30% of total prey by biomass) were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland *et al*., 2007).

12.5.5.4. Conservation Status

231. The current conservation status of minke whale, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), is 'favourable' (JNCC, 2013).

12.5.6. Grey seal

12.5.6.1. Distribution and Occurrence

232. Grey seals only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in north-west Europe (SCOS, 2017).

233. Approximately 38% of the world's grey seals breed in the UK and 88% of these animals breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in south-west England and Wales (SCOS, 2017). Although the number of grey seal pups born in the UK has been growing steadily since records began in 1960, the population growth is now

steadying in all areas except for the central and southern North Sea where population growth remains high (SCOS, 2017).

234. Long-term sightings rates data as collated in the Atlas of the Marine Mammals of Wales found that the main concentrations of grey seals sightings were off the north coast of Wales, as well as the southern coast of the Isle of Man (Baines and Evans, 2012).

235. Marine Scotland commissioned Sea Mammal Research Unit (SMRU) to produce maps of grey seal distribution in UK waters (Russell *et al*., 2017). These maps were produced by combining information about the movement patterns of electronically tagged seals with survey counts of seals at haul-out sites. The resulting maps show estimates of mean seal usage (seals per 5 km x 5 km grid cell). The maps indicate relatively higher usage in some areas of the Celtic and Irish Sea along coastal locations of Ireland and Wales, for example, Llŷn Peninsula and West Hoyle Bank in Wales and the waters surrounding Lambay Island, as well as the south-east tip (Saltee Islands) of Ireland. Although, mean grey seal usage is relatively low (1<5 animals) in the area in and around the MDZ (Russell *et al*., 2017).

236. Grey seal are regularly recorded in and around the Irish Sea, including north Anglesey (e.g. Westcott, 2002; Westcott and Stringell, 2003, 2004; Clarke *et al*., 2018). Grey seals are present year round on both the Irish and Welsh coasts and are known to move between the two, for example between the southeast coast of Ireland and the southwest coast of Wales (Kiely *et al*., 2000).

237. During the Natural Power surveys of the MDZ and 2 km buffer (**Appendix 11.1, Volume III**), grey seal were recorded throughout the survey period between November 2016 and October 2018. Records of unidentified seals were also made, but as no harbour seals were recorded, it is considered likely that these records were also of grey seals. Ten sightings of grey seal were recorded during the SEACAMS surveys (**Appendix 12.1, Volume III**).

12.5.6.2. Abundance and Density Estimates

238. Grey seal populations are assessed from the counts of pups born each year. Surveys are undertaken during the breeding season where females will congregate on land to give birth (SCOS, 2017). The most recent counts available are from the 2014 autumn breeding season surveys, that were released in 2016. The 2014 surveys of the principal grey seal breeding sites in Scotland, Wales, Northern Ireland and south-west England, resulted in an estimate of 60,500 pups (95% CI = 53,900 - 66,900; SCOS, 2017). The pup counts can be used to determine actual population size through a mathematical model and have been projected forward to 2016. This model provides an estimated UK population for 2016 of 141,000 (95% CI = 117,500 - 168,500; SCOS, 2017).

239. In addition to counts of grey seal pups during the breeding season, grey seal are also counted during harbour seal surveys. The most recent counts of grey seal in the August 2016 surveys estimated that the total count of grey seals in the UK was 40,662 (SCOS, 2017).

240. In Ireland, the grey seal population was estimated to between 7,284 and 9,365 individuals, during the 2009-2012 monitoring program at seven main breeding sites (O'Cadhla *et al*., 2013).

12.5.6.2.1. South and West England and Wales Management Unit

241. Grey seal population size is normally derived from the numbers of pups born during their autumn breeding season. Grey seal distribution during their breeding season is, however, very different to their distribution at other times of the year. For this reason, the numbers of grey seal pups born in the autumn is provided as well as the summer counts of grey seals for each MU (IAMMWG, 2013).

242. In the South and West England and Wales MU, the grey seal pup production (autumn) was 1,900 with an estimated summer population size of 6,000, based on summer survey counts 1994-2003 and 2007 (SCOS, 2017; IAMMWG, 2013; **Table 12-19**). However, IAMMWG (2013) note that the South and West England and Welsh count is less certain due to infrequent assessment over this large area.

12.5.6.2.2. Wales

243. The colonies around the coast of Wales are rarely monitored. The most recent estimate for pup production in 2014 at Welsh colonies was 1,650 (SCOS, 2017). It is estimated that 96 pups were born in North Wales, 465 in North Pembrokeshire and 379 on Skomer and nearby mainland (Stringell *et al*., 2014; Strong *et al*., 2006).

244. Haul-out sites in Anglesey and the Llŷn Peninsula surveyed in 2014 had a count of 96 pups. Based on this count, there are an estimated 242-307 grey seal pups in the whole of north Wales (Stringell *et al*., 2014).

245. Recent surveys of grey seal pup production in North Wales was conducted in Autumn 2017 between Aberystwyth and the Dee Estuary (Clarke *et al*., 2018). The results show that 279 individual pups were born across 79 active nursery sites throughout the season. This suggests an approximate increase in pup production of 180% and a 145% increase in the number of nursery sites in comparison to the last full census of grey seal pups in North Wales in 2004 (Clarke *et al*., 2018).

246. Based on August counts (2011-2015) of grey seals at haul-out sites in Wales there are an estimated 422 grey seal and an estimated 480 grey seal in south-west England (SCOS, 2017). However, there are no dedicated seal surveys in these areas and only sparse information is available, therefore, estimates are compiled from counts from various different sources (SCOS, 2017). In addition, it should be noted that grey seal summer counts are known to be more variable than harbour seal summer counts and therefore caution is advised when interpreting these numbers (SCOS, 2017).

12.5.6.2.3. Seal Density Maps

247. As outlined above, SMRU has produced maps of grey seal distribution in UK waters (Russell *et al*., 2017). The grey seal density estimate of 0.155 per km^2 for the MDZ has been calculated from the seal density maps (**Figure 12-2, Volume II**; **Table 12-19**), based on the highest density estimate for the grid squares within 2 km of the area. There is currently insufficient data from the site-specific surveys to provide robust density estimates, therefore the latest seal at sea density maps (Russell *et al*., 2017) have been used to estimate the density of grey seal for the

MDZ. This was agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

Table 12-19 Grey seal abundance and density estimates

Area	Abundance Estimate	Density Estimate	Source
South and West England and Wales MU	**6,000**	N/A	IAMMWG (2013)
Morlais site	N/A	**0.155/ km^2**	Russell *et al*. (2017)
OSPAR Region	40,223 (9,997 – 7,4105)	0.10/ km^2 (0.02 – 0.18)	Russell *et al*. (2017)

12.5.6.3. Movements and Foraging Ranges

248. Grey seals forage in the open sea and they may range widely to forage and frequently travel over 100 km between haul-out sites (SCOS, 2017). Foraging trips can last anywhere between one and 30 days. Tracking of individual grey seals has shown that most foraging probably occurs within 100 km of a haul-out site, although they can feed up to several hundred kilometres offshore (SCOS, 2017).

249. Telemetry data show much individual variability in the movement patterns of grey seals (Matthiopoulos *et al*., 2004; McConnell *et al*., 1999), with some animals ranging widely and spending time in a variety of locations; while others remain in one limited area for most of the time they were tagged.

250. Grey seals from telemetry studies off western Scotland and off northern France indicate that the tagged grey seals from these areas did not enter the Irish Sea (Matthiopoulos *et al*., 2004). Tagging data of grey seals from haul-out sites in Liverpool Bay, Wales and southeast Ireland, indicates that most movement from these sites was contained within the Irish Sea (Hammond *et al*., 2005).

251. SCOS (2014) described telemetry studies that have been undertaken by tagging grey seals at five SACs across the UK (Pembrokeshire Marine, Lleyn Peninsula and the Sarnau, Monach Islands, Isle of May, and Berwickshire and North Northumberland Coast). The results indicate that grey seal travel between Sir Benfro Forol/Pembrokeshire Marine SAC, Pen Llyn a'r Sarnau/Llyn Peninsula and the Sarnau SAC and the Saltee Islands SAC (Ireland).

252. Data from tagging studies in the Irish Sea were examined in order to describe the extent of ‘forging trips’ of grey seals in the Irish Sea (SCOS, 2014). The telemetry data included in this study were from adult grey seals tagged at Ramsey (n=7), Bardsey (n=4), and Hilbre island (n=7) in 2004 and from pups tagged at Anglesey in 2009 and 2010 (n= 3 and 5), Bardsey in 2009 (n=2) and Ramsey in 2010 (n=7).

253. Over the lifetime of the tags, pups made an average of 58 trips per seal (over the average tag duration of 151 days) with a median trip duration of 0.92 days (95% CI = 0.12-7.89) between haul-out locations and covered an average distance of 19.47 km. The greatest distance travelled by one pup was 435.8 km. Grey seal adults made less trips with an average of 41 trips per seal (over the average tag duration of 131 days) and covered less distance (average maximum of 16.94 km), with trips between haul-out locations lasting on average 0.75 days (as a median, 95% CI = 0.12-5.61). The greatest distance travelled by one adult was 172.6 km.

The tag data showed that seals often move between haul out locations, in particular between the Lleyn Peninsula, Cardigan Bay and haul out locations around the Isle of Anglesey.

12.5.6.4. Haul-Out Sites

254. Grey seals spend longer hauled out during their annual moult between December and April, generally three and five months after the breeding season and during the breeding season between August and December (SCOS, 2017).

255. Around Wales, the breeding and pupping season for grey seal is between August and December with a peak in October-November, but this is extending. Pups are typically weaned 17 to 23 days after birth, when they moult their white natal coat and then remain on the breeding colony for up to two or three weeks before going to sea (SCOS, 2017).

256. The main breeding and haul-out sites for grey seal in Wales are located at the Skerries (11 km northeast of the MDZ and cable route), East Mouse (28 km northeast of the MDZ and cable route), Puffin Island (52 km east of the MDZ and cable route), Bardsey Island (55 km south of the MDZ and cable route), Tudwals and Carreg y Trai (84 km southeast of the MDZ and cable route) and Skomer Island (176 km south of the MDZ and cable route). The location of these sites is shown in **Plate 12-11**.

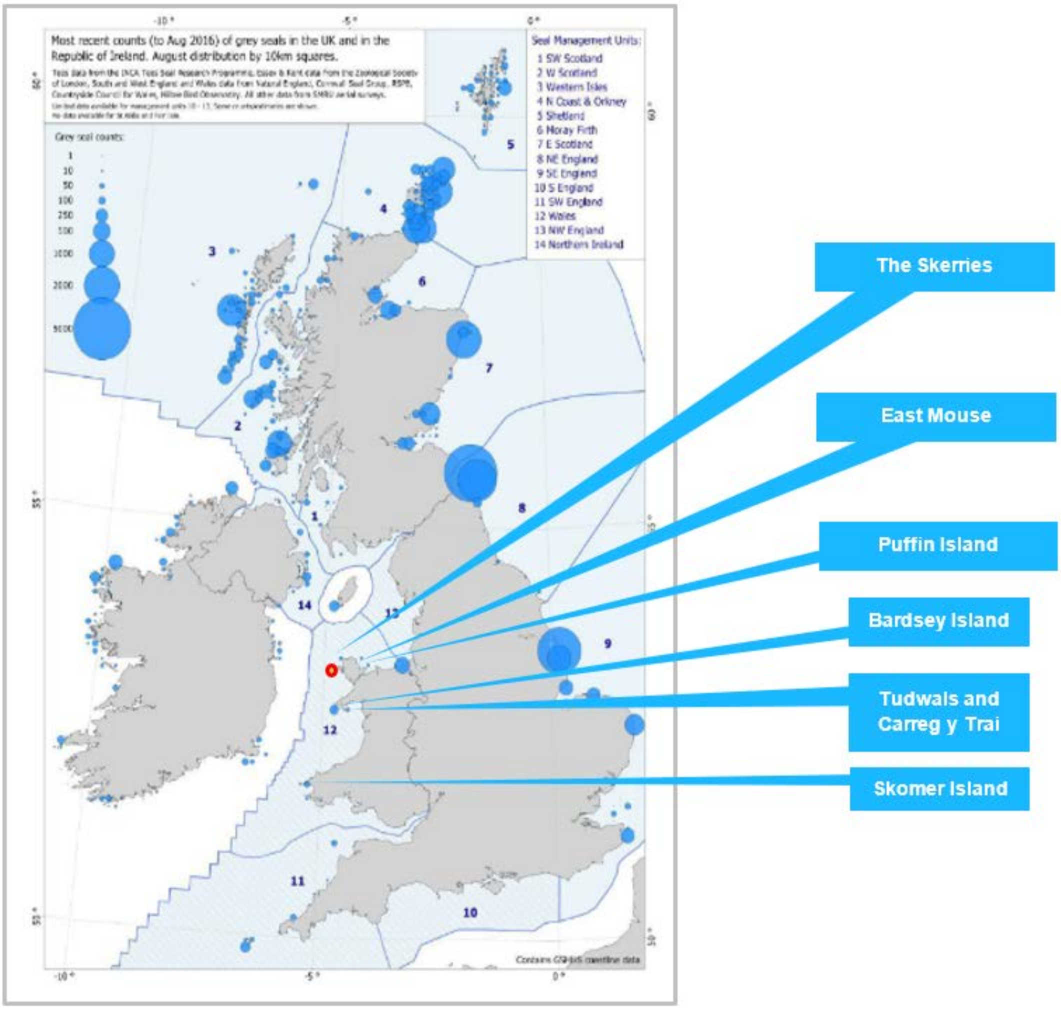

Plate 12-11 Grey seal haul out sites in Wales with MDZ indicated by red dot (source: SCOS, 2017)

257. In north Wales grey seal are known to use habitats such as intertidal rocky outcrops, beaches and sea caves that are tidally exposed. Breeding colonies in south-west England and in Wales are typically at the foot of steep cliffs or in caves and are therefore difficult to monitor (SCOS, 2017). During a grey seal haul-out site survey in Anglesey and the Llŷn Peninsula in 2014 (Stringell *et al*., 2014), an estimated 48% and 75% of pups born in Anglesey and the Llŷn Peninsula, respectively, were born in cave habitats (Stringell *et al*., 2014).

258. Recent surveys of grey seal pup production and distribution in North Wales conducted in Autumn 2017 between Aberystwyth and the Dee Estuary, identified 79 active nursery sites throughout the season (Clarke *et al*., 2018). The sites closest to the MDZ and cable area are indicted in **Figure 12-3** (**Volume II**) with the distances to these sites presented in **Table 12-20**.

Table 12-20 Distance to grey seal pupping sites near the MDZ and cable area (based on Clarke *et al.*, 2018)

Site Name	Distance to Cable Corridor (km)
Porth Namarch (West)	0.961
Porth Narach (East)	1.27
Yr Ogof Olaf	0.696
Porth y Nant	0.573
Ogof y Nant	0.554
Ogof Arw	0.338
Arw Cleft	0.069
Parliament House	0.22
Ogof Morlo	0.247
Ogof Migway (Yns Arw)	0.244
Ogof Ddeuddrws (Dream of White Horses)	0.300
Ofog Gogarth	0.549
Gof-du Big	2.306
Trearddur North	3.843

12.5.6.5. Diet

259. Grey seal are generalist feeders and will prey upon a variety of species. The most common food sources for grey seal are sandeels, gadoid species (such as cod, haddock, whiting and ling *Molva molva*) as well as flatfish species (such as plaice *Pleuronectes platessa*, sole *Soleidae sp.,* flounder and dab *Limanda limanda*), however this does vary from season and by location (Hammond and Grellier, 2006).

260. Food requirements for grey seal will depend on a number of factors, such as its size and fat content of the prey, but a general estimate is that a typical grey seal requires 4 to 7kg of prey a day, depending on the prey species (SCOS, 2017).

12.5.6.6. Conservation Status

239. The current conservation status of grey seal, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), is ‘favourable’ (JNCC, 2013).

12.5.7. Harbour seal

12.5.7.1. Distribution and Abundance

261. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one sub-species *Phoca vitulina vitulina* (SCOS, 2017).

262. Harbour seals are counted on land during their August moulting period, which gives a minimum population estimate. Combining the most recent counts available (2008-2016) gives a total count of 31,300 harbour seals in the UK (25,150 of which are in Scotland), and scaling this to reflect the number of seals missed by not being hauled-out, gives a total UK population estimate of 43,500 (95% CI = 35,600-58,000) in 2016 (SCOS, 2017).

263. The most recent estimate of the harbour seal population in the Wales MU is less than 50 individuals (SCOS, 2017; **Table 12-21**). The most recent harbour seal count (2011-2016) for the Wales MU was five (SCOS, 2017). Point of Ayr is the only haul-out location for harbour seal in this MU is located approximately 98 km east of the MDZ and cable area. **Plate 12-12** shows the location of the major harbour seal haul-out sites around the UK and the most recent seal counts for each site.

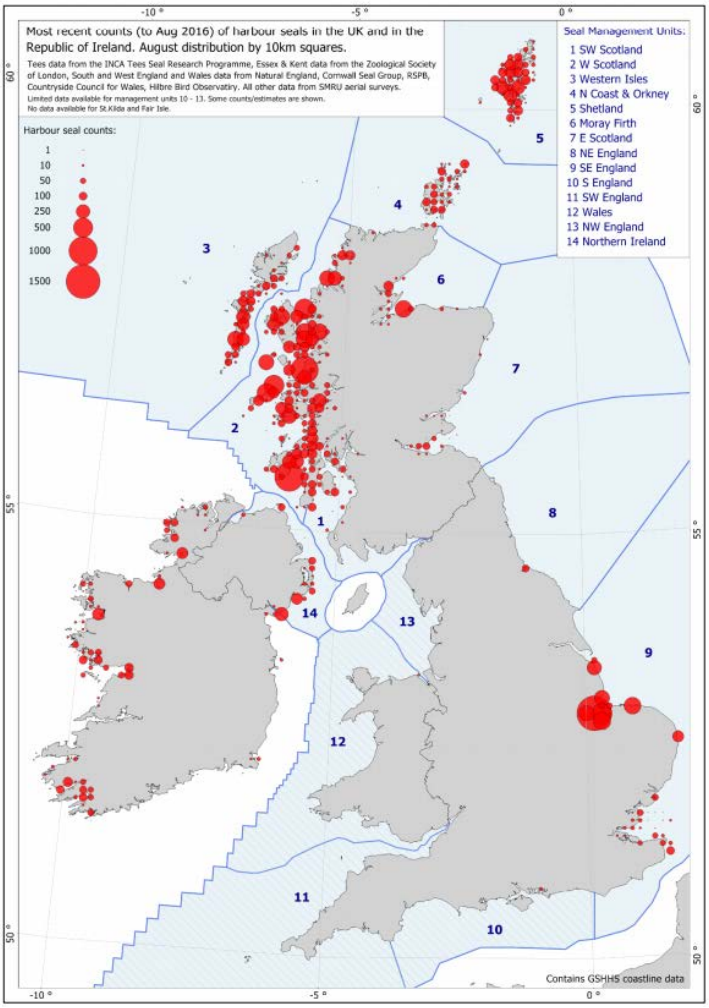

Plate 12-12 Location of the major harbour seal haul-out sites around the UK (source: SCOS, 2017)

264. It is noted in SCOS (2017) that very small numbers (<50) harbour seals are reported in the Wales MU are not included in this figure (SCOS, 2017). There are no systematic surveys for harbour seal in Wales.

265. The at-sea seal usage maps produced by SMRU show that the harbour seal usage is low in and around the MDZ, with a harbour seal density of 0.0005/ km^2 (**Figure 12-4, Volume II**; **Table 12-21**; Russel *et al*., 2017).

Table 12-21 Harbour seal abundance and density estimates

Area	Abundance Estimate	Density Estimate	Source
Wales	**50**	N/A	SCOS (2017)
Morlais site	N/A	**0.0005/ km^2**	Russell *et al*. (2017)
OSPAR Region	31,549 (13,217 – 50,218)	0.08/ km^2 (0.03 – 0.12)	Russell *et al*. (2017)

12.5.7.2. Movements and Foraging Ranges

266. SMRU, in collaboration with others, has deployed around 344 telemetry tags on harbour seals around the UK between 2001 and 2012 (Russell and McConnell, 2014). Spatial distributions indicate harbour seals persist in discrete regional populations, display heterogeneous usage and generally stay within 50 km of the coast (Russell and McConnell, 2014).

267. Harbour seals normally feed within 40 km and 50 km around their haul out sites (SCOS, 2017). Tracking studies have shown that harbour seal typically travel between 50 km and 100 km offshore and can travel 200 km between haul-out sites (Lowry *et al*., 2001; Sharples *et al*., 2012). Harbour seal exhibit relatively short foraging trips from their haul out sites. The range of these trips does vary depending on the surrounding marine habitat (e.g. 25 km on the west of Scotland; between 30 km and 45 km in the Moray Firth (Tollit *et al*., 1998; Thompson and Miller, 1990) and data from The Wash (from 2003- 2005)) suggest that harbour seal in this area travel further, and repeatedly forage between 75 km and 120 km offshore (with one seal travelling 220 km; Sharples *et al*., 2008).

268. Telemetry studies indicate that the tracks of tagged harbour seals have a more coastal distribution than grey seals and do not travel as far from haul-outs (Russell and McConnell, 2014).

269. The SMRU seal usage maps indicate there are small amounts of harbour seal usage around the north-east Irish coast, but no evidence of usage in the rest of the Irish Sea or along the Welsh coastline (Russell *et al*., 2017).

12.5.7.3. Haul-Out Sites

270. Harbour seal come ashore in sheltered waters, often on sandbanks and in estuaries, but also in rocky areas. Harbour seal haul out on land regularly in a pattern that is often related to the tidal cycle (SCOS, 2017).

271. Harbour seal give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS, 2017). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS, 2017).

12.5.7.4. Diet

272. Harbour seal take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish and cephalopods. Diet varies seasonally and regionally, prey diversity and diet quality also showed some regional and seasonal variation (SCOS, 2017).

273. It is estimated harbour seals eat 3-5 kg per adult seal per day depending on the prey species (SCOS, 2017).

12.5.7.5. Conservation Status

274. The current conservation status of harbour seal, as assessed in the 3rd UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), is ‘Bad’ (JNCC, 2013).

275. Harbour seals have been declining in recent years, with a loss of 21% of the UK population between 2000 and 2010 (JNCC, 2013). It was stated within JNCC (2013). that the reasons for the decline could potentially be down to shooting (under licence), bycatch, disturbance, dynamic positioning vessels (ducted propellers) or it could be bio-toxin related, competition with grey seals and predations by orca and grey seal (JNCC, 2013). More recent information describes only two of these factors as potential causes; interactions with grey seals and toxins from harmful algae (SCOS, 2017).

276. The decline was found predominantly in a few locations: Orkney with a population loss of 78% between 1978 and 2013; the east coast with a loss of 70% from 1997 to 2015; Firth of Tay loss of 92% from 2000 to 2015; and Shetland with a loss of 30% from 2000-2009 (this has now increased by 10% from 2009-2015) (SCOS, 2017). The population is now increasing again and is close to the levels before the decline described above.

12.5.8. European Designated Sites

277. All cetaceans in UK waters are classed as European Protected Species (EPS) under Annex IV of the Habitats Directive (EU Directive 92/43/EEC).

278. Bottlenose dolphin, harbour porpoise, grey seal and harbour seal are listed under Annex II of the Habitats Directive and are afforded protection through the designation of Natura 2000 (SAC) sites.

279. The HRA screening for the Project (**Document MOR/RHDHV/DOC/0067**) identified the following European Designated Sites for further assessment in the HRA:

- Gogledd Môn Forol/North Anglesey Marine SAC for harbour porpoise;
- Pen Llŷn a'r Sarnau/Llŷn Peninsula and the Sarnau SAC for bottlenose dolphin and grey seal;
- Gorllewin Cymru Forol/West Wales Marine SAC for harbour porpoise;
- Bae Ceredigion/Cardigan Bay SAC for bottlenose dolphin and grey seal;
- Dynesfeydd Môr Hafren/Bristol Channel Approaches SAC for harbour porpoise;

- Sir Benfro Forol/Pembrokeshire Marine SAC for grey seal;
- North Channel SAC for harbour porpoise;
- The Maidens SAC for grey seal;
- Rockabill to Dalkey SAC for harbour porpoise;
- Lambay Island SAC for harbour seal; and
- Saltee Islands SAC for grey seal.

280. These sites were determined based on:

- The European Designated Sites within the relevant MU area for each species;
- The potential for connectivity between individual marine mammals from European Designated Sites and the potential effects from the project (i.e. demonstration of a clear source-pathway-receptor relationship); and
- The potential for a realistic pathway for a possible effect on European Designated Sites for marine mammals.

281. The European Designated Sites are assessed further in the information to support the HRA (**Document MOR/RHDHV/DOC/0067**).

282. For harbour porpoise any European Designated Sites located more the 400 km from the Project in the Celtic and Irish Seas MU, it was determined that the potential did not exist for a LSE to arise and are therefore screened out of further assessment. Harbour porpoise are highly mobile. However, they have relatively high daily energy demands and it has been estimated that they can only rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997). Based on a swimming speed of approximately 1.5m/s (Otani *et al*., 2000), it is estimated that harbour porpoise could cover a distance of approximately 400 km in three days. In light of the above, it is highly unlikely that harbour porpoise from European Designated Sites located 400 km or more from the Project are dependent on the MDZ area. Although harbour porpoise from European Designated Sites more than 400 km away could have foraging ranges that overlap the MDZ, any potential indirect effects on prey are highly unlikely to have a significant effect on harbour porpoise from that European Designated Site.

283. For bottlenose dolphin, connectivity was considered possible between the Project and the two European Designated Sites within the Irish Sea MU.

284. Based on the foraging ranges for grey seal and the assessment of the telemetry data in and around the Irish Sea, it was determined that there was potentially connectivity for any European Designated Site for grey seal up to 200 km from the Project. Consequently, all European Designated Sites for grey seal beyond 200 km of the Project in the OSPAR region were not assessed further.

285. Based on the foraging ranges for harbour seal, it was determined that there was potential connectivity for any European Designated Sites for harbour seal up to 100 km of the Project. Consequently, all European Designated Sites for harbour seal beyond 100 km of the Project in the OSPAR region were not assessed further.

12.5.9. Anticipated Trends in Baseline Conditions

286. The existing baseline conditions for marine mammals as described in **Section 12.5** are considered to be relatively stable. The baseline environment of the Celtic and Irish Seas areas has been influenced by fishing by various methods for hundreds of years, coastal and harbour developments and the construction and operation of offshore wind farms for over ten years (for example, North Hoyle, Rhyl Flats and Burbo Bank). The baseline will continue to evolve as a result of global trends which include the effects of climate change.

287. For harbour porpoise, the observed distribution of harbour porpoises during the SCANS-III survey in 2016 was similar to that observed in SCANS-II in 2005, but one notable difference was more sightings were made throughout the English Channel (block C) in 2016 than previously (Hammond *et al*., 2017). Similarly, the observed distribution of bottlenose dolphin and common dolphin in 2016 was also similar to that observed during the SCANS-II and CODA surveys in 2005/07 (Hammond *et a*l., 2017).

288. Feingold and Evans (2014b), indicated that the low abundance values within Cardigan Bay SAC in 2012 and 2013, the lowest since monitoring began in 2001, may represent a shift in usage by the dolphins in the region since in recent years, bottlenose dolphin sightings have been reported regularly for the first time during summer months in North Wales, particularly around the Isle of Anglesey but extending east into Liverpool Bay and north to at least the Isle of Man.

289. The number of grey seal pups throughout Britain has grown steadily since the 1960s; when records began and there is clear evidence that the population growth is levelling off in all areas, except the central and southern North Sea where growth rates remain high (SCOS, 2017). Surveys of grey seal pup production and distribution in North wales in 2017 indicates an increase in pup production of 180% and a 145% increase in the number of nursery sites in comparison to the 2004 surveys (Clarke *et al*., 2017).

290. The potential impacts of climate change on marine mammals can be direct, such as the effects species tracking a specific range of water temperatures in which they can physically survive, or indirect effects, which could include changes in prey availability affecting distribution, abundance and community structure (Learmonth *et al*., 2006).

291. There is potential evidence of the effects of climate change on the composition and structure of cetacean communities off north-west Scotland (MacLeod *et al*., 2005). Analysis of strandings from 1948 to 2003 found that no new cetacean species per decade were recorded in north-west Scotland between 1965 and 1981, however, this rose to two new species per decade from 1988 onwards. The new species recorded since 1988 are generally restricted to warmer waters, while those recorded prior to 1981 regularly occur in colder waters. In the period 1992 to 2003, the relative frequency of stranding of white-beaked dolphin, a colder water species, had declined while stranding of common dolphin, a warmer water species, had increased. Similarly, sightings surveys conducted in May–September 2002 and 2003 show that the relative occurrence and abundance of white-beaked dolphins declined and common dolphins increased in comparison to previous studies. These observations are consistent with changes in the local cetacean community being driven by increases in local water temperature (MacLeod *et al*., 2005).

292. In a wider context, such changes may lead to populations of cetaceans moving out of areas specifically designated for their protection as they respond to changes in local oceanic conditions.

12.5.10. Summary of Marine Mammal Reference Populations and Density Estimates

293. **Table 12-22** summarises the reference populations and density estimates that are used to inform the assessments for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal. These were agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

Table 12-22 Reference populations and density estimates to inform the impact assessment for marine mammals

Species	Density Estimate (per km^2)	Reference Population
Harbour porpoise	0.783/ km^2	104,695 (Celtic and Irish Seas MU; IAMMWG, 2015)
Bottlenose dolphin	0.02/ km^2	397 (Irish Sea MU; IAMMWG, 2015)
Risso's dolphin	0.031/ km^2	8,794 (Celtic and Greater North Sea MU population; Paxton *et al.* 2016).
Common dolphin	0.22/ km^2	56,556 (Celtic and Greater North Seas MU population; IAMMWG, 2015).
Minke whale	0.017/ km^2	23,528 (Celtic and Greater North Seas MU population; IAMMWG, 2015).
Grey seal	0.155/ km^2	6,000 (South and West England and Wales MU; IAMMWG, 2013). 40,233 grey seal in the wider OSPAR region (based on Russell *et al.*, 2017)
Harbour seal	0.0005/ km^2	50 (Wales MU; SCOS, 2017). 31,549 harbour seal in the wider OSPAR region (based on Russell *et al*., 2017).

12.5.11. Sensitivity of Marine Mammal Populations in Welsh Waters

294. Sparling *et al*. (2015) provides a level of sensitivity for each MU for marine mammals in Welsh waters (as defined by IAMMWG, 2015), based on an appraisal of a number of features. The main factors that contribute to the sensitivity of a marine mammal population to impacts are the current population size and distribution, current and recent trends in demographic parameters (fecundity, juvenile and adult survival) and life history variables such as age at maturity and longevity. The ability to adapt to change and the degree of existing threats are also important.

295. **Table 12-23** provides the predetermined sensitivity for each MU from Sparling *et al*. (2015). As there is only a single MU of relevance to Wales, these are presented as a 'species' in the table.

296. Sparling *et al*. (2015) note that although other marine mammal species are present in Welsh waters and may be species of concern for some developments, it is expected that that for most developments, the primary species of concern will be harbour porpoise, grey seals and/or bottlenose dolphins. This is because these are the most abundant species in Wales and are the only marine mammal Annex II species present in Wales. Other species can include Risso's dolphins around Bardsey Island (Llŷn Peninsula) and common dolphins in the southwest of Wales (e.g. Outer Bristol Channel and Pembrokeshire).

Table 12-23 Sensitivity classification of Welsh marine mammal populations from Sparling *et al.* (2015)

Species	Sensitivity	Rationale
Harbour porpoise	Low	Large population Favourable condition (unknown whether stable or increasing) Moderately fast maturing species Moderately long lived Wide ranging species
Bottlenose dolphin	High	Small population Favourable condition (stable population) Moderately slow maturing Moderately long lived Not a highly mobile population
Common dolphin	High in some areas, such as the outer Bristol channel	Moderately large population Favourable condition (stable population) Moderately slow maturing species Moderately long lived Wide ranging species
Grey seal	Low	Moderately large population Favourable condition (increasing population) Moderately fast maturing species Moderately long lived Wide ranging species

297. Based on the sensitivity classification of the marine mammal populations by Sparling *et al*. (2015) in **Table 12-23**, the sensitivity of marine mammal populations to potential impacts for the proposed Morlais Project have been considered, for context only, as:

- Low for harbour porpoise, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal; and
- High for bottlenose dolphin.

298. However, the sensitivity for the assessments has been based on the impact assessment matrix approach, as outlined in **Section 12.4.4.1**.

12.6. IMPACT ASSESSMENTS

12.6.1. Overview of Potential Impacts for Marine Mammals

299. The following section provides an overview of all impacts identified during scoping study and those which have been determined as the EIA has progressed. Each impact may not be relevant to all stages of the project, and thus impacts have been assessed within the stage of the project at which they will occur (construction, operation, repowering and decommissioning). Further, these impacts are comprised of both direct and indirect impacts.

300. Impacts are classified as follows:

- Direct impacts: these may arise from impacts associated with the construction, operation and maintenance, repowering or decommissioning of the project;
- Indirect impacts: these may be experienced by a receptor that is removed (e.g. in space or time) from the direct impact (e.g. noise impacts upon fish which are a prey resource for marine mammals).
- Inter-relationships between impacts; or cumulative impacts: these may occur as a result of the project in conjunction with other existing or planned projects within the study area for each receptor.

301. The potential impacts assessed for marine mammals are:

1. During Construction, Installation and Repowering:

- Underwater noise and disturbance:
  - Installation tidal devices and hubs (for example, drilling of foundations);
  - Construction activities (such as, cable installation and cable protection); and
  - Vessels;
- Potential barrier effects from underwater noise during construction;
- Disturbance at haul out sites (for example, from vessels moving to and from the site and at cable landfall);
- Increased collision risk with vessels;
- Potential changes in water quality (for example, increased suspended sediments, or any accidental release of contaminants); and
- Potential changes in prey availability (for example, underwater noise, disturbance, temporary loss of seabed habitat, increased suspended sediment concentrations and sediment re-deposition).

2. During Operation, Maintenance and Repowering:

- Underwater noise and disturbance:
  - Operational tidal devices;
  - Maintenance and repowering activities (such as, cable re-burial and additional cable protection; removal and replacement of devices / array);
  - Vessels; and
  - Acoustic Deterrent Devices (ADDs), if required;
- Collision risk with tidal devices;
- Increased collision risk with vessels;
- Potential entanglement with moorings for floating devices;
- Potential electromagnetic fields (EMF) effects;
- Potential barrier effects;

- Potential changes in water quality (for example, any accidental release of contaminants); and
- Potential changes in prey availability (for example, underwater noise, disturbance, loss of seabed habitat, introduction of hard substrate (e.g. foundations, cable and scour protection), changes to water quality and EMF.

3. Decommissioning:

- Underwater noise and disturbance;
- Increased collision risk with vessels;
- Potential changes in water quality; and
- Potential changes in prey availability.

4. Potential Cumulative Impacts and In-combination Effects:

- Underwater noise and disturbance;
- Collision risk; and
- Potential changes in prey availability.

12.6.2. Embedded Mitigation

302. Menter Môn has committed to several techniques and engineering designs/modifications inherent as part of the project, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as possible.

303. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process (see **Chapter 4, Project Description** for further details). A range of different information sources has been considered as part of embedding mitigation into the design of the project including engineering preference, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice.

304. Embedded mitigation relevant to Marine Ornithology is as follows;

- The PDE for tidal devices defined using parameters available from established tidal device technologies, which has been assumed will be developed sufficiently for commercial use at time of deployment. These have been incorporated in the modelling outlined in **Section 12.6.4.5.1**.

12.6.1. Worst-Case Scenarios

305. The realistic worst-case parameters for each category of potential impact (as outlined in **Table 12-25 Section 12.6.1.4**) has been determined. This takes into account the Project Design Envelope (PDE) and tidal devices that could be deployed, as outlined in **Chapter 4, Project Description**.

306. For this assessment, the realistic worst-case scenario involves consideration of both the timing of impacts, as well as the physical parameters that define the PDE. The worst-case scenario

for each potential impact is outlined in **Table 12-25**. Further details on the project design are presented in **Chapter 4, Project Description**.

307. The realistic worst-case scenarios identified here also apply to the Cumulative Impact Assessment (CIA). When the worst-case scenarios for the project in isolation do not result in the worst-case for cumulative impacts, this is addressed within the cumulative section of this chapter (see **Section 12.6.6**).

12.6.1.1. Construction

12.6.1.1.1. Tidal Device and Infrastructure Foundation Systems and Installation Methods

308. As outlined in **Chapter 4 Project Description**, there are two types of foundation systems proposed within the MDZ; seabed mounted and anchored / moored systems.

309. Seabed mounted foundations include:

- Gravity Based Structures (GBS):
  - The footprint (the element of the foundation in direct contact with the seabed) of gravity foundations, proposed at the MDZ would typically be very small (<10m^2), with gravity bases often using 'feet' that focus the weight of the foundation on a small area of seabed.
- Multi-piled Structures (including tripod and quadrapod):
  - A tripod or quadrapod structure typically using three or four pin-piles. A socket is drilled into the seabed and the pin-pile is inserted into the socket and grouted into place.
- Monopiles:
  - Monopiles may also be utilised within the MDZ, primarily for the electrical hub infrastructure.

310. Anchored / moored foundation systems include:

- Catenary moorings with four GBS as anchors.
- Tension mooring system with four GBS as anchors.

311. Installation methods for these foundation systems include:

- Drilling for multi-piles and monopile foundations:
  - Due to the hard substrate (bedrock) in the MDZ, drilling will be required to install piled foundations.
- Gravity based foundations and anchors.

312. In addition to the tidal devices, other infrastructure at the site will include:

- Electrical hubs (seabed mounted fully submerged hubs; floating surface emergent hubs; or seabed mounted surface emergent hubs);
- Navigational and mooring buoys;

- Acoustic Doppler Current Profilers (ADCPs);
- Seabed mounted environmental monitoring platforms; and
- Floating environmental monitoring platforms.

313. The hubs could have drilled piled foundations while the other infrastructure would have GBS or anchor foundations, rather than requiring drilled piled foundations.

314. For the main installation phase of tidal devices and associated electrical hub infrastructure, the typical time for complete installations is between three and 15 days per device, including foundation installation.

315. For the tidal device installation, it is estimated there could be up to a total of 4,306 days required. However, in practice it will most likely be done by up to three separate vessels working in parallel.

316. For the hub installation, it is estimated there could be up to a total of 1,800 days required, based on up to 15 days per hub for 120 hubs. However, hub installation would be conducted in parallel with the inter-array cable installation.

317. The other infrastructure (navigational and mooring buoys and ADCPs) would be installed during the tidal device and hub installation periods.

12.6.1.1.2. Offshore Cables

318. Up to nine export cables will be installed between the MDZ and the shore. The individual cable route lengths are predicted to range between 1.2 km and 6 km. For the export cable installation, it is anticipated that each of the nine export cables would take up to 20 days installation (total of 180 days), plus up to 108 days for export cable protection installation

319. Inter-array cables will be laid between the tidal devices and hubs. For the full 240MW capacity, there could be up to 740 individual array cables, with a maximum length of 2.5 km per cable, but the majority of cables being less than this (<1 km). The total length of array cables will up to 204.5 km. Total installation duration for all the inter-array cables would be up to 1,110 days, based on up to 1.5 days per cable. It is assumed that two arrays would be installed in parallel.

320. Due to the hard and rocky nature of the seabed, it is expected that the majority of the cables will be free laid with strategic protection (rock bags or concrete mattresses) at locations along the length. Where burial may be possible this will be done using jet trenching. However, this will have to be confirmed by pre-installation geotechnical site investigations informing detailed design.

12.6.1.1.3. Offshore Construction Schedule

321. Offshore works (for installation of tidal devices and associated cabling and infrastructure) would be phased over a period of up to ten years (see **Chapter 4 Project Description** for further details).

322. The offshore construction schedule has been determined based on the number of days vessels could be required to be on site for each stage of construction, this is summarised in **Table 12-24**.

Table 12-24 Installation durations

Construction Stage	Predicted number of vessels on site	Indicative number of days vessels on site during 10 year construction	Indicative number of days vessels on site per year	Indicative number of days vessels on site per year	% of time vessels on site per year
Cable tail installation	3 vessels (1 x cable tail installation vessel; 1 x cable tail installation support vessel; and 1 x dive support vessel)	20 days (assumes single operation of up to 15 days with 5 days extra for protection)	20 days	N/A (works in nearshore area)	5.48%
Export cable installation	2 vessels (1 x cable installation vessel; and 1 x support vessel)	180 days (assumes 9 blocks of 20 days over 10yr period)	20 days (worst-case assumes that one 20 day block of activity occurs per year, for 9yrs of the 10yr build-out period)	Each 20 day block of export cable installation per year	5.48%
Export cable protection installation	3 vessels (1 x cable tail installation vessel; 1 x cable tail installation support vessel; and 1 x dive support vessel)	108 days (assumes 9 x blocks of 12 days following each block of export cable installation)	12 days (worst-case assumes that one 12 day block of activity occurs per year, for 9 yrs of the 10yr build-out period)	Each 12 day block of export cable protection installation per year	3.29%
Inter-array cable Installation	2 vessels (1 x cable installation vessel; and 1 x support vessel)	775 days (assumes a 10 year period build out of all 8 arrays, and no more than 2 arrays built in parallel at any time)	77.5 days	Up to 10 days	21.23%
Hub installation	2 vessels (1 x hub installation vessel; and 1 x support vessel)	1,800 days (assumes 15 days per hub for 120 hubs)	180 days	22.5 days	49.32%
Tidal device installation	2 vessels (1 x construction vessel; plus 1 support vessel) Or 4 vessels (2 x construction vessel; plus 2 support vessel)	4,306 days	431 days	54 days	100% & 18% (assumes 1 x construction vessel plus 1 support vessel on sites every day; plus for 18% of year assumes 2 x construction vessel plus 2 support vessels on site)

12.6.1.2. Operation, Maintenance and Repowering

12.6.1.2.1. Tidal Devices

323. The tidal devices which may be installed under the Project Design Envelope have the following key elements, common across all device types:

- Tidal Energy Converter (TEC) or converters;
- Foundations, anchors or moorings on the seabed;
- Substructures supporting the TECs; and
- Cable connections.

324. Tidal devices currently being considered can be placed in three broad categories:

- Seabed mounted and submerged;
- Buoyant and mid-water column; and
- Surface floating.

325. The TECs could be:

- Horizontal axis (axial flow) rotors; or
- Vertical axis (cross flow) rotors.

326. A number of other device categories have been excluded from further consideration following a review of device types, technologies (see **Chapter 4 Project Description** for further details), these include:

- Surface piercing seabed mounted tower;
- Large seabed mounted cross-flow, horizontally orientated;
- Ducted cross-flow; and
- Other novel designs.

327. Further details on the parameters used in the collision risk assessment for the tidal devices are provided in **Section 12.6.4.5.1**.

12.6.1.2.2. Tidal Array Layout

328. As outlined in **Chapter 4, Project Description**, the final array layout will be identified post consent, following the berth selection and allocation process. The final detailed device locations will be developed based on further site investigation works conducted post-consent to determine detailed construction constraints.

329. Seabed mounted devices (Category 1) may have a spacing of 70 m to 150 m between centres of devices perpendicular to the flow and 180 m to 25 0m parallel to the flow. Such spacings may need to be modified to allow for seabed conditions, and this could alter spacings considerably, resulting in larger spacings.

330. The maximum case in terms of spacing would be floating tidal devices sharing moorings (Category 3). Such devices may require up to 150 m between structure centres perpendicular to the flow and 250 m parallel to the flow.

331. Each device could move by up to 80 m (±40 m) in the direction parallel to the flow and 60m (±3 0m) in the direction perpendicular to the flow. Therefore, the overall surface area covered by device movement (including device yawing) is up to 4,800 m^2 for a single floating device (Category 3).

332. This equates to a maximum area taken up by all arrays, including spaces between devices (i.e. not the seabed footprint) of up to 12.5 km^2 (up to 35% of the MDZ array area of 35 km^2) for the full 240MW capacity project.

333. Indicative layouts are presented in **Chapter 4 Project Description**.

12.6.1.2.3. Maintenance and Repowering Activities

334. As outlined in **Chapter 4 Project Description**, typical maintenance jobs may include: diagnostic tests, oil changes and lubrication, replacement of control cards and sensors, removal of biofouling, overhaul or replacement of systems (gearboxes, generators, switchgear etc.). Major operations such as retrieval and repair following structural failures would require similar vessels and procedures as installation works.

335. The project is a tidal technology demonstration project and it is anticipated that the tidal devices/arrays may be replaced several times within the project life time.

336. A repowering of a device/array is defined as the end of a berth/array demonstration cycle, at which time the TECs, device foundations, support structures, electrical hubs, tenant monitoring equipment, and inter-array cabling will be removed and replaced.

337. As a worst-case scenario, maintenance and repowering activities have been based on the assessment for construction. Because both maintenance and repowering (assumed at 50% of construction) are less than initial construction, this assessment is conservative.

12.6.1.3. Decommissioning

338. Assumed to be no greater than during construction phase.

12.6.1.4. Worst-Case Parameters

339. The worst-case scenario for each potential impact is outlined in **Table 12-25**.

Table 12-25 Worst-case parameters for marine mammal assessments

Project Phase	Impact	Parameter	Maximum worst-case	Notes
Construction	Underwater noise for foundation	Number of tidal devices requiring drilled foundations	Up to 620	Up to 620 small (less than 300kW) devices; or Up to 240 large 1MW+ devices

Project Phase	Impact	Parameter	Maximum worst-case	Notes
	installation – drilling			Up to 180 surface piercing devices (large or small) Maximum of 30MW of any one device in an array (maximum of 150 devices)
		Number of hubs requiring drilled foundations	Up to 120	60 hubs (each with 3 x 2.6m diameter piles); plus 60 hubs (each with 4 x of 2.6m diameter piles)
		Maximum number of piles for tidal devices	3,675	80 devices (each with 4 x 2.6m diameter piles); plus 120 devices (each with 4 x 1.2m diameter piles); plus 90 devices (each with 3 x 2.6m diameter piles)
		Maximum number of piles for hubs	420	
		Maximum pile diameter	2.6m	
		Total maximum duration of drilling for tidal device foundations	2,730 days	The duration to drill each pile could be up to 2 days for 1.2m diameter piles and up to 3 days for 2.6 diameter piles. 80 devices (each with 4 x 2.6m diameter piles) x 3 days = 960 days; plus 120 devices (each with 4 x 1.2m diameter piles) x 2 days = 960 days; plus 90 devices (each with 3 x 2.6m diameter piles) x 3 days = 810 days
		Total maximum duration of drilling for hub foundations	1,260 days	60 hubs (each with 3 x 2.6m diameter piles) x 3 days = 540 days; plus 60 hubs (each with 4 x of 2.6m diameter piles) x 3 days = 720 days
		Total maximum duration of drilling for tidal device and hubs foundation installation	Up to 3,990 days for 1,490 drilled piles	2 days for each of 120 x 1.2 m diameter drills and 3 days each for other diameter drills.
		Number of concurrent foundation installations (drilling events)	2	Up to two deployment areas could be developed at the same time.
	Underwater noise from	Cable installation method	Surface laid with strategic protection.	Underwater noise potentially greater during jet trenching.

Project Phase	Impact	Parameter	Maximum worst-case	Notes
	cable installation		Jet trenching where possible.	
		Cable protection	Rock bags or concrete mattresses.	Underwater noise during placement of cable protection
		Duration of cable installation	1,310 days	Export cables = 180 days Inter-array cables = 1,110 days Cable tails = 20 days
		Duration of cable protection	Up to 108 days	Export cable protection: 9 x blocks of 12 days, to begin up to 1 month after commencement of export cable laying
		Number of concurrent cable installations	2	Up to two deployment areas could be developed at the same time.
	Underwater noise and disturbance from vessels	Number of vessels	Up to 16 vessels	See **Table 12-24**. Maximum is likely to be 14 vessels at any one time, but based on up to 16 as worst-case scenario.
		Cable tail vessel days	Up to 20 days	Assume as one operation of 20 days duration.
		Export cable vessel days	Up to 180 days	Assumes 9 x blocks of 20 days, with each block continuous, but the 9 blocks spread across a possible 5 year period (may be longer, perhaps much, but not shorter) build out to 240MW.
		Cable protection vessel days	Up to 108 days	Assumes 9 x blocks of 12 days, to begin up to 1 month after commencement of export cable laying
		Inter-array cable vessel days	Up to 775 days	Assuming a minimum 10 year period build out, 8 arrays, and no more than 2 arrays built in parallel at any time. 194 vessel days per array. Therefore, 774.5 days over the 3650 days (10 years) assuming 2 arrays in parallel up to 1,549 days over 3,650 days assuming in sequence.
		Hub installation vessel days	Up to 1,800 days	1,800 days across a 3,650 day period. Hubs and arrays will be installed in parallel.
		Tidal device installation days	4,306 days	4,306 days across a 3,650 day period.
		Note: Number of vessel days is not the sum of all these values as many installation operations will take place in parallel.		
	Barrier effects from	Maximum potential area and duration of underwater during construction.		

Project Phase	Impact	Parameter	Maximum worst-case	Notes
	underwater noise			
	Disturbance at seal haul-out sites	Distance of construction activities, vessels and landfall from seal haul-out and pupping sites.		
	Increased collision risk with vessels	Number of vessels	Up to 16 vessels on site	Increased risk from increased number of vessels during construction compared to baseline.
		Number of vessel trips	Up to 16 per day	Assumed worst-case that each vessel would move to and from the site each day. Increased risk from increased number of vessels movements during construction compared to baseline.
		Area	Up to 10.75 km^2	Based on construction vessels in two indicative largest potential deployment areas (3 km^2 + 3 km^2); plus, vessels in export cable corridor area (4.75 km^2).
		Vessel route area	4.34 km^2	Vessel route from Holyhead Port to MDZ and cable corridor, based on 250m buffer either side of vessel.
	Changes in water quality	Increased suspended sediments	117,780m^3	Based on a 240MW capacity, the worst-case volume of cuttings for the entire site. A single device requiring four drilled piles will produce 160m^3 of cuttings
		Accidental release of contaminants	7,000 vessel days	Approximately 7,000 vessel days throughout the duration of the construction phase
			For the liquid inventory of devices deployed within the MDZ, the following worst-case values have been assumed: Oil (gearboxes, transformers etc.) 240,000 litres; Grease (bearing, seals etc.) 12,000 litres; and Hydraulic fluid 192,000 litres.	
	Changes in prey availability	Underwater noise	Parameters as outlined above.	
		Temporary habitat loss during construction	0.42 km^2	Post-lay burial of cable = 27,259m^2 Deployment of anchor blocks by barges during cable installation = 100,240m^2 Deployment of anchor blocks by barges during TEC device installation = 248,000m^2

Project Phase	**Impact**	**Parameter**	**Maximum worst-case**	**Notes**
				Deployment of anchor blocks by barges during hub installation = 48,000m^2 (see Chapter 10 for details)
		Changes in water quality	Parameters as outlined above.	
Operation, Maintenance and Repowering	Collision risk with tidal devices	See **Section 12.6.4.5.1.**		
	Underwater noise and disturbance from operational tidal devices	Worst-case scenarios based on underwater noise modelling for PTEC. 90 dB_{ht}(*Species*) maximum range = 610m for harbour porpoise, 95m for dolphin species; 400m for minke whale and 75m for seal species.		
	Underwater noise and disturbance from maintenance and repowering activities	Although likely to be less than parameters assessed for construction. Assessment has been based on construction parameters as a worst-case scenario.		
		Export cable inspection	Annual inspections of the export cable for the first 2 or 3 years, reducing to every 2 years thereafter.	Inspection / maintenance = 15 single day events per year. Assumes that 10 are late spring, summer, early autumn. Other 5 are across rest of year.
		Device inspection	Device inspection up to 15 times annually (for both planned and unplanned maintenance activities).	
		Cable repairs	Up to 10 major cable repairs (5 days each) may be required throughout the project life. It is assumed that up to 750m of cable will be subject to repair works per event (7,500m in total).	Cable repairs – 10 x 5 days or 50 days across life of project. Assume project operation life is 25 - 35 years, then one event every 2.5 to 3.5 years
	Underwater noise and disturbance from vessels	Number of vessels	Up to 16 vessels on site	As a worst-case scenario, assessment based on construction parameters, although likely to be less. Annual inspections of all cables will occur for the first three years after installation, reducing to every two years thereafter. Up to ten major cable repairs of five days each may be required

Project Phase	Impact	Parameter	Maximum worst-case	Notes
				throughout the project life of 35 years. Devices will be visited up to 15 times annually. Approximately four groups of vessels may be present in the MDZ and ECC at any one time during the lifespan of the project, of which two would be in the MDZ, and two in the ECC.
	Acoustic Deterrent Devices (ADDs)	Potential area of disturbance	1 km	Based on ADD review (see **Section 12.6.4.4**).
		Duration of activation	10-20 minutes	
		Number of ADDs	Up to 40 ADDs	Indicative as will depend on final mitigation plan and requirements.
	Increased collision risk with vessels	Area	Up to 10.75 km^2	As for construction, based on vessels in two indicative largest potential deployment areas (3 km^2 + 3 km^2); plus, vessels in export cable corridor area (4.75 km^2).
		Vessel route area	4.34 km^2	Vessel route from Holyhead Port to MDZ and cable corridor, based on 250m buffer either side of vessel.
	Entangle-ment with moorings for floating devices	Mooring will either be via tensioned systems, or catenary anchors. No loose mooring cables anticipated.		
	Electromag-netic fields (EMF) from offshore cables	Cable area	0.042 km^2	Foot print of cables and protection systems: Export cables = 11,745m^2: Inter-array cables = 30,040m^2; and Offshore cable tails = 120m^2.
	Barrier effects	Physical structures	12.5 km^2 (up to 36% of the MDZ array area)	Maximum area taken up by all arrays, including spaces between devices (i.e. not the seabed footprint) of up to 12.5 km^2 (up to 36% of the MDZ array area of 35 km^2) for the full 240 MW capacity project.
	Changes in water quality	Accidental release of contaminants	Same as for construction	There is also the possibility of pollution incidents due to ejection of contaminants or accidents involving tidal devices, and/or vessels. Any discharge will be limited and rapidly dispersed in tidal environment.

Project Phase	Impact	Parameter	Maximum worst-case	Notes
		Increased suspended sediments from 50% of all devices replaced via repowering works.	124,000 m^2	Footprint of temp seabed disturbance via anchor barges = 124,000m^2 (50% of 248,000 m^2 of temp seabed disturbance via TEC installation in construction phase)
		Increased suspended sediments during cable repairs	3,000 m^2	Up to 10 major cable repairs (5 days each) may be required throughout the project life. It is assumed that up to 750m of cable will be subject to repair works per event (7,500 m in total). Using same value of 400 m^2 temp seabed disturbance per 1 km of cable works (400 x 7.5) = 3,000 m^2
	Changes in prey availability	Underwater noise	Parameters as outlined above.	
		Temporary habitat loss	0.12 km^2	50% of all devices replaced via repowering works = 124,000 m^2 Cable repairs = 3,000 m^2 (see **Chapter 10** for details)
		Permanent habitat loss	2.18 km^2	Based on area for Gravity Base Structures (GBS) (74,790 m^2), swept area of catenary cables (2,055,000 m^2), export cable footprint (cables and protection systems; 11,745 m^2), array cable footprint (cables and protection systems; 30,040 m^2), additional cable protection material (4,860 m^2), cable tails (120 m^2), trench for 9 x landfall cables (7,400 m^2), footprint of navigation marker buoys (540 m^2), footprint of Acoustic Doppler Current Profiler (ADCP) moorings (280 m^2), footprint of seabed mounted environmental monitoring units (112 m^2) and footprint of mooring for floating environmental monitoring units (45 m^2). (see **Chapter 10** for details)
		EMF effects	Parameters as outlined above.	
		Changes in water quality	Parameters as outlined above.	
Decommissioning	Underwater noise	Assumed to be no greater than during construction phase		

Project Phase	Impact	Parameter	Maximum worst-case	Notes
	Increased collision risk with vessels	Assumed to be no greater than during construction phase		
	Changes in water quality	Assumed to be no greater than during construction phase		
	Changes in prey availability	Assumed to be no greater than during construction phase		

12.6.2. Mitigation

12.6.2.1. Embedded Mitigation

340. Menter Môn has committed to several techniques and engineering designs/modifications inherent as part of the project, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as possible. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process. A range of different information sources has been considered as part of embedding mitigation into the design of the project including engineering preference, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice.

341. Embedded mitigation in the project design stage has involved not including several types of devices, restrictions on the position in the water column for some devices and maximum potential number of devices due to the initial collision risk assessments.

12.6.2.2. Water Quality

342. Menter Môn is committed to the use of best practice and pollution prevention guidelines at all times. A Marine Pollution Contingency Plan (MPCP) would be in place and agreed with NRW in line with the Integrated Pollution Prevention and Control (IPPC) Directive such that any potential risk is minimised.

12.6.2.3. Proposed Approach to Marine Mammal Mitigation and Monitoring

12.6.2.3.1. Proposed Mitigation for Underwater Noise During Construction

343. Marine Mammal Mitigation Protocols (MMMPs) will be prepared to reduce the risk of any permanent auditory injury (Permanent Threshold Shift (PTS)) to marine mammals as a result of underwater noise during construction. The MMMP(s) will be developed in the pre-construction period and based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design.

344. The MMMP(s) will be developed in consultation with NRW and the relevant SNCBs, detailing the proposed mitigation measures to reduce the risk of any physical or permanent auditory injury (PTS) to marine mammals from underwater noise. This will include details of any embedded mitigation, as well as details of the mitigation zone and any additional mitigation measures required in order to minimise potential impacts of any physical or permanent auditory injury

(PTS), for example, the use of Marine Mammal Observers (MMOs), Passive Acoustic Monitoring (PAM) and / or activation of acoustic deterrent devices (ADDs). The methods for achieving the mitigation zone would be agreed with NRW and the relevant SNCBs.

345. It is currently proposed, that a MMMP for drilling activity would be prepared prior to construction, for example with the option of having MMOs on site during drilling activities to ensure marine mammals do not enter a predetermined mitigation zone (for example, 500m), based on the maximum potential PTS impact range, e.g. 210m for minke whale (see **Table 12-30**).

346. It is also proposed that a MMMP for cable installation and cable protection activities would be prepared prior to construction, for example with the option of having MMOs on site to ensure marine mammals do not enter a predetermined mitigation zone, based on the potential PTS impact range of up to 100m (see **Table 12-40**).

12.6.2.3.2. Proposed Mitigation and Monitoring for Collision Risk with Operational Turbines

347. The mitigation and monitoring plan to reduce the collision risk of marine mammals with operational turbines will be developed in the pre-construction period so that it can be based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design.

348. It will be developed in consultation with NRW and the relevant SNCBs, detailing the proposed mitigation measures which could include, but may not be limited to, detecting marine mammals in and around the arrays (this could be done using remotely monitored PAM, underwater cameras, autonomous recorders, and / or high definition (HD) and thermal imaging camera systems). There would also be the use of active sonar to detect marine mammals in close proximity to the arrays / devices which could be used to trigger mitigation measures, such as the automatic activation of ADDs to deter marine mammals from a predetermined mitigation zone around the arrays / devices.

349. The approach would be based on deployment, monitoring and adaptive management, with regular reviews of the installation at appropriate deployment increments directly related to collision risk to marine mammals, specifically bottlenose dolphin, to ensure that no more than one bottlenose dolphin could be theoretically at risk of collision or other significant impact.

350. An outline Environmental Mitigation and Monitoring Plan (EMMP) has been submitted with the ES (**Document MOR/RHDHV/DOC/0072**). The EMMP will develop alongside the development of the project, and the “proposed approach to the EMMP is that it will provide a flexible framework, through which further knowledge and understanding of the risks presented from the project that can be achieved throughout the project lifespan.” In addition, the EMMP will meet the project specific licence conditions.

351. The EMMP will focus on the potential collision risk of marine mammals and seabirds, as well as outlining the Marine Mammal Mitigation Plan (MMMP) for reducing the risk of any auditory injury in marine mammals as a result of underwater noise, which will be submitted as a separate document six months prior to construction.

352. The EMMP will be developed in consultation with NRW with a schedule of agreed milestones to meet the requirements prior to construction.

12.6.3. Assessment of Potential Impacts During Construction

12.6.3.1. Underwater Noise During Installation of Tidal Devices and Hubs

353. As outlined in **Chapter 4, Project Description** and **Section 12.6.1.1.1**, due to the hard substrate (bedrock) in the MDZ, drilling will be required to install pin-pile and monopiles foundations for the tidal devices and hubs. Of the potential installation methods that could be used, this has been considered as the worst-case scenario for underwater noise during the installation of the foundations for the tidal devices and hubs, compared to GBS and weighted anchors.

354. Underwater noise can cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals (e.g. Bailey *et al*., 2010; Madsen *et al*., 2006; Thomsen *et al*., 2006, Thompson *et al*., 2010).

355. High exposure levels from underwater noise sources can cause auditory injury or hearing impairment taking the form of a permanent loss of hearing sensitivity (Permanent Threshold Shift (PTS)) or a temporary loss in hearing sensitivity (Temporary Threshold Shift (TTS)). The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The level of impact on an individual is a function of the Sound Exposure Level (SEL) that an individual receives as a result of underwater noise.

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

- The potential impact of underwater noise will depend on a number of factors which include, but are not limited to:
- The source levels of noise;
- Frequency relative to the hearing bandwidth of the animal (dependent upon species);
- Propagation range, which is dependent on:
- Sediment/sea floor composition;
- Water depth;
- Duration of exposure;
- Distance of the animal to the source; and
- Ambient noise levels.

357. A series of underwater noise monitoring stations were installed by SEACAMS (University of Bangor) to sample the background noise levels in and around the MDZ over periods of between

15 and 30 days in 2016, 2017 and 2018. Four of these datasets from different time periods and locations have been analysed by Subacoustech (**Appendix 12.4, Appendix III**) to provide a range of noise levels to define a baseline over a daily (high-low) and fortnightly (springs-neaps) tidal cycle. All measurements analysed were taken with a 48 kHz sample rate and with contiguous 10-minute samples, except the June 2017 sample period which used a finer 1-minute sample period throughout.

358. The results of the background noise monitoring in these locations in and around the MDZ show a remarkable degree of consistency in all locations and time periods, and noise levels varying with position of the tide. There were occasional, rare outliers expected to be associated with passing vessel traffic. All locations show a range of noise levels of 89 dB to 107 dB SPLRMS re 1 µPa (as either 1-minute or 10-minute samples).

359. An overview of the noise levels sampled at each location is given in **Table 12-26** (excluding outliers).

Table 12-26 Summary of background noise levels in and around the MDZ

Period	Overall average noise level	Tide cycle: Springs		Tide cycle: Neaps	
		Max SPL_{RMS}	Min SPL_{RMS}	Max SPL_{RMS}	Min SPL_{RMS}
April 2017	98.3 dB SPL_{RMS}	103.0 dB	91.9 dB	99.7 dB	90.7 dB
June 2017	96.9 dB SPL_{RMS}	104.1 dB	89.1 dB	97.5 dB	89.7 dB
July 2017	98.9 dB SPL_{RMS}	106.4 dB	92.7 dB	100.2 dB	95.2 dB
July 2018	98.0 dB SPL_{RMS}	106.6 dB	89.9 dB	99.8 dB	92.6 dB

360. At MeyGen during August 2011 measurements of background underwater noise were recorded in the Inner Sound (Kongsberg, 2012). The Inner Sound is a turbulent location, with tides reaching speeds of 8-9 knots. Measurements were made from a drifting vessel, so that the differential flow of water across the hydrophone was minimised. **Table 12-27** summaries the background sea noise measurements undertaken in the Inner Sound (August 2011) and data are presented in sound pressure levels (SPL), sound exposure levels (SEL) and M-weighted SEL formats.

Table 12-27 Summary of the background sea noise measurements undertaken in the Inner Sound (August 2011)

Metric	Inner Sound
RMS SPL / SEL	106 - 139 dB re 1 µPa
M-Weighted SEL for low frequency cetaceans (minke whale)	102 – 131 dB re 1 µPa
M-Weighted SEL for mid frequency cetaceans (dolphin species)	106 - 139 dB re 1 µPa
M–Weighted SEL for high frequency cetaceans (harbour porpoise)	106 -139 dB re 1 µPa
M–Weighted SEL for pinnipeds in water (grey and harbour seal)	137 dB re 1 µPa

12.6.3.1.1. Underwater Noise Assessment

361. Underwater noise modelling has not currently been conducted for the MDZ, as the types of devices and how they could be installed has still to finalised. If required, underwater noise modelling will be undertaken pre-construction once the project design has been finalised. However, as a worst-case scenario, it has been assumed that the foundations of the tidal devices and hubs could be installed by drilling piles. Therefore, the assessment has been based on underwater noise modelling that has been conducted for drilling into a hard substrate at the

nearby Wylfa Newydd Development Area, drilling at the Perpetuus Tidal Energy Centre (PTEC) off the coast of the Isle of Wight and drilling at MeyGen in the Inner Sound of the Pentland Firth.

12.6.3.1.1.1. Drilling at Wylfa Newydd Development Area

362. The proposed Wylfa Newydd Development Area is located on the Wylfa peninsula, extending into the Irish Sea between the bays of Cemlyn and Cemaes, on the northern tip of the Isle of Anglesey off the North Wales coast. The distance to the Wylfa Newydd Development Area from the MDZ is 16.6 km.

363. Underwater noise modelling for the Wylfa Newydd Development Area was undertaken for rotary drilling, percussive drilling and concurrent drilling (HNP, 2018) and was updated to take into account the National Oceanographic and Atmospheric Association (NOAA) (National Marine and Fisheries Service (NMFS), 2018) thresholds and criteria (**Table 12-28**).

364. The NMFS (2018) guidance groups marine mammals into functional hearing groups and applies filters to the noise level to approximate the hearing response of the receptor:

- High Frequency (HF) Cetaceans, such as harbour porpoise;
- Mid Frequency (MF) Cetaceans, includes dolphin species, such as bottlenose dolphin, Risso's dolphin and common dolphin;
- Low Frequency (LF) Cetaceans, such as minke whale; and
- Phocid Pinnipeds Underwater (PW), such as grey and harbour seal.

365. For non-impulsive (i.e. continuous) noise, which is representative of drilling activity, NMFS (2018) presents cumulative weighted sound exposure criteria (SEL_{cum}) for both permanent threshold shift (PTS), where unrecoverable hearing damage may occur, and temporary threshold shift (TTS), where a short-term, recoverable effect on hearing sensitivity may occur in individual receptors. **Table 12-28** summarise the NMFS (2018) criteria for onset of risk of PTS and TTS for each of the key marine mammal hearing groups for non-impulsive noise.

Table 12-28 NMFS (2018) non-impulsive noise exposure criteria for PTS and TTS

Non-Impulsive noise	**PTS criteria**	**TTS criteria**
Hearing group	**Weighted SEL_{cum} (dB re 1 μPa^{2}s)**	**Weighted SEL_{cum} (dB re 1 μPa^{2}s)**
HF Cetaceans: harbour porpoise	173	153
MF Cetaceans: dolphin species	198	178
LF Cetaceans: minke whale	199	179
PW Pinnipeds: grey and harbour seal	201	181

366. Sound may be expressed in many different ways depending on the particular type of noise and the parameters of the noise that allow it to be evaluated in terms of a biological effect.

367. The attenuation of sound in the water as it propagates from the noise source must be considered in an assessment of potential impacts. As the measurement or receiver point moves away from the source, the sound pressure measured will decrease due to spreading. To standardise all source levels, regardless of where they are measured, they are referred back to a conceptual point 1m away from the point of origin of the noise. Consequently, source levels (**Table 12-29**) are presented with units of 'dB re 1 μPa @ 1 m'.

368. The sound pressure level (SPL) is normally used to characterise noise and vibration of a continuous nature such as drilling, boring, or background sea levels. To calculate the SPL, the variation in sound pressure is measured over a specific time period to determine the root mean square (RMS) level of the time varying acoustic pressure. The SPL_{RMS} therefore can be considered to be a measure of the average unweighted level of the sound over the measurement period.

369. The peak sound pressure level (SPL_{peak}) is the maximum level of sound. SPL_{peak} is often used to characterise sound transients from impulsive sources where there is a clear positive peak, such as impact piling or following the detonation of explosives. A peak SPL is calculated using the maximum variation of the pressure from positive to zero within the wave. This represents the maximum change in positive pressure (differential pressure from positive to zero) as the transient pressure wave propagates.

370. The Sound Exposure Level (SEL) sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound source and the duration for which the sound is present in the acoustic environment.

371. The cumulative sound exposure level (SEL_{cum}) takes into account the potential sound exposure level during the duration of the activity. For the SEL_{cum} modelling a worst-case static animal model was assumed for the Wylfa site. This assumes that the animal remains at a fixed distance from the noise source throughout, which in this case is a 24-hour period. This is assumed to be a very worst-case scenario, as it is more likely that animals exposed to high noise levels will move away from the noise source.

372. The source levels used in the underwater noise modelling for drilling at the Wylfa Newydd Development Area are summarised in **Table 12-29**. These source levels were derived using a combination of measurement data and extrapolations based on the differences in methodology, equipment and location.

Table 12-29 Summary of predicted source levels used for modelling drilling at Wylfa site

Noise source	**Predicted unweighted source level** (dB re 1 µPa (RMS) @ 1m)	**Predicted NMFS (2018) weighted source level** (dB re 1 µPa^{2}s @ 1m) (SEL)			
		LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Pinniped**
Rotary drilling (242 kW)	161.2	153.3	116.9	110.1	139.6
Rotary drilling (570 kW)	164.9	157.0	120.6	113.8	143.3
Percussive drilling	185.3	181.4	146.5	139.9	167.5

373. Rotary drilling consists of two diameters and the rotating head is forced into the ground. Typical noise outputs from rotary drilling are characterised by a fairly continuous low pitch rumble with numerous higher levels of noise for short periods of time, as a result of the drill bit hitting inconsistencies in the rock.

374. Percussive drilling is different from rotary drilling as it adds a rapid hammer action to the rotating head. The noise is characterised by very rapid transient peaks associated with the hammer action of the drilling rig being used. Compared to rotary drilling, percussive drilling is a louder

process overall. Percussive drilling could be used over rotary drilling where harder substrate exists as the hammer action of the drill head would enable penetration into the harder material.

375. Measurements used in the modelling of rotary drilling were taken from measurements at close range to operations in Strangford Lough, Northern Ireland and the percussive drilling measurements that have been used were taken at the EMEC site off the coast of Eday, Orkney. The drills proposed for Wylfa varied in size compared to these measurements and as such a scaling factor was applied to the measurements in order to give a good estimate of the likely source levels.

376. The underwater noise modelling for the Wylfa Newydd Development Area was undertaken using the RAMSGeo software package which is designed to model any noise source where it is reasonable to assume it is a point source. RAMSGeo is a fully range dependent parabolic equation (PE) model that performs underwater acoustic transmission loss calculations. RAMSGeo is a purely theoretical model based solely around the physical acoustic processes that occur underwater.

377. The speed of sound in water is connected to temperature, and a representative sound speed of 1,489m/s was used in the modelling, based on a uniform temperature profile.

378. The seabed along the transects was assumed to be made up of predominately rock and hard substrate covered by a layer of sandy gravel. Similar to the predominately rock and hard substrate at the MDZ.

379. A location in 10m above ordinance datum water depth was used for the modelling at the Wylfa Newydd Development Area. All modelling for the Wylfa Newydd Development Area was conducted assuming a worst-case mean high water springs (MHWS) tide of 6.6m above LAT from the nearby Cemaes Bay. Three transects were modelled to illustrate the propagation of noise from the Wylfa site, with two of these extending out into the Irish Sea and deeper water, with 40-50m water depth in 5 km range of the noise modelling location. The results used in this assessment are based on the maximum potential impact ranges.

12.6.3.1.1.2. Drilling at PTEC

380. Underwater noise modelling of tidal devices and other associated noise at the Perpetuus Tidal Energy Centre off the coast of the Isle of Wight, England (Subacoustech, 2014) was undertaken prior to the NOAA (NMFS, 2016, 2018) thresholds and criteria. The noise metrics used were unweighted metrics (Parvin *et al*., 2007), the dB_{ht}(*Species*) (Nedwell *et al*., 2007) and M-Weighted SELs (Southall *et al*., 2007). The Source Level for the noise from percussive drilling operations was estimated to be 179.8 dB re 1 μPa@1 m (RMS) for installing a 4m diameter pile.

12.6.3.1.1.3. Drilling at MeyGen

381. Underwater noise modelling for the tidal turbine development in Inner Sound, Pentland Firth (Konsberg, 2012) was also undertaken prior to the NOAA (NMFS, 2016, 2018) thresholds and criteria. Drilling noise measurements indicate that limits of 144 dB re 1 μPa at 1m to 178 dB re 1 μPa at 1m may be considered representative for the activities at the Inner Sound site.

12.6.3.1.2. Potential Impacts from Underwater Noise During Drilling

12.6.3.1.2.1. Permanent Auditory Injury (PTS)

382. The maximum predicted impact ranges for the risk of PTS using the non-impulsive NMFS (2018) criteria for the proposed drilling operations at the Wylfa Newydd Development Area, assuming a stationary animal remaining in the vicinity over a 24-hour period, are presented in **Table 12-30**.

Table 12-30 Summary of the maximum predicted PTS impact ranges (and areas) for marine mammal species for drilling operations at Wylfa, based on NMFS (2018) weighted SEL_{cum} criteria for non-impulsive sounds

Potential Impact	Rotary drilling [570 kW]	Percussive drilling	Two rotary drilling rigs	Two percussive drilling rigs
Range (and area*) for PTS in High Frequency Cetaceans (harbour porpoise) 173 dB re 1 µPa^{2}s Weighted SEL_{cum}	<1m (0.000003 km^2)	9m (0.00025 km^2)	<1m (0.000003 km^2)	10m (0.0003 km^2)
Range (and area*) for PTS in Mid Frequency Cetaceans (dolphin species) 198 dB re 1 µPa^{2}s Weighted SEL_{cum}	<1m (0.000003 km^2)	<1m (0.000314 km^2)	<1m (0.000003 km^2)	1m (0.000003 km^2)
Range (and area*) for PTS in Low Frequency Cetaceans (minke whale) 199 dB re 1 µPa^{2}s Weighted SEL_{cum}	4m (0.00005 km^2)	100m (0.03 km^2)	6m (0.0001 km^2)	210m (0.14 km^2)
Range (and area*) for PTS in Pinnipeds in water (grey and harbour seals) 201 dB re 1 µPa^{2}s Weighted SEL_{cum}	<1m (0.000003 km^2)	9m (0.00025 km^2)	<1m (0.000003 km^2)	10m (0.0003 km^2)

*based on area of a circle

383. The maximum number of harbour porpoise, bottlenose dolphin, Risso’s dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for two percussive drilling operations are presented in **Table 12-31**.

Table 12-31 Maximum number of individuals (and % of reference population) that could be at risk of permanent auditory injury (PTS) from cumulative exposure over a 24 hour period for two percussive drilling operations at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
PTS in harbour porpoise	0.00024 individuals (based on density estimate of 0.783/ km^2) (0.00000023% of the 104,695 reference population).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in bottlenose dolphin	0.00000006 individuals (based on density estimate of 0.02/ km^2) (0.000000015% of the reference population of 397 bottlenose dolphin)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in Risso’s dolphin	0.00000009 individuals (based on density estimate of 0.031/ km^2) (0.000000001% of the reference population of 8,794 Risso’s dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
PTS in common dolphin	0.00000066 individuals (based on density estimate of 0.22/ km^2) (0.000000001% of the reference population of 56,556 common dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in minke whale	0.0024 individuals (based on density estimate of 0.017/ km^2) (0.00001% of the reference population of 23,528 minke whale).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in grey seal	0.000049 individuals (based on density estimate of 0.155/ km^2) (0.0000008% of the reference population of 6,000 grey seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in harbour seal	0.00000015 individuals (based on density estimate of 0.0005/ km^2) (0.0000003% of the reference population of 50 harbour seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

384. The magnitude of the potential risk of PTS is assessed as **negligible / very low** for all species, with less than 0.001% of all relevant reference populations anticipated to be exposed to the permanent effect without any mitigation (**Table 12-31**).

385. Taking into account the high sensitivity of all marine mammal species to any permanent auditory injury (i.e. receptor has very limited capacity to recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species; **Table 12-31**), the impact significance (as defined in **Table 12-10**) for any permanent auditory injury in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal from cumulative exposure for two percussive drilling operations over 24 hours has been assessed as **minor (not significant)** (**Table 12-33**).

386. For PTEC, the source levels for the noise from percussive drilling operations was estimated to be 179.1 dB re 1 μPa@1 m (RMS) for the installation of 3m diameter piles. These levels are below the 240 and 220 dB re 1 μPa (SPL_{peak}) criteria for lethal effect and physical injury (Subacoustech, 2014). Therefore, no injury is anticipated.

387. Modelling undertaken for drilling at PTEC, based on the dB_{ht}(*Species*) criteria also indicates that for drilling noise the highest predicted source level was for harbour porpoise, for percussive drilling to install a 4m diameter pile, was 118.8 dB_{ht}(*Phocoena phocoena*)@1m. This is below 130 dB_{ht}(*Species*) perceived level used to indicate traumatic hearing damage (Subacoustech, 2014).

388. The modelling for PTEC, based on the M-weighted SEL Southall *et al*. (2007) thresholds is summarised in **Table 12-32**. The largest impact ranges are for the pinniped due to the more conservative criterion and shows a maximum range of 29m for installing the 3m pile through percussive drilling and 34m for a 4m pile. This means if a pinniped was positioned closer than 29m or 34m, respectively, from the drilling operation for 24 hours it would receive an exposure to sound that could be injurious using the Southall *et al*. (2007) criteria for non-pulses. However, the chance of a receptor staying this close to a noise source for such a long period of time is extremely unlikely (Subacoustech, 2014).

Table 12-32 Summary of the ranges out to which the injury criteria for non-pulses (Southall *et al*, 2007) is reached for percussive drilling noise over a 24 hour period modelled for PTEC (Subacoustech, 2014)

Percussive drilling	Range (m)			
	High Freq. Cetaceans (harbour porpoise) Range to 215 dB re 1 µPa²s	Mid Freq. Cetaceans (dolphin species) Range to 215 dB re 1 µPa²s	Low Freq. Cetaceans (minke whale) Range to 215 dB re 1 µPa²s	Pinnipeds (in water) (grey and harbour seal) Range to 203 dB re 1 µPa²s
1m diameter pile	2m	3m	4m	18m
2m diameter pile	3m	4m	5m	25m
3m diameter pile	4m	5m	6m	29m
4m diameter pile	6m	7m	8m	34m

389. For MeyGen, the source levels for drilling were considerably below the levels at which lethal injury to species of marine mammal might occur (240 dB re. 1 µPa). It was therefore considered unlikely that any marine animals would be killed as a consequence of the underwater noise from drilling activities at the Inner Sound development area.

390. The noise modelling for MeyGen also indicates that the peak source levels associated with drilling were also below the levels at which hearing damage from the underwater noise might occur (230 dB re. 1µPa and 224 dB re. 1µPa for the onset of Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) for cetaceans and 218 dB re. 1µPa and 212 dB re. 1µPa for the onset of PTS and TTS for pinnipeds). Even taking into account the more conservative criteria proposed by Lucke *et al*. (2009) for harbour porpoises (193.7 dB re 1 µPa) and those put forward by the US National Marine Fisheries Service (NMFS) (1995), whereby auditory injury may occur to pinnipeds and cetaceans following prolonged exposure to underwater sound at levels at or above 190 dB re. 1 µPa and 180 dB re. 1 µPa respectively, the source levels were sufficiently low such that the NMFS impact criteria were not exceeded (Kongsberg, 2012).

12.6.3.1.2.1.1. Mitigation

391. A MMMP for drilling activity would be prepared prior to construction, for example with the option of having MMOs on site during drilling activities to ensure marine mammals do not enter a predetermined mitigation zone, based on the maximum potential PTS impact range, e.g. 210m for minke whale. Although, to take into account the deeper water at the MDZ compared to the Wylfa site and the potential for increased noise propagation, the proposed mitigation zone for drilling activity would be a precautionary 500m.

12.6.3.1.2.1.2. Residual Impact

392. After the proposed mitigation, the residual impact would be negligible as marine mammals would be outwith the mitigation zone and potential area for any permanent auditory injury.

Table 12-33 Assessment of impact significance for any permanent auditory injury (PTS) in marine mammals from underwater noise during drilling to install tidal device and hub foundations at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS during drilling to install tidal device and hub foundations	Harbour porpoise	High	Negligible / very low	Minor (not significant)	MMMP	Negligible
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Negligible
	Risso's dolphin		Negligible / very low	Minor (not significant)		Negligible
	Common dolphin		Negligible / very low	Minor (not significant)		Negligible
	Minke whale		Negligible / very low	Minor (not significant)		Negligible
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Negligible

12.6.3.1.2.2. Temporary Auditory Injury (TTS) and Disturbance

393. For all marine mammal species considered, a fleeing response is assumed to occur at the same noise levels as TTS and the potential impact is also described as 'likely disturbance'. The behavioural response of individuals to a noise stimulus will vary, and not all individuals will respond, or in the same way, however, for the purposes of this assessment, it is assumed that at the 'likely disturbance' range of TTS onset, 100% of the individuals exposed to the noise stimulus will respond and flee the area.

394. The maximum predicted impact ranges for TTS using the non-impulsive NMFS (2018) criteria for the proposed drilling operations at the Wylfa Newydd Development Area, assuming a stationary animal remaining in the vicinity over a 24-hour period, are presented in **Table 12-34**.

395. The maximum predicated impact range for minor behavioural response in harbour porpoise based on the unweighted Lucke *et al*. (2009) criteria of 145 dB re 1 μPa^{2}s (SEL_{ss}) for single strike and not cumulative exposure for two percussive drilling rigs was up to 530m a the Wylfa site. However, it should be noted that this criteria is for possible behavioural response and not all animals within this range would be predicted to be disturbed. Therefore, using the weighted TTS ranges for cumulative exposure based on the NOAA (NMFS, 2018) thresholds and criteria modelled for Wylfa also represents a good indication of the potential disturbance ranges.

Table 12-34 Summary of the maximum predicted TTS / fleeing response impact ranges (and areas) for marine mammal species for drilling operations at Wylfa, based on NMFS (2018) weighted SEL_{cum} criteria for non-impulsive sounds

Potential Impact	Rotary drilling [570 kW]	Percussive drilling	Two rotary drilling rigs	Two percussive drilling rigs
Range (and area*) for TTS in High Frequency Cetaceans (harbour porpoise) 153 dB re 1 μPa^{2}s Weighted SEL_{cum}	6m (0.0001 km^2)	250m (0.2 km^2)	7m (0.00015 km^2)	320m (0.32 km^2)

Potential Impact	Rotary drilling [570 kW]	Percussive drilling	Two rotary drilling rigs	Two percussive drilling rigs
Range (and area*) for TTS in Mid Frequency Cetaceans (dolphin species) 178 dB re 1 µPa^{2}s Weighted SEL_{cum}	<1m (0.000003 km^2)	10m (0.0003 km^2)	<1m (0.000003 km^2)	20m (0.0013 km^2)
Range (and area*) for TTS in Low Frequency Cetaceans (minke whale) 179 dB re 1 µPa^{2}s Weighted SEL_{cum}	60m (0.01 km^2)	1.5 km (7.07 km^2)	90m (0.025 km^2)	2.1 km (13.85 km^2)
Range (and area*) for TTS in Pinnipeds in water (grey and harbour seals) 181 dB re 1 µPa^{2}s Weighted SEL_{cum}	7m (0.00015 km^2)	240m (0.18 km^2)	8m (0.0002 km^2)	320m (0.32 km^2)

*based on area of a circle

396. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of TTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for two percussive drilling operations are presented in **Table 12-35**.

Table 12-35 Maximum number of individuals (and % of reference population) that could be at risk of temporary auditory injury (TTS) and fleeing response / disturbance from cumulative exposure over a 24 hour period for two percussive drilling operations at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
TTS / fleeing response in harbour porpoise	0.25 individuals (based on density estimate of 0.783/ km^2) (0.00024% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in bottlenose dolphin	0.000026 individuals (based on density estimate of 0.02/ km^2) (0.0000065% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in Risso's dolphin	0.00004 individuals (based on density estimate of 0.031/ km^2) (0.0000005% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in common dolphin	0.0003 individuals (based on density estimate of 0.22/ km^2) (0.0000005% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in minke whale	0.24 individuals (based on density estimate of 0.017/ km^2) (0.001% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in grey seal	0.05 individuals (based on density estimate of 0.155/ km^2) (0.0008% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
TTS / fleeing response in harbour seal	0.00016 individuals (based on density estimate of 0.0005/ km^2) (0.0003% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

397. The magnitude of the potential of TTS / fleeing response is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-35**).

398. Taking into account the medium sensitivity of all marine mammal species to any temporary auditory injury (i.e. receptor has limited capacity to recover from the anticipated impact; **Table 12-6**) and low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species; **Table 12-35**), the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any temporary auditory injury or disturbance in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal from cumulative exposure for two percussive drilling operations over 24 hours has been assessed as **minor (not significant)** for TTS and **negligible** for disturbance (**Table 12-36**).

399. The modelling for PTEC, based on the dB_{ht}(*Species*) criteria that:

- For 90 and above, strong avoidance reaction by virtually all individuals; and
- For 75 and above, some avoidance reaction by the majority of individuals, but habituation or context may limit effect (e.g. in the presence of another biological imperative (such as migration to breeding or feeding grounds or avoiding a predator) individuals may not exhibit any behavioural reaction to the noise source).

400. The maximum range for 90 dB_{ht} is 76m for harbour porpoise, 22m for bottlenose dolphin, 42m for minke whale and 12m for grey and harbour seal and that the maximum range for 75 dB_{ht} is 780m for harbour porpoise, 180m for bottlenose dolphin, 280m for minke whale and 78m for grey and harbour seal (Subacoustech, 2014).

401. For Meygen, in a relatively noisy environment such as the Inner Sound where background noise levels are fairly high (in the range 106 – 139 dB re 1 μP), drilling noise propagates over only short distances (0.5 km) before it falls below background noise levels (Konsberg, 2012).

12.6.3.1.2.2.1. Mitigation

402. The proposed mitigation to reduce the risk of any PTS, for example, 500m mitigation zone and MMOs during drilling activity, will also reduce the risk of animals in the predicted impact area for TTS.

12.6.3.1.2.2.2. Residual Impact

403. After the proposed mitigation, the residual impact would be negligible for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, grey seal and harbour seal, as they would be outwith the mitigation zone (500m) and potential area for any temporary auditory injury. After

the proposed mitigation, the residual impact would be minor (not significant) for minke whale (**Table 12-36**).

Table 12-36 Assessment of impact significance for any temporary auditory injury (TTS) and disturbance in marine mammals from underwater noise during drilling to install tidal device and hub foundations within the MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS during drilling to install tidal device and hub foundations	Harbour porpoise	Medium	Negligible / very low	Minor (not significant)	MMMP	Negligible
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Negligible
	Risso's dolphin		Negligible / very low	Minor (not significant)		Negligible
	Common dolphin		Negligible / very low	Minor (not significant)		Negligible
	Minke whale		Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Negligible
Disturbance during drilling to install tidal device and hub foundations	Harbour porpoise	Low	Negligible / very low	Negligible	No mitigation required.	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.3.1.2.3. Duration of Potential Disturbance during Drilling

404. As outlined in **Table 12-25**, the estimated total maximum duration of drilling for all tidal device and hubs foundation installation for 240MW array is up to 3,990 drilling days. Based on two deployment areas being developed at the same time, this could result in 1,995 days during the 10 year construction period (approximately 55%).

405. The 240MW array would not be installed all at once, but rather in phases with different deployment areas being developed at different times with different devices.

406. Drilling would not be continuous during the phases or construction period, but with gaps in drilling activity as vessels move to different positions within the sites, between different deployment areas being developed, plus any downtime for weather or any technical issues.

407. This assessment also does not take into account that not all foundations will require drilling (i.e. some will be GBS or anchored).

408. As a worst-case scenario it is assumed that marine mammals could be disturbed from areas for two percussive drilling rigs presented in **Table 12-34**, throughout the year for up to 5.5 years during the construction period. However, based on the maximum number of individuals that could potential be disturbed (**Table 12-35**), this is unlikely to result in significant disturbance (**Table 12-36**).

12.6.3.2. Underwater Noise During Other Construction Activities

409. In addition to the installation of the tidal device and hub foundations, other construction activities will include the cable installation and cable protection. Due to the hard substrate (bedrock) in the MDZ there will be very little, if any, seabed preparation.

410. As outlined in **Chapter 4, Project Description** and **Section 12.6.1.1.2**, due to the hard and rocky nature of the seabed, it is expected that the majority of the cables will be free laid with strategic protection (rock bags or concrete mattresses) at locations along the length. Where burial may be possible this will be done using jet trenching.

411. There are no clear indications that underwater noise caused by the installation of sub-sea cables poses a high risk of harming marine fauna (OSPAR, 2009). However, behavioural responses of marine mammals to dredging, an activity emitting comparatively higher underwater noise levels, are predicted to be similar to those during cable installation (OSPAR, 2009).

412. Based on reviews of published sources of underwater noise during dredging activity (e.g. Thomsen *et al*., 2006; CEDA, 2011; Theobald *et al*., 2011; WODA, 2013; Todd *et al*., 2014), sound levels that marine mammals may be exposed to during dredging activities are usually below auditory injury thresholds or PTS exposure criteria; however, TTS cannot be ruled out if marine mammals are exposed to noise for prolonged periods (Todd *et al*., 2014), although marine mammals remaining in close proximity to such activities for long periods of time is unlikely. Therefore, the potential risk of any auditory injury (permanent or temporary) in marine mammals as a result of dredging / cable installation activity is highly unlikely.

413. Underwater noise as a result of dredging activity/cable installation, has the potential to disturb marine mammals. Therefore, there is the potential for short, perhaps medium-term behavioural reactions and disturbance to marine mammals in the area during dredging / cable installation activity. Marine mammals may exhibit varying behavioural reactions intensities as a result of exposure to noise (Southall *et al*., 2007).

12.6.3.2.1. Underwater Noise Assessment

414. Underwater noise modelling has not been conducted for the MDZ, however, underwater noise modelling has been conducted for the nearby Wylfa Newydd Development Area, this included cutter-suction dredging on a hard substrate (HNP, 2018) and was updated to take into account the NOAA (NMFS, 2018) thresholds and criteria (**Table 12-28**).

415. The underwater noise modelling for cutter-suction dredging at Wylfa has been used as a precautionary worst-case scenario for the underwater noise that could be generated during the cable installation and placement of cable protection at the MDZ.

416. Cutter-suction dredging involves the use of a rotating cutter head to loosen rock in conjunction with a suction inlet that sucks up material onto the dredge vessel. Cutter-suction dredgers are often used in areas with harder substrata, such as rock. The dominant noise generated is characterised by short pulses that correspond with the cutter tool on the dredger, although noise from the vessel's engines can also be heard.

417. The source levels used in the underwater noise modelling of cutter-suction dredging for the Wylfa Newydd Development Area are summarised in **Table 12-37**. The source levels were derived using a combination of measurement data and extrapolations based on the differences in methodology, equipment and location. Further details of the underwater noise modelling conducted for the Wylfa Newydd Development Area is provided in **Section 12.6.3.1.1**.

Table 12-37 Summary of predicted source levels used for modelling cutter suction dredging at Wylfa

Noise source	**Predicted unweighted source level** (dB re 1 µPa (RMS) @ 1m)	**Predicted NMFS (2018) weighted source level** (dB re 1 µPa^{2}s @ 1m) (SEL)			
		LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Pinniped**
Cutter-suction dredging	176.1	171.7	150.2	144.7	163.4

418. In addition to the underwater noise modelling for cutter-suction dredging in the Wylfa Newydd Development Area, reference is also made to underwater noise modelling for cable laying, rock placement and trenching in the Southern North Sea.

419. The underwater noise modelling in the Southern North Sea was undertaken for sites with water depths of 45-55m and sandy sediment. Although the sediments are different for the majority of the MDZ, this modelling provides an indication of potential underwater noise for areas where burial using jet trenching may be possible.

420. The underwater noise propagation modelling for the Southern North Sea sites was undertaken using a simple modelling approach for a number of offshore construction activities; using measured sound source data scaled to relevant parameters for the site. The unweighted source levels used were:

- Cable laying: estimated sound source of 171dB re 1µPs @1m (RMS)
  Based on eleven datasets from a pipe laying vessel measuring 300m in length; this is considered a worst-case noise source for cable laying operations.
- Rock placement: estimated sound source of 172dB re 1µPs @1m (RMS)
  Based on four datasets from rock placement vessel 'Rollingstone.'
- Trenching: estimated sound source of 172dB re 1µPs @1m (RMS)
  Based on three datasets of measurements from trenching vessels more than 100m in length.

12.6.3.2.2. Potential Impacts from Underwater Noise During Other Construction Activities

12.6.3.2.2.1. Permanent Auditory Injury (PTS)

421. The maximum predicted impact ranges for the risk of PTS using the non-impulsive NMFS (2018) criteria for the proposed cutter-suction dredging operations at the Wylfa Newydd Development Area, assuming a stationary animal remaining in the vicinity over a 24-hour period, are presented in **Table 12-38**.

Table 12-38 Summary of the maximum predicted PTS impact ranges (and areas) for marine mammal species for cutter-suction dredging operations at Wylfa, based on NMFS (2018) weighted SEL_{cum} criteria for non-impulsive sounds

Potential Impact	Cutter-suction dredging
Range (and area*) for PTS in High Frequency Cetaceans (harbour porpoise) 173 dB re 1 µPa^2s Weighted SEL_{cum}	10m (0.0003 km^2)
Range (and area*) for PTS in Mid Frequency Cetaceans (dolphin species) 198 dB re 1 µPa^2s Weighted SEL_{cum}	1m (0.000003 km^2)
Range (and area*) for PTS in Low Frequency Cetaceans (minke whale) 199 dB re 1 µPa^2s Weighted SEL_{cum}	10m (0.0003 km^2)
Range (and area*) for PTS in Pinnipeds in water (grey and harbour seals) 201 dB re 1 µPa^2s Weighted SEL_{cum}	9m (0.00025 km^2)

*based on area of a circle

422. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for cutter-suction dredging operations / cable installation and protection at MDZ are presented in **Table 12-39**.

423. The magnitude of the potential risk of PTS is assessed as **negligible / very low** for all species, with less than 0.001% of all relevant reference populations anticipated to be exposed to the permanent effect without any mitigation (**Table 12-39**).

Table 12-39 Maximum number of individuals (and % of reference population) that could be at risk of permanent auditory injury (PTS) from cumulative exposure over a 24 hour period for cutter-suction dredging operations / cable installation and protection at MDZ, based on Wylfa modelling

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
PTS in harbour porpoise	0.00024 individuals (based on density estimate of 0.783/ km^2) (0.00000023% of the 104,695 reference population).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in bottlenose dolphin	0.00000006 individuals (based on density estimate of 0.02/ km^2) (0.000000015% of the reference population of 397 bottlenose dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in Risso's dolphin	0.00000009 individuals (based on density estimate of 0.031/ km^2) (0.000000001% of the reference population of 8,794 Risso's dolphin)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in common dolphin	0.00000066 individuals (based on density estimate of 0.22/ km^2) (0.000000001% of the reference population of 56,556 common dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in minke whale	0.000005 individuals (based on density estimate of 0.017/ km^2) (0.00000002% of the reference population of 23,528 minke whale).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in grey seal	0.00004 individuals (based on density estimate of 0.155/ km^2) (0.0000007% of the reference population of 6,000 grey seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in harbour seal	0.0000001 individuals (based on density estimate of 0.0005/ km^2) (0.0000002% of the reference population of 50 harbour seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

424. The maximum predicted impact ranges for the risk of PTS using the impulsive NMFS (2018) criteria for cable laying, rock placement and trenching in the Southern North Sea sites is presented in **Table 12-40**. In this assessment, a fleeing animal model has been used for SEL_{cum}. This more realistically assumes that the animal exposed to high noise levels will swim away from the noise source. For this a constant fleeing speed of 3.25m/s has been assumed for the low frequency (LF) cetaceans group (Blix and Folkow, 1995), based on data for minke whale, and for other receptors a constant rate of 1.5m/s has been assumed, which is a cruising speed for a harbour porpoise (Otani *et al.*, 2000). These are considered 'worst-case' as marine mammals are expected to be able to swim much faster under stress conditions. For example, Kastelein *et al*. (2018) recorded harbour porpoise swimming speeds of 1.97m/s during playbacks of pile driving sounds.

425. The modelling ranges smaller than 100m (cumulative) were not presented for the Southern North Sea sites and could therefore be a lot less than 100m. However, as a worst-case scenario, impact ranges of up to 100m have been assumed.

Table 12-40 Summary of the maximum predicted PTS impact ranges (and areas) for marine mammal species for cable laying, rock placement and trenching at Southern North Sea sites, based on NMFS (2018) weighted SEL_{cum} criteria for impulsive sounds

Potential Impact	Cable laying	Rock placement	Trenching
Range (and area*) for PTS in High Frequency Cetaceans (harbour porpoise) 155 dB re 1 µPa^{2}s Weighted SEL_{cum}	<100m (0.03 km^2)	<100m (0.03 km^2)	<100m (0.03 km^2)
Range (and area*) for PTS in Mid Frequency Cetaceans (dolphin species) 185 dB re 1 µPa^{2}s Weighted SEL_{cum}	<100m (0.03 km^2)	<100m (0.03 km^2)	<100m (0.03 km^2)
Range (and area*) for PTS in Low Frequency Cetaceans (minke whale) 183 dB re 1 µPa^{2}s Weighted SEL_{cum}	<100m (0.03 km^2)	<100m (0.03 km^2)	<100m (0.03 km^2)
Range (and area*) for PTS in Pinnipeds in water (grey and harbour seals) 185 dB re 1 µPa^{2}s Weighted SEL_{cum}	<100m (0.03 km^2)	<100m (0.03 km^2)	<100m (0.03 km^2)

*based on area of a circle

426. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS from cumulative exposure, based on the density estimates for the MDZ and maximum area of impact for cable laying, rock placement and trenching are presented in **Table 12-41**.

427. The magnitude of the potential risk of PTS is again assessed as **negligible / very low** for all species, with less than 0.001% of all relevant reference populations anticipated to be exposed to the permanent effect without any mitigation (**Table 12-41**).

Table 12-41 Maximum number of individuals (and % of reference population) that could be at risk of permanent auditory injury (PTS) from cumulative exposure for cable laying, rock placement and trenching at MDZ, based on Southern North Sea modelling

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
PTS in harbour porpoise	0.024 individuals (based on density estimate of 0.783/ km^2) (0.000023% of the 104,695 reference population).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in bottlenose dolphin	0.0006 individuals (based on density estimate of 0.02/ km^2) (0.00015% of the reference population of 397 bottlenose dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in Risso's dolphin	0.0009 individuals (based on density estimate of 0.031/ km^2) (0.00001% of the reference population of 8,794 Risso's dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in common dolphin	0.0066 individuals (based on density estimate of 0.22/ km^2)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
	(0.00001% of the reference population of 56,556 common dolphin).	reference population anticipated to be exposed to effect).
PTS in minke whale	0.0005 individuals (based on density estimate of 0.017/ km^2) (0.000002% of the reference population of 23,528 minke whale).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in grey seal	0.005 individuals (based on density estimate of 0.155/ km^2) (0.00008% of the reference population of 6,000 grey seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in harbour seal	0.000015 individuals (based on density estimate of 0.0005/ km^2) (0.00003% of the reference population of 50 harbour seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

428. Taking into account the high sensitivity of all marine mammal species to any permanent auditory injury (i.e. receptor has very limited capacity to recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species; **Table 12-39** and **Table 12-41**), the impact significance (as defined in **Table 12-10**) for any permanent auditory injury in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal from cumulative exposure for cable installation and protection has been assessed as **minor (not significant)** (**Table 12-42**).

12.6.3.2.2.1.1. Mitigation

429. A MMMP for cable installation and cable protection activities would be prepared prior to construction, for example with the option of having MMOs on site to ensure marine mammals do not enter a predetermined mitigation zone, based on the potential PTS impact range, e.g. 100m. Although, the proposed mitigation zone could be a precautionary 500m.

12.6.3.2.2.1.2. Residual Impact

430. After the proposed mitigation, the residual impact would be negligible as marine mammals would be outwith the mitigation zone and potential area for any permanent auditory injury.

Table 12-42 Assessment of impact significance for any permanent auditory injury (PTS) in marine mammals from underwater noise during cable installation and protection at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS during cable installation and cable protection	Harbour porpoise	High	Negligible / very low	Minor (not significant)	MMMP	Negligible
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Negligible
	Risso's dolphin		Negligible / very low	Minor (not significant)		Negligible
	Common dolphin		Negligible / very low	Minor (not significant)		Negligible
	Minke whale		Negligible / very low	Minor (not significant)		Negligible

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Negligible

12.6.3.2.2.2. Temporary Auditory Injury (TTS) and Disturbance

431. The maximum predicted impact ranges for TTS / disturbance using the non-impulsive NMFS (2018) criteria for the cutter-suction dredging operations at the Wylfa Newydd Development Area, assuming a stationary animal remaining in the vicinity over a 24-hour period, are presented in **Table 12-43**.

432. The maximum predicated impact range for minor behavioural response in harbour porpoise based on the unweighted Lucke *et al*. (2009) criteria of 145 dB re 1 μPa^{2}s (SEL_{ss}) for single strike and not cumulative exposure for cutter-suction dredging was up to 580m a the Wylfa site. However, as previously noted that this criteria is for possible behavioural response and not all animals within this range would be predicted to be disturbed. Therefore, using the weighted TTS ranges for cumulative exposure based on the NOAA (NMFS, 2018) thresholds and criteria modelled for Wylfa also represents a good indication of the potential disturbance ranges.

Table 12-43 Summary of the maximum predicted TTS / fleeing response impact ranges (and areas) for marine mammal species for cutter-suction dredging operations at Wylfa, based on NMFS (2018) weighted SEL_{cum} criteria for non-impulsive sounds

Potential Impact	Cutter-suction dredging
Range (and area*) for TTS in High Frequency Cetaceans (harbour porpoise) 153 dB re 1 μPa^{2}s Weighted SEL_{cum}	260m (0.21 km^2)
Range (and area*) for TTS in Mid Frequency Cetaceans (dolphin species) 178 dB re 1 μPa^{2}s Weighted SEL_{cum}	10m (0.0003 km^2)
Range (and area*) for TTS in Low Frequency Cetaceans (minke whale) 179 dB re 1 μPa^{2}s Weighted SEL_{cum}	280m (0.25 km^2)
Range (and area*) for TTS in Pinnipeds in water (grey and harbour seals) 181 dB re 1 μPa^{2}s Weighted SEL_{cum}	70m (0.015 km^2)

*based on area of a circle

433. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of TTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for cutter-suction dredging operations / cable installation and protection are presented in **Table 12-44**.

434. The maximum predicted impact ranges for the risk of TTS / fleeing response using the non-impulsive NMFS (2018) criteria for cable laying, rock placement and trenching in the Southern North Sea sites was assessed as less than 100m (0.03 km^2) for all species, with the exception of rock placement for harbour porpoise which had a maximum predicted impact range of up to 990m (3.08 km^2).

435. The magnitude of the potential of TTS / fleeing response is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-44**).

Table 12-44 Maximum number of individuals (and % of reference population) that could be at risk of temporary auditory injury (TTS) and fleeing response / disturbance from cumulative exposure over a 24 hour period for cable installation and cable protection at MDZ, based on worst-case modelling for Wylfa and Southern North Sea sites

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
TTS / fleeing response in harbour porpoise[1]	2.4 individuals in 3.08 km^2 (based on density estimate of 0.783/ km^2) (0.002% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in bottlenose dolphin[2]	0.00006 individuals in 0.03 km^2 (based on density estimate of 0.02/ km^2) (0.00015% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in Risso's dolphin[2]	0.0009 individuals in 0.03 km^2 (based on density estimate of 0.031/ km^2) (0.00001% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in common dolphin[2]	0.007 individuals in 0.03 km^2 (based on density estimate of 0.22/ km^2) (0.000012% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in minke whale[3]	0.004 individuals in 0.25 km^2 (based on density estimate of 0.017/ km^2) (0.00017% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in grey seal[2]	0.005 individuals in 0.03 km^2 (based on density estimate of 0.155/ km^2) (0.00008% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in harbour seal[2]	0.000015 individuals in 0.03 km^2 (based on density estimate of 0.0005/ km^2) (0.00003% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

[1]based on 990m range modelled for rock placement at Southern North Sea Sites; [2]based on 100m range modelled for cable laying, rock placement and trenching at Southern North Sea; [3]based on cutter-suction dredging at Wylfa.

436. Taking into account the medium sensitivity of all marine mammal species to any temporary auditory injury (i.e. receptor has limited capacity to recover from the anticipated impact; **Table 12-6**) and low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species), the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any temporary auditory injury or disturbance in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal from cumulative exposure during cable installation and cable protection activities has been assessed as **minor (not significant)** for TTS and **negligible** for disturbance (**Table 12-45**).

12.6.3.2.2.2.1. Mitigation

437. The proposed mitigation to reduce the risk of any PTS, for example, 500m mitigation zone and MMOs, will also reduce the risk of animals in the predicted impact area for TTS.

12.6.3.2.2.2.2. Residual Impact

438. After the proposed mitigation, the residual impact would be negligible as marine mammals would be outwith the mitigation zone and potential area for any temporary auditory injury.

Table 12-45 Assessment of impact significance for any temporary auditory injury (TTS) and disturbance in marine mammals from underwater noise during cable installation and cable protection at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS during cable installation and cable protection	Harbour porpoise	Medium	Negligible / very low	Minor (not significant)	MMMP	Minor (not significant)
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Negligible
	Risso's dolphin		Negligible / very low	Minor (not significant)		Negligible
	Common dolphin		Negligible / very low	Minor (not significant)		Negligible
	Minke whale		Negligible / very low	Minor (not significant)		Negligible
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Negligible
Disturbance during cable installation and cable protection	Harbour porpoise	Low	Negligible / very low	Negligible	No mitigation required.	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.3.2.2.3. Duration of Potential Disturbance during Other Construction Activities

439. As outlined in **Table 12-25**, the estimated total maximum duration of cable installation for 240MW array is up to 1,310 days, with an additional 108 days for cable protection with would begin up to one month after the start of the export cable laying. Based on two deployment areas being developed at the same time, this could result in 709 days during the 10 year construction period (approximately 19%).

440. The 240MW array would not be installed all at once, but rather in phases with different deployment areas being developed at different times with different devices.

441. Cable installation and cable protection activities would not be continuous during the phases or construction period, but with gaps as vessels move to different positions within the sites, between different deployment areas being developed, plus any downtime for weather or any technical issues.

442. As a worst-case scenario it is assumed that marine mammals could be disturbed from the areas presented in **Table 12-43**, for up to 1,418 days during the construction period. Or for two concurrent installation activities, twice the areas for half the duration (up 709 days). However, based on the maximum number of individuals that could potential be disturbed (**Table 12-44**), this is unlikely to result in significant disturbance (**Table 12-45**).

12.6.3.3. Underwater Noise and Disturbance from Construction Vessels

443. During the construction phase of the proposed scheme, there will be an increase in the number of vessels associated with construction activities. Vessel movements during construction will be within the MDZ and cable corridor area or travelling to and from the site. Installation support ports are likely to be Holyhead, Mostyn, Liverpool or Birkenhead; although ports further afield may be used.

444. As outlined in **Chapter 4, Project Description**, foundations would mainly be installed by a moored barge or Dynamic Positioning (DP) vessel. If a moored barge is used for installation, this will require one or two small support vessels to assist with positioning and anchor deployment. The TECs and supporting structures would then be installed separately using a DP vessel (likely to be the same as for the foundation installation) or a multi-cat vessel.

445. Cables will be installed using specialist cable installation vessel, barge or multi-cat, plus vessel or barge for installation of cable protection (rockbags / mattresses) and additional support vessel(s).

446. It is estimated that there could be up to 14 construction vessels in the MDZ and cable corridor at any one time, however, as a precautionary worst-case scenario the assessment has been based on 16 vessels, to allow for additional guard vessels.

447. Modelling by Heinänen and Skov (2015) indicates that the number of ships represents a relatively important factor determining the density of harbour porpoise in the CIS MU during summer, with markedly lower densities with increasing levels of traffic. A threshold level in terms of impact seems to be approximately 15,000 ships per year (approximately 50 vessels per day within a 5 km^2 area).

448. The number of construction vessels within the MDZ array area (35 km^2) and cable corridor area (4.75 km^2) would be well below this threshold with an estimated two vessels per 5 km^2. If all the vessels were within one development area (e.g. indicative smallest area of 1.85 km^2) and the cable corridor area (4.75 km^2) at any one time, there could be up to 11.5 vessels per 5 km^2.

449. **Chapter 15, Shipping and Navigation** provides a description of the existing marine traffic in and around the MDZ. Most vessel movements are inshore by small vessels such as recreational craft, workboats and small fishing vessels and the ferry route to the north of the MDZ.

450. Current traffic density of larger vessels carrying Automatic Identification System (AIS) is low within the MDZ during winter with less than four transits per month and up to 12 transits per month occurring in the northern most 200m of the MDZ as a result of the ferry route. In addition to ferries, five transits were made by four cruise ship vessels; within the two-week summer 2017 dataset. The cruise ships, while infrequent, are noted occupying a larger portion of the proposed MDZ.

451. Other vessel types which are active in and around the MDZ, include tugs and tows, survey vessels, RNLI vessels, construction and maintenance vessels and cable laying vessels. This vessel category is active across the entirety of the proposed MDZ. Holyhead is one of three main commercial fishing ports in Wales.

452. Holyhead Port is the third busiest port in Wales, providing a link to Ireland. There are approximately 8,500 vessel arrivals at Holyhead Harbour every year, equating to approximately 23 vessel movements (including commercial and recreational) per day.

453. Based on the precautionary worst-case scenario, including existing vessel movements in around the MDZ and cable corridor area, but taking into account that other vessels would be restricted from entering the immediate construction site (with a 500m safety zone around construction vessels and partially installed foundations), the number of vessels would be unlikely to exceed the Heinänen and Skov (2015) threshold level of 50 vessels per day in a 5 km^2 area. Therefore, there is unlikely to be the potential for significant disturbance to harbour porpoise as a result of the increased number of vessels during construction.

454. The construction vessels within the MDZ and cable corridor will be slow moving (or stationary) and most noise emitted is likely to be of a lower frequency, associated with large, slow moving vessels and the use of dynamic positioning systems.

455. Noise levels reported by Malme *et al*. (1989) and Richardson *et al*. (1995) for large surface vessels indicate that physiological damage to auditory sensitive marine mammals is unlikely. However, the levels could be sufficient to cause local disturbance to sensitive marine mammals in the immediate vicinity of the vessel, depending on ambient noise levels.

456. Underwater noise generated by vessels would not be sufficient to cause PTS and the potential for TTS is only likely if the animal remains in very close proximity to a vessel for a prolonged period of time, which is highly unlikely. Disturbance is therefore the only potential impact associated with the presence and underwater noise of vessels.

457. Thomsen *et al*. (2006) reviewed the effects of ship noise on harbour porpoise and seal species. As both species use lower frequency sound for communicating (with acute hearing capabilities at 2kHz) there is the potential for detection, avoidance and masking in both species. Thomsen *et al*. (2006) considered the detection thresholds for harbour porpoises (hearing threshold = 115dB rms re 1 µPa at 0.25 kHz; ambient noise = 91dB rms re 1 µPa at 2kHz) and concluded that ship noise around 0.25kHz could be detected at distances of 1 km; and ship noise around 2kHz could be detected at around 3 km. However, although the ship noise could be detected this does not mean that there would be an adverse reaction or disturbance.

12.6.3.3.1. Underwater Noise Assessment

458. Underwater noise modelling has not been conducted for the MDZ, however, underwater noise modelling has been conducted for vessels at the Wylfa Newydd Development Area (HNP, 2018) and was updated to take into account the NOAA (NMFS, 2018) thresholds and criteria (**Table 12-28**).

459. For the purposes of modelling, vessels were divided into two categories: medium sized and large sized. Medium sized vessels include support boats such as tugs and workboats, while the large sized vessels are equivalent of barges and the vessels used for foundations and cable installation.

460. The underwater noise propagation modelling was undertaken using a simple modelling approach for underwater noise associated with both medium and large sized vessels, using measured sound source data. The source levels used in the underwater noise modelling of large and medium vessels for the Wylfa Newydd Development Area are summarised in **Table 12-46**.

Table 12-46 Summary of predicted source levels used for modelling of vessels at Wylfa

Noise source	Predicted NMFS (2018) weighted source level (dB re 1 µPa^{2}s @ 1m) (SEL)			
	LF Cetacean	MF Cetacean	HF Cetacean	Pinniped
Large vessel movements	162.8	133.9	129.7	164.9
Medium vessel movements	155.0	126.1	121.9	157.1

461. It is important to highlight the transitory nature of underwater noise from passing vessels. Vessels used for foundations and cable installation would operate over an extended period in a defined area, so the cumulative noise exposure in a fixed position would be greater than the exposure from a vessel passing by.

462. For the modelling it was assumed that the vessels are travelling at an average speed of approximately 10 knots; the speed of the vessel would alter the sound level, with faster moving vessels generally creating more noise. The average vessel speed of 10 knots is based on the worst-case scenario, with vessels in and around the construction area typically moving at slower speeds.

463. Ambient underwater sound pressure levels were acquired between 2013 and 2014 to establish a baseline level of noise in the vicinity of Cemlyn Bay, Cemaes Bay and the Wylfa Newydd Development Area. This indicates that existing natural background noise levels for the area, with the mean underwater noise levels recorded between 111.4dB re 1µPa (SPL_{RMS}) and 120.9dB re 1µPa (SPL_{RMS}) (based on all transects measured). The noise levels generated from vessel movements would not be discernible above background noise after approximately 4.4 km for large vessels and 2.4 km for medium vessels (HNP, 2018).

12.6.3.3.2. Potential Impacts for Underwater Noise from Vessels

12.6.3.3.2.1. Permanent Auditory Injury (PTS)

464. The maximum predicted impact ranges for the risk of PTS using the non-impulsive NMFS (2018) criteria for large and medium vessels at the Wylfa Newydd Development Area, assuming a stationary animal remaining in the vicinity over a 24-hour period, are presented in **Table 12-47**.

Table 12-47 Summary of the maximum predicted PTS impact ranges (and areas) for marine mammal species for large and medium vessels at Wylfa, based on NMFS (2018) weighted SEL_{cum} criteria for non-impulsive sounds

Potential Impact	Large vessels	Medium vessels
Range (and area*) for PTS in High Frequency Cetaceans (harbour porpoise) 173 dB re 1 µPa^{2}s Weighted SEL_{cum}	4m (0.00005 km^2)	<1m (0.000003 km^2)
Range (and area*) for PTS in Mid Frequency Cetaceans (dolphin species) 198 dB re 1 µPa^{2}s Weighted SEL_{cum}	<1m (0.000003 km^2)	<1m (0.000003 km^2)
Range (and area*) for PTS in Low Frequency Cetaceans (minke whale) 199 dB re 1 µPa^{2}s Weighted SEL_{cum}	10m (0.0003 km^2)	3m (0.00003 km^2)
Range (and area*) for PTS in Pinnipeds in water (grey and harbour seals) 201 dB re 1 µPa^{2}s Weighted SEL_{cum}	<1m (0.000003 km^2)	<1m (0.000003 km^2)

*based on area of a circle

465. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for large vessels at MDZ are presented in **Table 12-48**.

466. The magnitude of the potential risk of PTS is assessed as **negligible / very low** for all species, with less than 0.001% of all relevant reference populations anticipated to be exposed to the permanent effect (**Table 12-48**).

Table 12-48 Maximum number of individuals (and % of reference population) that could be at risk of permanent auditory injury (PTS) from cumulative exposure over a 24 hour period for large vessels at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)		Magnitude
	One large vessel	Up to 16 large vessels	
PTS in harbour porpoise	0.00004 individuals (based on density estimate of 0.783/ km^2) (0.0000004% of the 104,695 reference population).	0.0006 individuals (based on density estimate of 0.783/ km^2) (0.0000006% of the 104,695 reference population).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in bottlenose dolphin	0.00000006 individuals (based on density estimate of 0.02/ km^2) (0.000000015% of the reference population of 397 bottlenose dolphin).	0.000001 individuals (based on density estimate of 0.02/ km^2) (0.0000002% of the reference population of 397	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

Potential Impact	Maximum number of individuals and (% of reference population)		Magnitude
	One large vessel	Up to 16 large vessels	
PTS in Risso's dolphin	0.00000009 individuals (based on density estimate of 0.031/ km^2) (0.000000001% of the reference population of 8,794 Risso's dolphin)	0.000002 individuals (based on density estimate of 0.031/ km^2) (0.00000002% of the reference population of 8,794 Risso's dolphin)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in common dolphin	0.00000066 individuals (based on density estimate of 0.22/ km^2) (0.000000001% of the reference population of 56,556 common dolphin).	0.00001 individuals (based on density estimate of 0.22/ km^2) (0.00000002% of the reference population of 56,556 common dolphin).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in minke whale	0.000005 individuals (based on density estimate of 0.017/ km^2) (0.00000002% of the reference population of 23,528 minke whale).	0.00008 individuals (based on density estimate of 0.017/ km^2) (0.0000004% of the reference population of 23,528 minke whale).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in grey seal	0.0000005 individuals (based on density estimate of 0.155/ km^2) (0.000000008% of the reference population of 6,000 grey seal).	0.000007 individuals (based on density estimate of 0.155/ km^2) (0.0000001% of the reference population of 6,000 grey seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
PTS in harbour seal	0.0000000015 individuals (based on density estimate of 0.0005/ km^2) (0.000000003% of the reference population of 50 harbour seal).	0.00000002 individuals (based on density estimate of 0.0005/ km^2) (0.00000005% of the reference population of 50 harbour seal).	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

467. Taking into account the high sensitivity of all marine mammal species to any permanent auditory injury (i.e. receptor has very limited capacity to recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species), the impact significance (as defined in **Table 12-10**) for any permanent auditory injury in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal from cumulative exposure for vessels has been assessed as **minor (not significant)** (**Table 12-49**).

12.6.3.3.2.1.1. Mitigation

468. Given the small impact ranges (10m or less around each vessel) and very small number of marine mammals that could potentially be at risk of any permanent auditory injury (PTS) and the assessment of minor (not significant) impact, no mitigation measures are required or proposed.

12.6.3.3.2.1.2. Residual Impact

469. The residual impact would remain minor (not significant).

Table 12-49 Assessment of impact significance for any permanent auditory injury (PTS) in marine mammals from underwater noise from vessels at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS from large vessels	Harbour porpoise	High	Negligible / very low	Minor (not significant)	None required or proposed	Minor (not significant)
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Risso's dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Minke whale		Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Minor (not significant)

12.6.3.3.2.2. Temporary Auditory Injury (TTS) and Disturbance

470. The maximum predicted impact ranges for TTS / disturbance using the non-impulsive NMFS (2018) criteria for large and medium vessels at the Wylfa Newydd Development Area, assuming a stationary animal remaining in the vicinity over a 24-hour period, are presented in **Table 12-50**.

Table 12-50 Summary of the maximum predicted TTS / fleeing response impact ranges (and areas) for marine mammal species for large and medium vessels at Wylfa, based on NMFS (2018) weighted SEL_{cum} criteria for non-impulsive sounds

Potential Impact	Large vessels	Medium vessels
Range (and area*) for TTS in High Frequency Cetaceans (harbour porpoise) 153 dB re 1 µPa^{2}s Weighted SEL_{cum}	140m (0.062 km^2)	30m (0.003 km^2)
Range (and area*) for TTS in Mid Frequency Cetaceans (dolphin species) 178 dB re 1 µPa^{2}s Weighted SEL_{cum}	3m (0.00003 km^2)	<1m (0.000003 km^2)
Range (and area*) for TTS in Low Frequency Cetaceans (minke whale) 179 dB re 1 µPa^{2}s Weighted SEL_{cum}	480m (0.72 km^2)	130m (0.053 km^2)
Range (and area*) for TTS in Pinnipeds in water (grey and harbour seals) 181 dB re 1 µPa^{2}s Weighted SEL_{cum}	40m (0.005 km^2)	9m (0.0003 km^2)

*based on area of a circle

471. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of TTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for large vessels are presented in **Table 12-51**.

472. The magnitude of the potential of TTS / fleeing response is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-51**).

Table 12-51 Maximum number of individuals (and % of reference population) that could be at risk of temporary auditory injury (TTS) and fleeing response / disturbance from cumulative exposure over a 24 hour period for large vessels at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)		Magnitude
	One large vessel	Up to 16 large vessels	
TTS / fleeing response in harbour porpoise	0.05 individuals (based on density estimate of 0.783/ km^2) (0.00005% of the 104,695 reference population).	0.78 individuals (based on density estimate of 0.783/ km^2) (0.0007% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in bottlenose dolphin	0.0000006 individuals (based on density estimate of 0.02/ km^2) (0.00000015% of the reference population of 397 bottlenose dolphin).	0.00001 individuals (based on density estimate of 0.02/ km^2) (0.000002% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in Risso's dolphin	0.0000009 individuals (based on density estimate of 0.031/ km^2) (0.00000001% of the reference population of 8,794 Risso's dolphin).	0.00001 individuals (based on density estimate of 0.031/ km^2) (0.0000002% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in common dolphin	0.000007 individuals (based on density estimate of 0.22/ km^2) (0.00000001% of the reference population of 56,556 common dolphin).	0.0001 individuals (based on density estimate of 0.22/ km^2) (0.0000002% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in minke whale	0.01 individuals (based on density estimate of 0.017/ km^2) (0.00004% of the reference population of 23,528 minke whale).	0.20 individuals (based on density estimate of 0.017/ km^2) (0.0008% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in grey seal	0.0008 individuals (based on density estimate of 0.155/ km^2) (0.00001% of the reference population of 6,000 grey seal).	0.01 individuals (based on density estimate of 0.155/ km^2) (0.0002% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in harbour seal	0.0000025 individuals (based on density estimate of 0.0005/ km^2) (0.000005% of the reference population of 50 harbour seal).	0.00004 individuals (based on density estimate of 0.0005/ km^2) (0.00008% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

473. Taking into account the medium sensitivity of all marine mammal species to any temporary auditory injury (i.e. receptor has limited capacity to recover from the anticipated impact; **Table 12-6**) and low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species), the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any temporary auditory injury or disturbance in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal from cumulative exposure from vessels has been assessed as **minor (not significant)** for TTS and **negligible** for disturbance (**Table 12-53**).

12.6.3.3.2.2.1. Mitigation

474. No mitigation measures are required or proposed.

12.6.3.3.2.2.2. Residual Impact

475. The residual impact would remain minor (not significant) for TTS and negligible for disturbance.

Table 12-52 Assessment of impact significance for any temporary auditory injury (TTS) and disturbance in marine mammals from underwater noise from vessels at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS from vessels	Harbour porpoise	Medium	Negligible / very low	Minor (not significant)	None required or proposed	Minor (not significant)
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Risso's dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Minke whale		Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Minor (not significant)
Disturbance from vessels	Harbour porpoise	Low	Negligible / very low	Negligible	None required or proposed	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.3.3.2.3. Duration of Potential Disturbance from Construction Vessels

476. As outlined in **Table 12-24** and **Table 12-25**, there could be up to 16 vessels within the MDZ throughout the construction period. However, the activities and number of vessels required will vary throughout the construction period and it is unlikely that construction activities and the number of vessels on site would be continuous during the construction period.

477. As a worst-case scenario it is assumed that marine mammals could be disturbed from areas presented in **Table 12-50** throughout the construction period. However, based on the maximum number of individuals that could potential be disturbed (**Table 12-51**), this is unlikely to result in significant disturbance (**Table 12-52**).

12.6.3.4. Potential Barrier Effects from Underwater Noise During Construction

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

479. The worst-case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. longest duration) scenarios. This assumes the maximum potential disturbance and possible barrier effects during construction, in that there could be at any one time:

- Up to two drilling activities;
- Up to two cable installation activities;
- Up to two cable protection activities; and
- Up to 16 vessels on site.

480. The maximum duration for this potential combination of activities could be up to 709 days based on the maximum duration for two concurrent cable installation and protection activities, which could be underway at the same time as drilling activities for the foundation installation.

481. This assessment is precautionary as the vessels have been assessed separately, but in reality, these would be within the potential areas of disturbance for drilling, cable installation and cable protection activities.

482. The maximum predicted impact area for any potential barrier effects has been assessed based on the maximum predicted ranges for TTS / disturbance using the non-impulsive NMFS (2018) criteria for drilling, cable installation, cable protection and vessels (**Table 12-53**).

Table 12-53 Summary of the maximum predicted barrier effects for marine mammal species during construction, based on NMFS (2018) weighted SEL_{cum} criteria for TTS / fleeing response

Potential Impact	Two percussive drilling rigs	Cable installation and protection	Up to 16 large vessels	Maximum total area (% of MDZ and ECC area)
Area* for TTS / fleeing response in	0.32 km^2	6.58 km^2	0.99 km^2	7.89 km^2 (20%)

Potential Impact	Two percussive drilling rigs	Cable installation and protection	Up to 16 large vessels	Maximum total area (% of MDZ and ECC area)
High Frequency Cetaceans (harbour porpoise)				
Area* for TTS / fleeing response in Mid Frequency Cetaceans (dolphin species)	0.0013 km^2	0.12 km^2	0.0005 km^2	0.12 km^2 (0.3%)
Area* for TTS / fleeing response in Low Frequency Cetaceans (minke whale)	13.85 km^2	1 km^2	11.5 km^2	26.35 km^2 (66.3%)
Area* for TTS / fleeing response in Pinnipeds in water (grey and harbour seals)	0.32 km^2	0.12 km^2	0.08 km^2	0.52 km^2 (1.3%)

*based on area of a circle

483. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of potential barrier effects during construction has been based on the maximum areas for TTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for drilling, cable installation, cable protection and vessels (**Table 12-54**).

484. The magnitude of the potential of TTS / fleeing response is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-54**).

Table 12-54 Maximum number of individuals (and % of reference population) that could be impacted by any potential barrier effects from underwater noise during construction at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
TTS / fleeing response in harbour porpoise	6.2 individuals (based on density estimate of 0.783/ km^2) (0.006% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in	0.002 individuals (based on density estimate of 0.02/ km^2)	Temporary effect with negligible / very low magnitude (less than 1% of the reference

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
bottlenose dolphin	(0.0006% of the reference population of 397 bottlenose dolphin).	population anticipated to be exposed to effect).
TTS / fleeing response in Risso's dolphin	0.004 individuals (based on density estimate of 0.031/ km^2) (0.00004% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in common dolphin	0.03 individuals (based on density estimate of 0.22/ km^2) (0.00005% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in minke whale	0.45 individuals (based on density estimate of 0.017/ km^2) (0.0019% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in grey seal	0.08 individuals (based on density estimate of 0.155/ km^2) (0.001% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in harbour seal	0.0003 individuals (based on density estimate of 0.0005/ km^2) (0.0005% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

485. There is unlikely to be any potential barrier effects that could significantly affect the movements of marine mammals in or through the MDZ and ECC area during construction. As outlined in **Table 12-53**, the maximum area for disturbance and any barrier effects as a result of underwater noise during construction in relatively small in relation to the MDZ array and ECC area and when put into the context of the marine mammal MUs.

486. The potential for displacement from underwater noise is unlikely to result in any significant increase in energy expenditure that could be required by harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, grey seal and harbour seal to temporary avoid the maximum potential areas of disturbance in **Table 12-53**. Although the potential area of disturbance for minke whale is greater than for the other species, however, taking into account the movements and areas covered by minke whale, along with the number of whales that could be present in the area, again this is unlikely to result in any significant impacts (**Table 12-55**).

487. It is highly unlikely two drilling activities, two cable installation activities, two cable protection activities and 16 vessels on site, would occur all at the same time or for any prolonged period of time. Any disturbance during construction would be limited to the area around the activity within the MDZ array area and / or ECC, rather than across the entire site and as such there is unlikely to be any barrier effects as animals would be able to move around these discrete areas. For example, two drilling foundations installation events would be within two different deployment areas and likewise the related cable installation, protection and vessels would be associated with the two different deployment areas.

488. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact and the potential magnitude of

the effect (negligible/ very low for all species), the impact significance (based on the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any potential barrier effects as a result of underwater noise during construction for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal has been assessed as **negligible** (**Table 12-55**).

12.6.3.4.1. Mitigation

489. No mitigation measures are required or proposed.

12.6.3.4.2. Residual Impact

490. The residual impact would remain negligible.

Table 12-55 Assessment of impact significance for any temporary disturbance and barrier effects as a result of underwater noise during construction at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Barrier effects from underwater noise	Harbour porpoise	Low	Negligible / very low	Negligible	None required or proposed	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.3.5. Disturbance at Seal Haul-Out Sites

491. Hauled-out seals are sensitive to disturbance, particularly if they are in their breeding or moult periods. For grey seal, this is from August to December with a peak in October-November (see **Section 12.5.6.4**). There are no harbour seal haul-out sites in the vicinity of the MDZ (see **Plate 12-12**).

492. Studies on the distance of disturbance, on land or in the water, from hauled-out seals have found that the closer the disturbance, the more likely seals are to move into the water. For the grey seal, mothers responded by moving into the water more due to boat speed rather than as a result of the distance, although movement into the water was generally observed to occur at distances of between 20 and 70m, with no detectable disturbance at 150m (Wilson, 2014; Strong and Morris, 2010). However, grey seals have also been reported to move into the water when vessels are at a distance of approximately 200m to 300m (Wilson, 2014).

493. As outlined in **Table 12-20**, the closest grey seal pupping sites (based on Clarke *et al.*, 2018) are located at Arw Cleft, 69m from the nearest point of the MDZ cable corridor area, however, no pups were recorded at this site during the 2017 survey. The rest of the grey seal sites are

beyond 200m from the nearest point of the MDZ cable area, with the closest located at Parliament House site 220m from the cable corridor area (**Figure 12-4, Volume II**).

494. There are no haul-out sites identified in the area for the proposed landfall at Abraham's Bosom on the west coast of Holy Island (**Figure 12-4, Volume II**).

495. Taking into account the distance of the proposed cable corridor area from the nearest grey seal pupping site (over 200m) and the proximity of current vessel movements to these sites (see **Chapter 15, Shipping and Navigation**), there is unlikely to be any increased disturbance at grey seal pupping sites as a result of vessels and any cable laying activity in the MDZ cable corridor area.

496. With the proximity of vessel movements, including current vessel routes to and from Holyhead Port, it is likely that seals hauled-out along these routes and in the area of the port would be habituated to the noise, movements and presence of vessels. Therefore, the sensitivity of grey seals at haul-out sites to disturbance from vessels during construction is likely to be negligible. As a very precautionary approach, it is proposed that sensitivity during the breeding season and annual moult could be slightly higher and has therefore been considered as low in this assessment for any activity in the cable corridor area at this time.

497. Vessel movements to the offshore project area would use direct routes and are unlikely to be close to the shore (i.e. within a few hundred metres) except when near the landfall site or port to avoid the risk of collision and grounding.

498. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible / very low), the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any potential disturbance at grey seal haul-out sites has been assessed as **negligible** (**Table 12-56**).

12.6.3.5.1. Mitigation

499. No mitigation measures are required or proposed.

12.6.3.5.2. Residual Impact

500. The residual impact would remain negligible.

Table 12-56 Assessment of impact significance for any disturbance at grey seal haul-out sites during construction at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance haul-out sites	Grey seal	Low	Negligible / very low	Negligible	No mitigation is required or proposed	Negligible

12.6.3.6. Increased Collision Risk with Vessels

501. Marine mammals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al*., 2007). Therefore, increased vessel movements, especially those out-with recognised vessel routes, can pose an increased risk of vessel collision to harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal.

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

503. Harbour porpoise are small and highly mobile and given their responses to vessel noise (e.g. Thomsen *et al*., 2006; Evans *et al*.,1993; Polacheck and Thorpe, 1990), are expected to largely avoid vessel collisions. The Heinänen and Skov (2015) report indicates a negative relationship between the number of ships and the distribution of harbour porpoise in the Celtic and Irish Seas, suggesting that the species could exhibit avoidance behaviour which reduces the risk of strikes.

504. Of the 274 reported harbour porpoise strandings in 2015 (latest UK Cetacean Stranding's Investigation Programme (CSIP) Report currently available), 53 were investigated at post mortem (27 were conducted in England, 13 in Scotland and 13 in Wales). A cause of death was established in 51 examined individuals (approximately 96% of examined cases). Of these, four (8%) had died from physical trauma of unknown cause, which could have been vessel strikes (CSIP, 2015). Approximately 4% of all harbour porpoise post mortem examinations from the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS area) are thought to have evidence of interaction with vessels (Evans *et al*., 2011). The UK CSIP report for 2015 reported a total of 18 minke whale stranding's; four of which were investigated at post mortem with none showing signs of vessel strike (CSIP, 2015). A total of 20 minke post mortems undertaken through the ASCOBANS area revealed that three (15%) show signs of physical trauma (Evans *et al*., 2011).

505. There is limited information on which to quantity the collision risk of marine mammals from the vessels likely to be used during construction. Although the risk of collision is likely to be low, as a precautionary worse-case scenario, the number of harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal that could be at increased collision risk with vessels during construction of the proposed scheme has been assessed based on precautionary 5% to 10% of the number of individuals that could be present in the area potentially being at increased collision risk.

506. As outlined in **Section 12.6.3.3**, Holyhead Port is the third busiest port in Wales, and there are approximately 8,500 vessel arrivals at Holyhead Harbour every year, equating to approximately 23 vessel movements (including commercial and recreational) per day. Therefore, marine mammals in and around the MDZ would be custom to the presence and movements of vessels and would therefore be expected to detect and avoid vessels. Taking into account the potential

disturbance as a result of underwater noise (as assessed in **Section 12.6.3.3**) and that the construction vessels within the MDZ and cable corridor will be slow moving or stationary, harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal are considered to have a low sensitivity to the risk of a vessel strike.

507. During the construction there will be an increase in vessel movements to and from the MDZ. However, where possible, vessels will follow established shipping routes to the relevant ports in order to minimise vessel traffic in the wider area.

508. As outlined in **Table 12-25**, the potential for increased collision risk with vessels during construction has been based on up to 16 vessels on site at any one time, with up to 16 vessel movements to and from the site per day. The maximum area of potential risk has been estimated based on construction vessels in indicative examples of the two potentially largest deployment areas (3 km^2 and 3 km^2); plus, vessels in ECC area (4.75 km^2). In addition, increased collision risk has also been estimated based on the potential vessel route area to and from Holyhead Harbour, based on a precautionary 250m buffer either side of the vessels.

Table 12-57 Estimated number of individuals (and % of reference population) that could be at increased collision risk with vessels during construction at MDZ

Species	Increased collision risk (5-10% of individuals in area at increased risk)			
	Two indicative deployment areas and cable corridor area (10.75 km^2).	**Vessel route to Holyhead Port (4.34 km^2)**	**Number of individuals (% of reference population) at potential increased risk in total area (15.09 km^2)**	**Magnitude**
Harbour porpoise	0.42-0.84 individuals (based on density estimate of 0.783/ km^2) (0.0004-0.008% of the 104,695 reference population).	0.17-0.34 individuals (based on density estimate of 0.783/ km^2) (0.0002-0.0003% of the 104,695 reference population).	0.59-1.18 individuals (0.0006-0.0011% of MU)	Potential permanent effect with negligible to low magnitude (0.01% or less of the reference population anticipated to be exposed to effect).
Bottlenose dolphin	0.011-0.022 individuals (based on density estimate of 0.02/ km^2) (0.003-0.0054% of the reference population of 397 bottlenose dolphin)	0.0043-0.009 individuals (based on density estimate of 0.02/ km^2) (0.0011-0.0022% of the reference population of 397 bottlenose dolphin)	0.015-0.031 individuals (0.0038-0.0076% of MU)	Potential permanent effect with low magnitude (between 0.001% and 0.01% of the reference population anticipated to be exposed to effect).
Risso's dolphin	0.017-0.033 individuals (based on density estimate of 0.031/ km^2) (0.0002-0.0004% of the reference population of 8,794 Risso's dolphin).	0.007-0.014 individuals (based on density estimate of 0.031/ km^2) (0.0001-0.0002% of the reference population of 8,794 Risso's dolphin).	0.024-0.047 individuals (0.0003-0.0005% of MU)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).

Species	Increased collision risk (5-10% of individuals in area at increased risk)			
	Two indicative deployment areas and cable corridor area (10.75 km²).	**Vessel route to Holyhead Port (4.34 km²)**	**Number of individuals (% of reference population) at potential increased risk in total area (15.09 km²)**	**Magnitude**
Common dolphin	0.12-0.24 individuals (based on density estimate of 0.22/ km²) (0.0002-0.0004% of the reference population of 56,556 common dolphin).	0.05-0.096 individuals (based on density estimate of 0.22/ km²) (0.0001-0.0002% of the reference population of 56,556 common dolphin).	0.17-0.336 individuals (0.0003-0.0006% of MU)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
Minke whale	0.009-0.02 individuals (based on density estimate of 0.017/ km²) (0.00004-0.0001% of the reference population of 23,528 minke whale).	0.004-0.007 individuals (based on density estimate of 0.017/ km²) (0.00002-0.00003% of the reference population of 23,528 minke whale).	0.013-0.027 individuals (0.0001-0.0001% of MU)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
Grey seal	0.083-0.17 individuals (based on density estimate of 0.155/ km²) (0.0014-0.003% of the reference population of 6,000 grey seal).	0.034-0.067 individuals (based on density estimate of 0.155/ km²) (0.0006-0.0011% of the reference population of 6,000 grey seal).	0.117-0.237 individuals (0.0019%-0.0039% of MU)	Potential permanent effect with negligible to low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Harbour seal	0.0003-0.0005 individuals (based on density estimate of 0.0005/ km²) (0.0005-0.0011% of the reference population of 50 harbour seal).	0.0001-0.0002 individuals (based on density estimate of 0.0005/ km²) (0.0002-0.0004% of the reference population of 50 harbour seal).	0.0004-0.0007 individuals (0.0008-0.0015% of MU)	Potential permanent effect with negligible to low magnitude (0.01% or less of the reference population anticipated to be exposed to effect).

509. Taking into account the low sensitivity of all marine mammal species to increased collision risk with vessels and the potential magnitude of the effect (negligible or low for all species), the impact significance for any permanent impact on harbour porpoise, bottlenose dolphin, grey seal and harbour seal has been assessed as **minor (not significant)** and **negligible** for Risso's dolphin, common dolphin and minke whale (**Table 12-58**).

12.6.3.6.1. Mitigation

510. Where possible, all vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. No further mitigation is proposed.

12.6.3.6.2. Residual Impact

511. The residual impact would remain negligible or minor (not significant).

Table 12-58 Assessment of impact significance for increased collision risk with vessels during construction at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Increased collision risk with vessels	Harbour porpoise	Low	Negligible to low	Negligible to minor (not significant)	No mitigation is required or proposed	Negligible to minor (not significant)
	Bottlenose dolphin		Low	Minor (not significant)		Minor (not significant)
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible to low	Negligible to minor (not significant)		Negligible to minor (not significant)

12.6.3.7. Potential Changes in Water Quality

512. As outlined in **Chapter 8, Marine Water and Sediment Quality**, the potential impacts on marine water quality are:

- Changes in marine water quality as a result of sediment re-suspension caused by seabed disturbance;
- Change in marine water quality as a result of mobilisation of contaminants adsorbed onto potentially re-suspended seabed sediments; and
- Impacts on marine water quality and sediment quality as a result of potential accidental discharge and spillage of oils, fuels and materials.

513. During the construction phase there is the potential for disturbance and re-suspension of sediments, either directly from the sea bed, or from sub-seabed cuttings, and for these re-suspended sediments to be dispersed through the water column as a plume. This has the potential to increase the suspended sediment concentrations and potentially increase turbidity around the MDZ.

514. Based on a 240MW capacity, the worst-case volume of cuttings for the entire site would amount to 117,780m^3. This is the total for all foundations and foundations will be installed sequentially. A single device requiring four drilled piles will produce 160m^3 of cuttings.

515. The maximum envisaged effect associated with sediment plumes arising from the foundation installation activities will cause a small increase in suspended sediment concentration (typically less than 1mg/l a short distance from the release point) over only a small geographical area (a few hundred metres). The effects will be temporary, with a return to very low background concentrations occurring rapidly upon cessation of installation activities (i.e. the effect is temporary only). Other than at the immediate release point, such a change would be

immeasurable and has been assessed as negligible in **Chapter 8, Marine Water and Sediment Quality**, with no mitigation required.

516. The free-laying of cables and the placement of cable protection would not cause plumes along the offshore sections of the cable corridor because the sea bed is characterised by bedrock or, where sparse sediment cover does exist, by sediments with a particle size that cannot be suspended in the water column.

517. In the nearshore, the bedrock is overlain by sand which has the potential to be disturbed. The assessment in **Chapter 8, Marine Water and Sediment Quality**, indicates that there could be a minor adverse (not significant) impact via increased suspended sediments in the area around the sandwave field and close to shore. However, the likely increase in suspended sediment concentration in areas with sand cover nearer to shore (including at the landfall) will remain within the natural variation that are governed by storm waves and surge effects. Any increase in suspended sediments would reduce rapidly with distance from the point of disturbance to a few mg/l over a small geographical area (within a few hundred metres, along the axis of tidal currents). Furthermore, these effects will be one-off and temporary in duration, with a return to the very low background concentrations occurring rapidly upon cessation of installation.

518. Marine mammals often inhabit turbid environments and cetaceans utilise sonar to sense the environment around them and there is little evidence that turbidity affects cetaceans directly (Todd *et al*., 2014). Pinnipeds are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision. Studies have shown that vision is not essential to seal survival, or ability to forage (Todd *et al*., 2014).

519. Increased turbidity is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. This is likely because other senses are utilised, and vision is not relied upon solely. Therefore, harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal have negligible sensitivity to increases in suspended sediments during construction.

520. The re-suspension of sediments during construction activities could also lead to the release of any contaminants that may be present within them. However, as outlined in **Chapter 8, Marine Water and Sediment Quality**, sediment contamination within the MDZ is low, due to the dynamic hydrological regime and generally low level of industrial activity in this region. The low proportion of fine sediments within the MDZ is another factor that indicates low sediment contamination levels. Therefore, the assessment determined a negligible impact on general water quality in the MDZ via release of contaminated sediments, as even though mobilisation of the relatively limited amount of sediments in the MDZ will occur via construction works, none of these sediments are known to have high levels of contaminants.

521. During construction there is the potential for changes in water quality as a result of accidental discharge and spillage of oils, fuels and materials. As outlined in **Chapter 8, Marine Water and Sediment Quality**, the liquid inventory for the Project indicates that there are large amounts of chemicals including oil, grease and hydraulic fluid that could be accidentally released/leaked from project components. Other sources of potential chemicals include drilling fluids from any drilled pin-piles. However, Menter Môn is committed to the use of best practice and pollution prevention guidelines at all times. An Marine Pollution Contingency Plan (MPCP) would be in

place and agreed with NRW in line with the Integrated Pollution Prevention and Control (IPPC) Directive such that any potential risk is minimised. Any permitted discharges would be small volumes, intermittent and dilute and disperse quickly.

522. If any such substances were accidentally released/leaked, quantities would likely be small due to relatively small amounts being present in individual devices. Due to the dynamic nature of the tidal and wave regime in and around the MDZ, lateral and vertical dispersion rates of any spilled substances would be expected to be high.

523. The assessment in **Chapter 8, Marine Water and Sediment Quality**, indicates the magnitude of this potential effect is considered to be low, as it is not anticipated to significantly affect local water quality and would also be temporary in nature (established controls would prevent further spillage/leakage once an event was detected).

524. Due to the limited chance of exposure of marine mammals to any contaminants released from the re-suspension of sediments or from the accidental discharge and spillage of oils, fuels and materials, the sensitivity of marine mammals has been classed as negligible.

525. Taking into account the negligible sensitivity of all marine mammal species to any changes in water quality and the potential magnitude of the effect (negligible or low), the impact significance for any temporary impact on harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale grey seal and harbour seal has been assessed as negligible (**Table 12-59**).

12.6.3.7.1. Mitigation

526. As outlined above and in **Chapter 8, Marine Water and Sediment Quality**, mitigation would include adherence to project-specific Environmental Management Plans (EMPs) and Marine Pollution Contingency Plans (MPCP). No further mitigation for marine mammals in proposed.

12.6.3.7.2. Residual Impact

527. The residual impact would remain negligible.

Table 12-59 Assessment of impact significance for any changes in water quality during construction at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Increased suspended sediments	Harbour porpoise	Negligible	Negligible	Negligible	EMP and MPCP	Negligible
	Bottlenose dolphin		Negligible	Negligible		Negligible
	Risso's dolphin		Negligible	Negligible		Negligible
	Common dolphin		Negligible	Negligible		Negligible
	Minke whale		Negligible	Negligible		Negligible
	Grey and harbour seal		Negligible	Negligible		Negligible

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Release of contaminants from re-suspension of sediments	Harbour porpoise	Negligible	Negligible	Negligible		Negligible
	Bottlenose dolphin		Negligible	Negligible		Negligible
	Risso's dolphin		Negligible	Negligible		Negligible
	Common dolphin		Negligible	Negligible		Negligible
	Minke whale		Negligible	Negligible		Negligible
	Grey and harbour seal		Negligible	Negligible		Negligible
Accidental discharge and spillage of oils, fuels and materials	Harbour porpoise	Negligible	Low	Negligible		Negligible
	Bottlenose dolphin		Low	Negligible		Negligible
	Risso's dolphin		Low	Negligible		Negligible
	Common dolphin		Low	Negligible		Negligible
	Minke whale		Low	Negligible		Negligible
	Grey and harbour seal		Low	Negligible		Negligible

12.6.3.8. Potential Changes in Prey Availability

528. Potential impacts on marine mammal prey species which could result in changes to prey availability include

- Underwater noise (that could lead to mortality, physical injury, auditory injury or behavioural responses);
- Physical disturbance and temporary loss of seabed habitat; and
- Increased suspended sediment concentrations and sediment re-deposition.

529. The diet of the harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet its daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

530. Bottlenose and common dolphins are opportunistic feeders that have large foraging ranges (Santos *et al*., 2001; Reid *et al*., 2003; Sea Watch Foundation, 2012) and are therefore considered to have low sensitivity to changes in prey resources. Risso's dolphins have a more restricted diet than other dolphin species, feeding mostly on cephalopods (Santos *et al*., 1994) and are therefore are considered to have medium sensitivity to changes in prey resource.

531. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level. Therefore, minke whale are considered to have a medium sensitivity to changes in prey resource.

532. Grey and harbour seal feed on a variety of prey species. Both species are considered to be opportunistic feeders that are able to forage in other areas and have relatively large foraging ranges. Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

12.6.3.8.1. Prey Impacts from Underwater Noise during Construction

533. As outlined in the assessments for underwater noise on marine mammals, underwater noise modelling has not been conducted for the MDZ, however, underwater noise modelling has been conducted for the nearby Wylfa Newydd Development Area for drilling into a hard substrate, cutter-suction dredging as a proxy for cable installation and cable protection, and for large vessels (**Table 12-60**). The modelling was conducted based on the Popper *et al*. (2014) thresholds and criteria.

534. Fish responses to noise are in part related to the anatomy of their hearing mechanisms. The presence of a swim bladder enhances hearing sensitivity as the bladder acts as a pressure transducer, converting sound pressure to particle velocity. Those species where the swim bladder is near to or connected to the ear have increased hearing sensitivity. The hearing range of fish varies extensively amongst species, and it is not only related to anatomy, for example, cod and Atlantic salmon both have a swim bladder, but cod is sensitive to pressure at higher frequencies (Popper *et al*., 2014).

535. The categories for fish are based on the presence or absence of a swim bladder and the potential for the swim bladder to enhance hearing sensitivity:

- Fish with no swim bladder or other gas chamber, e.g. flatfish. These species generally only detect particle motion and are less sensitive to sound pressure.
- Fish with swim bladders in which hearing does not involve the swim bladder or other gas volume, e.g. Atlantic salmon. These species hear through particle motion.
- Fish in which hearing involves a swim bladder or other gas volume, e.g. herring and cod. These species detect sound pressure and particle velocity.

536. Fish with swim bladders involved in hearing are more sensitive to underwater noise and have the greatest potential impact ranges, therefore the results have been presented for these species as a worst-case scenario. The results are based on the stationary animal model (**Table 12-60**).

537. The number of marine mammals that could affected by any changes in prey availability has been assessed, based on the maximum potential area of impact (TTS) for prey species (based on two percussive drilling rigs, two cable installation activities, two cable protection activities (4 x cutter-suction dredging area) and up to 16 large vessels in **Table 12-61**.

538. It is important to note that the potential impact areas for marine mammals are greater than those predicted for their prey, therefore there would be no further impact as marine mammals would already be disturbed from the area of potential prey displacement.

Table 12-60 Summary of the maximum predicted impact ranges (and areas) for marine mammal prey species for drilling, cutter-suction dredging operations and large vessels at Wylfa, based on Popper *et al.* (2014) criteria for continuous sounds and predicted maximum total area of impact on prey species during construction

Potential Impact	Two percussive drilling rigs	Cutter-suction dredging / cable installation and protection	Large vessel	Maximum total area during construction*
Recoverable injury (fish with swim bladders involved in hearing) (48h) 170 dB re 1 µPa (SPL_{RMS})	13m (0.00053 km^2)	2m (0.000013 km^2)	<1m (0.000003 km^2)	0.00063 km^2
TTS (fish with swim bladders involved in hearing) (12h) 158 dB re 1 µPa (SPL_{RMS})	100m (0.031 km^2)	13m (0.00053 km^2)	4m (0.00005 km^2)	0.034 km^2

Areas based on area of a circle
*based on maximum area for two percussive drilling rigs, two cable installation activities, two cable protection activities and up to 16 large vessels.

539. The magnitude of the potential displacement due to changes in prey availability as a result of underwater noise during construction is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-61**).

Table 12-61 Maximum number of individuals (and % of reference population) that could be impacted by any changes of prey availability as a result of underwater noise during construction at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
Displacement of harbour porpoise due to changes in prey availability	0.3 individuals (based on density estimate of 0.783/ km^2) (0.00003% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of bottlenose dolphin due to changes in prey availability	0.0007 individuals (based on density estimate of 0.02/ km^2) (0.00017% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of Risso's dolphin due to changes in prey availability	0.001 individuals (based on density estimate of 0.031/ km^2) (0.000012% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of common dolphin due to	0.0075 individuals (based on density estimate of 0.22/ km^2)	Temporary effect with negligible / very low magnitude (less than 1% of the reference

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
changes in prey availability	(0.000013% of the reference population of 56,556 common dolphin).	population anticipated to be exposed to effect).
Displacement of minke whale due to changes in prey availability	0.001 individuals (based on density estimate of 0.017/ km^2) (0.000002% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of grey seal due to changes in prey availability	0.001 individuals (based on density estimate of 0.155/ km^2) (0.0001% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of harbour seal due to changes in prey availability	0.00002 individuals (based on density estimate of 0.0005/ km^2) (0.00003% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

540. The assessment in **Chapter 10 Fish and Shellfish Ecology**, has determined that the potential impacts of underwater noise on prey species would result a low magnitude of the effect, coupled with the medium sensitivity of the receptors, the impact significance was assessed as minor adverse on the receptors during construction. No mitigation measures were considered to be required.

12.6.3.8.2. Prey Impacts from Temporary Loss of Seabed Habitat during Construction

541. As outlined in **Chapter 10 Fish and Shellfish Ecology** and in **Table 12-25**, the worst-case scenario for temporary habitat loss during construction could be up to 0.42 km^2, based on area for post-lay burial of cables (27,259m^2), deployment of anchor blocks by barges during cable installation (100,240m^2), deployment of anchor blocks by barges during TEC device installation (248,000m^2) and deployment of anchor blocks by barges during hub installation(48,000m^2).

542. The magnitude of the potential displacement due to changes in prey availability as a result of temporary habitat loss during construction is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-63**).

Table 12-62 Maximum number of individuals (and % of reference population) that could be impacted by any changes of prey availability as a result of temporary habitat loss during construction at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
Displacement of harbour porpoise due to changes in prey availability	0.33 individuals (based on density estimate of 0.783/ km^2) (0.0003% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
Displacement of bottlenose dolphin due to changes in prey availability	0.0084 individuals (based on density estimate of 0.02/ km^2) (0.002% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of Risso's dolphin due to changes in prey availability	0.013 individuals (based on density estimate of 0.031/ km^2) (0.00015% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of common dolphin due to changes in prey availability	0.09 individuals (based on density estimate of 0.22/ km^2) (0.0002% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of minke whale due to changes in prey availability	0.007 individuals (based on density estimate of 0.017/ km^2) (0.00003% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of grey seal due to changes in prey availability	0.07 individuals (based on density estimate of 0.155/ km^2) (0.0011% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Displacement of harbour seal due to changes in prey availability	0.0002 individuals (based on density estimate of 0.0005/ km^2) (0.0004% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

543. The assessment in **Chapter 10, Fish and Shellfish Ecology**, has determined that the potential impacts of temporary habitat disturbance on prey species would result a low magnitude of the effect, coupled with the medium sensitivity of the receptors, the impact significance was assessed as minor adverse on the receptors during construction. No mitigation measures were considered to be required.

12.6.3.8.3. Prey Impacts from Increased Suspended Sediment and Sediment Re-Deposition during Construction

544. As outlined in **Section 12.6.3.7**, any changes in water quality will be negligible.

545. The assessment in **Chapter 10, Fish and Shellfish Ecology**, has also determined that the potential impacts of increased suspended sediment concentrations and sediment deposition on prey species would result a low magnitude of the effect, coupled with the medium sensitivity of the receptors, the impact significance was assessed as minor adverse on the receptors during construction. No mitigation measures were considered to be required.

12.6.3.8.4. Mitigation

546. No mitigation measures are required or proposed.

12.6.3.8.5. Residual Impact

547. The residual impact would remain negligible or minor (not significant).

Table 12-63 Assessment of impact significance for any displacement as a result of any changes to prey availability during construction at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Displacement due to underwater noise impact on prey species	Harbour porpoise	Low to medium	Negligible / very low	Negligible to Minor (not significant)	None required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Negligible / very low	Negligible		Negligible
	Risso's dolphin	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Negligible / very low	Negligible		Negligible
	Minke whale	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Negligible / very low	Negligible		Negligible
Displacement due to temporary habitat loss impact on prey species	Harbour porpoise	Low to medium	Negligible / very low	Negligible to Minor (not significant)	None required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Negligible / very low	Negligible		Negligible
	Risso's dolphin	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Negligible / very low	Negligible		Negligible
	Minke whale	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Negligible / very low	Negligible		Negligible
Displacement due to increased suspended sediment concentrations and sediment re-deposition impact on prey species	Harbour porpoise	Low to medium	Negligible / very low	Negligible to Minor (not significant)	None required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Negligible / very low	Negligible		Negligible
	Risso's dolphin	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Negligible / very low	Negligible		Negligible
	Minke whale	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Negligible / very low	Negligible		Negligible

12.6.4. Assessment of Potential Impacts During Operation, Maintenance and Repowering

12.6.4.1. Underwater Noise from Operational Tidal Devices

12.6.4.1.1. Review of Tidal Device Operational Noise

548. There is currently limited information on the underwater noise generated from operational tidal devices. However, some consented projects have taken turbine noise measurements from scaled down test devices and extrapolated these to provide a predicted source level. This has been reviewed and summarised below.

549. A study by Malinka *et al*. (2018) of the turbine at Strangford Lough found that metal flaps used to reduce the inflow of silt to the turbine produced regular low frequency (0.7 – 1.4 kHz) clanging noises with a source level of up to 185 - 198 dB re 1 µPa[2] which is approximately 96 dB above the auditory threshold for harbour porpoises at 1kHz (Kastelein *et al.,* 2002). Hydraulic pumps that rotate the turbine into the current were also a significant source of noise and caused false whistle detections at 13 kHz. However, the infrequent nature of this noise meant changes to average background noise levels were not deemed to be significant (Malinka *et al.,* 2018).

550. Measurements of noise emitted by a single tidal current turbine were taken in France using 19 drifting transects at varying distances (100 – 2,400m) from the device. Measured source level (SL) was between 118 to 152 dB re 1 µ Pa at 1m in third octave bands at frequencies between 40 and 8,192 Hz. This level was compared to a 19m boat travelling at 10 knots. The 'acoustic footprint' of the device was modelled and was found to extend to a radius of 1.5 km, however physiological injury to mammals, fish and invertebrates was considered to be improbable. Behavioural disturbance was estimated to occur within 1 km for harbour porpoises (Lossent *et al.,* 2018).

551. Schmitt *et al*. (2018) characterised the noise emitted by a subsea tidal kite and found broadband noise between 0.2 and 0.7 kHz. Sound levels varied in a repetitive cycle every seven seconds. Emitted noise levels decreased when rotations per minute were reduced from 500-700 rpm to 300-500 rpm from 105 dB re µPa to 95 re µPa. At higher kite speeds (4 to 5.5ms^{-1}) emitted noise levels were observed over a wider range of frequencies (0.05 to 0.9 kHz) (Schmitt *et al.,* 2018).

552. Robertson *et al.* (2018) conducted field trials in spring, summer and autumn 2017 where marine mammals were observed from land over a trial period of two weeks during each season. For half of each trial period, an underwater projector played recordings of tidal turbine sound at a broadband source level of 158 dB re µPa at 1m. Harbour seals did not show a significant behavioural response to the simulated turbine noise, however harbour seals would have needed to have been 10m away from the playback location to experience noise levels equivalent to previous studies that found a significant effect (Hastie *et al.,* 2017). During trial 1 (spring) calculated distances suggest harbour porpoise avoided the playback location by 300m, however in trial 2 (summer) this distance was reduced to 100m and during trial 3 (autumn) this distance disappeared and was reduced to zero. This change could suggest that the harbour porpoise became tolerant or habituated to the turbine noise (Robertson *et al.,* 2018).

553. Halvorsen *et al*. (2011) measured a turbine in the Bay of Fundy and found no change in ambient noise level greater than 200m away from the turbine and a source level of 162 dB re µm referred to 1m.

554. Vertical Axis turbines in Cobscook Bay, USA emit noise lower than the NOAA threshold for behavioural harassment by continuous noise (120 dB). Noise produced depended on if the turbine was freewheeling or generating, with a peak in source level of 110 dB at 105 Hz whilst freewheeling (Ocean Renewable Power Company, 2014).

555. The Brims Underwater Noise Assessment (Xodus, 2015) indicated that for 30 turbines, the extent of the potential disturbance for marine mammals for the operational tidal array was a radius of approximately 1 km from the centre of the array, and for 170 turbines, the extent of the potential disturbance could be 2 to 4 km. These noise ranges relate to device operation during full tidal flow, however during these periods the background noise will also be at its highest and this is not taken into consideration in the underwater noise modelling.

556. A study by Lossent *et al*. (2018) for a 16 m diameter, 0.5 MW, OpenHydro turbine, predicted a source noise level of 152 dB SPL_{RMS} and an acoustic spectrum with most energy in the 125 Hz ⅓ octave frequency band. Outside of this band, noise levels are a minimum of 10 dB lower. The low frequency for the OpenHydro turbine is below the peak hearing sensitivity of both pinniped and harbour porpoise, where at the greatest sensitivity range for these species the predicted octave-band source noise level from the device is at least 25 and 35 dB, respectively, below the low frequency peak. These noise levels are considerably below any which could potentially lead to PTS or TTS in the species. Moving away from the source location, this will fall quickly to the order of background noise levels and Lossent *et al*. (2018) estimated that this ‘footprint’ would be of the order of 1.0 to 1.5 km^2 around a turbine (**Appendix 12.4, Appendix III**).

557. For PTEC, a wide variety of tidal device designs and models were used to inform the Rochdale Envelope of the development site, these included:

- An axial flow device, mounted on a tripod base, secured with pin piles to the seabed. An example of this is the Deep Gen by Tidal Generation Ltd (TGL) Alstom, which has a rotor diameter of 18m.
- An axial flow device, mounted to the seabed using a monopile base; this has a higher rotational speed than the tripod base axial flow device with a tip speed of up to 41m/s. An example of this is the hyTyde by Voith Hydro, which has a rotor diameter of 16m.
- A bottom mounted pile with a surface piercing tower, for example, the SeaGen S by Marine Current Turbines, which is available with a rotor diameter of up to 24m.
- A ducted device, which is mounted to the seabed using a gravity base. Example of this includes the Tidal Turbine Generator by Clean Current Power Systems, which could have a rotor diameter of up to 10m and OpenHydro with a rotor diameter of up to 16m.
- Floating, surface piercing, multiple tidal energy convertors (TECs), such as the Scotrenewables Tidal Turbine or BlueTEC, which has two TECs, each with a rotor diameter of up to 24m for axial flow TECs or 10m diameter by 15m long vertical transverse axis TECs.

- Multiple buoyant, mid-water column, TECs attached to a single platform. An example of this is the PLAT-O by SME, which features two up to 12m diameter rotors.
- A bottom mounted, single platform with multiple TECs, for example the Deltastream by Tidal Energy Limited, which has 3 TECs mounted on a frame, each with rotor diameters of up to 20m.
- Transverse axis devices, for example the Turbine generator unit by Kepler, which uses a horizontal rotor which is up to 15m in diameter and 90m long.
- Multiple TECs on a single platform attached to a surface piercing structure attached to seabed, for example the Triton system by Tidal Stream Limited, which can be configured with up to 6 large rotors (up to 20m diameter) or 36 small TECs (around 4.5m in diameter).

558. Previous measurements of operational tidal devices undertaken by Subacoustech Environmental (Parvin *et al*., 2005; Parvin *et al*., 2008a) have shown that, using the information available, the level of noise introduced by the tidal devices was directly linked to the size of the tidal device, i.e. the larger the tidal device, the greater the sound it will produce while operational.

559. Therefore, in order to cover all of these designs in the underwater noise modelling for PTEC, three rotor diameters were chosen to give an idea of the sound from small, medium and large TECs; the three diameters were 10m, 15m and 20m. This covered all of the sizes of TEC considered for PTEC, as well as encompassing models where several smaller TECs are used on the same platform such as the device type with multiple small (approximately 4.5m) diameter rotors noted above; this range of TEC sizes also gives conservative estimates for any smaller size TECs.

560. Modelling of an operational tidal device with a rotor diameter of 24m was also been undertaken as a worst-case scenario in terms of rotor size and location for noise propagation at PTEC.

561. It should also be noted that this approximation was based on the data available at the time of the assessment (Subacoustech, 2014). The overall noise level does increase when a larger TEC is used but the frequency characteristics of the resulting noise will also differ due to mechanical differences in the TEC. For example, the tonal characteristics of noise from the gearbox of the tidal devices listed above, or the different types of rotors (open, ducted, transverse, etc.), may be different from the devices previously measured by Subacoustech Environmental (Subacoustech, 2014).

562. For the MeyGen project in the Pentland Firth, the predicted noise levels were up to 177 dB SPL_{RMS} for a 2.4MW turbine (extrapolated from a measured 0.3MW turbine in Strangford Lough, Northern Ireland). Most noise energy for this turbine was below 100Hz, although there were also significant peaks in the 1,500Hz and 5,000Hz bands (Kongsberg, 2012).

12.6.4.1.2. Potential Impacts for Underwater Noise from Operational Tidal Devices

563. The noise measurements and modelling for a range of different operational tidal devices, indicates that the noise levels would not be sufficient to result in any auditory injury. Therefore, the only potential impact is disturbance.

564. For PTEC, the source levels for the operational tidal device noise were estimated to be 155.8, 162.2, and 165.4 dB re 1 μPa@1 m (RMS) for the 10m, 15m, and 20m rotor diameters respectively, were below the 240 and 220 dB re 1 μPa (SPL_{peak}) criteria for lethal effect and physical injury (Subacoustech, 2014).

565. The modelling for MeyGen indicates that the source levels for operational noise from either the 1MW turbine or the 2.4MW turbine were below the levels at which lethal injury to species of marine mammal might occur (240 dB re. 1 μPa). It was therefore considered unlikely that any marine animals would be killed as a consequence of the underwater noise from any operational turbines in the Inner Sound development area (Konsberg, 2012).

566. The modelling for MeyGen also indicates that peak source levels associated with operational noise from either the 1MW or 2.4MW turbines were below the levels at which hearing damage from the underwater noise might occur (230 dB re. 1μPa and 224 dB re. 1μPa for the onset of PTS and TTS in cetaceans and 218 dB re. 1μPa and 212 dB re. 1μPa for the onset of PTS and TTS in pinnipeds). Even taking into account the more conservative criteria proposed by Lucke *et al*. (2009) for harbour porpoises (193.7 dB re 1 μPa) and NMFS (1995), whereby auditory injury may occur to pinnipeds and cetaceans following prolonged exposure to underwater sound at levels at or above 190 dB re. 1 μPa and 180 dB re. 1 μPa respectively, the source levels for operational noise for each turbine were sufficiently low such that the NMFS impact criteria were not exceeded (Konsberg, 2012).

Potential Disturbance from Underwater Noise of Operational Turbines

567. Although the noise levels are below injury levels, they may still be high enough to lead to avoidance behaviour. For example, Hastie *et al*. (2018) studied the reaction of harbour seals to simulated turbine noise in Kyle Rhea on the west coast of Scotland. The study found a reduction in seal abundance of between 11% and 41% at the source location. At up to 500m the reduction was just under 10%. The source used by Hastie *et al*. (2018) was based on a 1.2MW turbine design measured at SeaGen at Strangford Lough (**Appendix 12.4, Appendix III**).

568. The underwater noise modelling for PTEC predicted that the largest impact ranges were for harbour porpoise with a maximum range for 90 dB_{ht}(*Species*) level where a strong behavioural avoidance reaction is likely of 450m and a maximum range for 75 dB_{ht}(*Species*) of 7 km where some avoidance reaction could occur; both of these impact ranges are estimated for the largest 20m rotor diameter. The estimated impact ranges for the 24m diameter rotor were expected to extend the furthest for harbour porpoise, with a maximum 90 dB_{ht} impact range out to 610m and a 75 dB_{ht} impact range out to 9.1 km (Subacoustech, 2014; **Table 12-64**).

569. For PTEC, using the levels where the onset of TTS was found to occur in a harbour porpoise by Kastelein *et al*. (2012), a receptor would have to be present at a range of 800m around an operational 20m rotor diameter for an hour (Subacoustech, 2014).

Table 12-64 Summary of the modelled ranges for 90 and 75 dB$_{ht}$(*Species*) levels from an operational tidal device with a rotor diameter of 24m at PTEC

Potential Impact	90 dB$_{ht}$(*Species*) maximum range (m)	75 dB$_{ht}$(*Species*) maximum range (m)
Disturbance of harbour porpoise	610m	9,100m
Disturbance of bottlenose dolphin (dolphin species)	95m	2,200m
Disturbance of minke whale	400m	4,700m
Disturbance of grey and harbour seal	75m	2,000m

570. The underwater noise modelling for MeyGen indicates that odontocetes such as the harbour porpoise and dolphin species (bottlenose dolphin, Risso's dolphin and common dolphin) may not show signs of strong behavioural reactions from each 1MW turbine, while mysticetes such as minke whales, may respond out to 14m. Mild reactions in odontocetes and mysticetes may be seen at distances up to 140m and 364m, respectively, from the 1MW turbines. When exposed to 2.4MW turbine, odontocetes may exhibit strong behavioural reactions up to 14m from the turbines and mild behavioural reactions up to 350m and for mysticetes (minke whale) there could be mild behavioural reactions out to 1,736m (**Table 12-65**; Konsberg, 2012).

Table 12-65 Summary of the modelled ranges for 90 and 75 dB$_{ht}$(*Species*) levels from 2.4MW operational tidal devices at MeyGen

Potential Impact	90 dB$_{ht}$(*Species*) maximum range (m) (strong avoidance)	75 dB$_{ht}$(*Species*) maximum range (m) (mild avoidance)
Disturbance of harbour porpoise	14m	336m
Disturbance of bottlenose dolphin (dolphin species)	14m	336m
Disturbance of minke whale	42m	1,736m
Disturbance of grey and harbour seal	13m	28m

571. Based on the worst-case scenario for the PTEC noise modelling (**Table 12-64**), the number of marine mammals that could be disturbed from the underwater of operational turbines at MDZ has been estimated for one device based on the possible mild avoidance range for 75 dB$_{ht}$(*Species*) and 90 dB$_{ht}$(*Species*) (**Table 12-66**).

572. For full deployment the assessment has been based on the more realistic possible strong avoidance (90 dB$_{ht}$(*Species*) range from the worst-case scenario of the modelling for PTEC. The assessment for the full deployment has been based on arrays rather than individual tidal devices, as individual marine mammals would be more likely to be disturbed by the closest turbine they approach rather than all individual turbines within the array. As an indicative precautionary worst-case, the assessment has been based on up to 10 arrays, however the maximum number of arrays at the MDZ is likely to be eight. The areas are based on an area of a circle and assessment also assumes no overlap in disturbance areas between arrays / groups of turbines (**Table 12-66**).

Table 12-66 Maximum number of individuals (and % of reference population) that could be disturbed as a result of underwater from operational tidal devices at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)			Magnitude
	One device (possible mild avoidance (75dB$_{ht}$))	One device (possible strong avoidance (90dB$_{ht}$))	Full deployment* (possible strong avoidance (90dB$_{ht}$))	
Disturbance of harbour porpoise	204 individuals in 260.2 km^2 (based on density estimate of 0.783/ km^2) (0.195% of the 104,695 reference population).	0.92 individuals in 1.17 km^2 (based on density estimate of 0.783/ km^2) (0.0009% of the 104,695 reference population).	9.2 individuals in 11.7 km^2 (0.009% of MU)	Long term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of bottlenose dolphin	0.3 individuals in 15.21 km^2 (based on density estimate of 0.02/ km^2) (0.08% of the reference population of 397 bottlenose dolphin).	0.0006 individuals in 0.028 km^2 (based on density estimate of 0.02/ km^2) (0.00015% of the reference population of 397 bottlenose dolphin).	0.006 individuals in 0.28 km^2 (0.0015% for MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of Risso's dolphin	0.47 individuals in 15.21 km^2 (based on density estimate of 0.031/ km^2) (0.005% of the reference population of 8,794 Risso's dolphin).	0.0009 individuals in 0.028 km^2 (based on density estimate of 0.031/ km^2) (0.00001% of the reference population of 8,794 Risso's dolphin).	0.009 individuals in 0.28 km^2 (0.0001% for MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of common dolphin	3.35 individuals in 15.21 km^2 (based on density estimate of 0.22/ km^2) (0.006% of the reference population of 56,556 common dolphin).	0.006 individuals in 0.028 km^2 (based on density estimate of 0.22/ km^2) (0.00001% of the reference population of 56,556 common dolphin).	0.06 individuals in 0.28 km^2 (0.0001% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of minke whale	1.18 individuals in 69.4 km^2 (based on density estimate of 0.017/ km^2) (0.005% of the reference population of 23,528 minke whale).	0.0085 individuals (0.5 km^2; based on density estimate of 0.017/ km^2) (0.00004% of the reference population of 23,528 minke whale).	0.0085 individuals in 5 km^2 (0.0004% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of grey seal	1.95 individuals in 12.75 km^2 (based on density estimate of 0.155/ km^2) (0.003% of the reference population of 6,000 grey seal).	0.012 individuals in 0.018 km^2 (based on density estimate of 0.155/ km^2) (0.0002% of the reference population of 6,000 grey seal).	0.03 individuals in 0.18 km^2 (0.0005% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of harbour seal	0.006 individuals in 12.75 km^2 (based on density estimate of 0.0005/ km^2)	0.000009 individuals in 0.018 km^2 (based on density estimate of 0.0005/ km^2)	0.00009 individuals in 0.18 km^2 (0.00018% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of

Potential Impact	Maximum number of individuals and (% of reference population)			Magnitude
	One device (possible mild avoidance (75dBht))	One device (possible strong avoidance (90dBht))	Full deployment* (possible strong avoidance (90dBht))	
	(0.013% of the reference population of 50 harbour seal).	(0.000018% of the reference population of 50 harbour seal).		the reference population anticipated to be exposed to effect).

573. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect of very low / negligible for all marine mammal species, the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any possible long-term disturbance in harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal has been assessed as **negligible** (**Table 12-67**).

Table 12-67 Assessment of impact significance for long-term disturbance of marine mammals from underwater noise of operational tidal devices at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance from operational tidal devices	Harbour porpoise	Low	Very low / negligible	Negligible	No mitigation required or proposed.	Negligible
	Bottlenose dolphin		Very low / negligible	Negligible		Negligible
	Risso's dolphin		Very low / negligible	Negligible		Negligible
	Common dolphin		Very low / negligible	Negligible		Negligible
	Minke whale		Very low / negligible	Negligible		Negligible
	Grey and harbour seal		Very low / negligible	Negligible		Negligible

12.6.4.1.2.1.1. Mitigation

574. No mitigation measures are required or proposed.

12.6.4.1.2.1.2. Residual Impact

575. The residual impact would remain minor (not significant) for disturbance from operational turbines.

12.6.4.2. Underwater Noise and Disturbance from Maintenance and Repowering Activities

576. Although impacts will be less than during construction, as a worst-case scenario assessment has been based on assessment for construction in **Sections 12.6.3.1.2**, **12.6.3.2.2** and **12.6.3.4**.

577. As a precautionary worst-case scenario, the assessment is based on the assessment of potential barrier effects as a result of underwater noise during construction, which assumed

there could be up to two drilling activities; two cable installation activities; two cable protection activities; and up to 16 vessels on site (**Table 12-68**).

Table 12-68 Maximum number of individuals (and % of reference population) that could be disturbed by underwater noise during maintenance and repowering activities at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
Disturbance of harbour porpoise	1.7 individuals (based on density estimate of 0.783/ km^2) (0.0016% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of bottlenose dolphin	0.00006 individuals (based on density estimate of 0.02/ km^2) (0.000015% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of Risso's dolphin	0.00009 individuals (based on density estimate of 0.031/ km^2) (0.000001% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of common dolphin	0.0007 individuals (based on density estimate of 0.22/ km^2) (0.0000012% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of minke whale	0.45 individuals (based on density estimate of 0.017/ km^2) (0.0019% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of grey seal	0.07 individuals (based on density estimate of 0.155/ km^2) (0.0012% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of harbour seal	0.00023 individuals (based on density estimate of 0.0005/ km^2) (0.00046% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

578. It is highly unlikely two drilling activities, two cable installation activities, two cable protection activities and 16 vessels on site, would occur all at the same time or for any prolonged period of time. Any disturbance would be limited to the area around the activity within the MDZ array area and / or ECC.

579. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species), the impact significance (based on the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any disturbance as a result of underwater noise during maintenance and repowering activities for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal has been assessed as **negligible** (**Table 12-69**).

12.6.4.2.1. Mitigation

580. No mitigation measures are required or proposed.

12.6.4.2.2. Residual Impact

581. The residual impact would remain negligible.

Table 12-69 Assessment of impact significance for any temporary disturbance as a result of underwater noise during maintenance and repowering activities at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance during maintenance and repowering activities	Harbour porpoise	Low	Negligible / very low	Negligible	None required or proposed	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.4.3. Underwater Noise and Disturbance from Vessels

582. Although impacts from vessels during operation, maintenance and repowering will be less than during construction, as a worst-case scenario assessment has been based on assessment for construction in **Section 12.6.3.3**. However, it should be noted that vessels have also been included in the assessment for underwater noise and disturbance from maintenance and repowering activities in Section 12.6.4.2. Therefore, this is not an additional impact.

583. The maximum number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of TTS from cumulative exposure over a 24 hour period, based on the density estimates for the MDZ and maximum area of impact for large vessels are presented in **Table 12-75**.

584. The magnitude of the potential of TTS / fleeing response is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the temporary effect (**Table 12-75**).

Table 12-70 Maximum number of individuals (and % of reference population) that could be at risk of temporary auditory injury (TTS) and fleeing response / disturbance from cumulative exposure over a 24 hour period for large vessels at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)		Magnitude
	One large vessel	Up to 16 large vessels	
TTS / fleeing response in harbour porpoise	0.05 individuals (based on density estimate of 0.783/ km^2) (0.00005% of the 104,695 reference population).	0.78 individuals (based on density estimate of 0.783/ km^2) (0.0007% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

Potential Impact	Maximum number of individuals and (% of reference population)		Magnitude
	One large vessel	Up to 16 large vessels	
TTS / fleeing response in bottlenose dolphin	0.0000006 individuals (based on density estimate of 0.02/ km^2) (0.00000015% of the reference population of 397 bottlenose dolphin).	0.00001 individuals (based on density estimate of 0.02/ km^2) (0.000002% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in Risso's dolphin	0.0000009 individuals (based on density estimate of 0.031/ km^2) (0.00000001% of the reference population of 8,794 Risso's dolphin).	0.00001 individuals (based on density estimate of 0.031/ km^2) (0.0000002% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in common dolphin	0.000007 individuals (based on density estimate of 0.22/ km^2) (0.00000001% of the reference population of 56,556 common dolphin).	0.0001 individuals (based on density estimate of 0.22/ km^2) (0.0000002% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in minke whale	0.01 individuals (based on density estimate of 0.017/ km^2) (0.00004% of the reference population of 23,528 minke whale).	0.20 individuals (based on density estimate of 0.017/ km^2) (0.0008% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in grey seal	0.0008 individuals (based on density estimate of 0.155/ km^2) (0.00001% of the reference population of 6,000 grey seal).	0.01 individuals (based on density estimate of 0.155/ km^2) (0.0002% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
TTS / fleeing response in harbour seal	0.0000025 individuals (based on density estimate of 0.0005/ km^2) (0.000005% of the reference population of 50 harbour seal).	0.00004 individuals (based on density estimate of 0.0005/ km^2) (0.00008% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

585. Taking into account the medium sensitivity of all marine mammal species to any temporary auditory injury (i.e. receptor has limited capacity to recover from the anticipated impact; **Table 12-6**) and low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible/ very low for all species), the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) has been assessed as **minor (not significant)** for TTS and **negligible** for disturbance for all species.

12.6.4.3.1.1.1. Mitigation

586. No mitigation measures are required or proposed.

12.6.4.3.1.1.2. Residual Impact

587. The residual impact would remain minor (not significant) for TTS and negligible for disturbance.

Table 12-71 Assessment of impact significance for any temporary auditory injury (TTS) and disturbance in marine mammals from underwater noise from vessels at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS from vessels	Harbour porpoise	Medium	Negligible / very low	Minor (not significant)	None required or proposed	Minor (not significant)
	Bottlenose dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Risso's dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin		Negligible / very low	Minor (not significant)		Minor (not significant)
	Minke whale		Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal		Negligible / very low	Minor (not significant)		Minor (not significant)
Disturbance from vessels	Harbour porpoise	Low	Negligible / very low	Negligible	None required or proposed	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.4.4. Acoustic Deterrent Devices (ADDs)

588. Acoustic deterrent devices (ADDs) may be used as part of the mitigation plan to deter. The principle behind the use of ADDs is that they produce an aversive signal that causes a marine mammal to move away and out of the area of potential collision risk. ADDs have been used widely in an attempt to deter mammals from aquaculture facilities and fishing gear. ADDs have also been adopted as a method of deterring marine mammals to a 'safe distance' from the potential impact area surrounding a piling event to reduce the risk of permanent auditory injury (Gordon *et al*., 2007). ADDs are presently employed as a voluntary supplement to the 'standard' components of a Marine Mammal Management Plan (MMMP) in the UK and have been used recently for piling at UK offshore windfarm (OWF) sites including, for example, Beatrice, Dudgeon and Galloper. Several other UK wind farm projects are known to be including them in their current plans. In contrast, several European countries stipulate the use of ADDs as a standard component of their MMMPs for OWFs.

589. A potential disadvantage of ADDs is that their use introduces additional noise into the marine environment. ADDs rely on behavioural disturbance to work, although the risk of marine mammals receiving a dose of sound sufficient to cause auditory injury from ADDs is very low. The Joint Nature Conservation Committee (JNCC) guide to selection of ADDs (McGarry *et al*., 2018) modelled the potential for auditory injury from ADDs, assuming a swim speed of 2.5m/s

and 30 minutes of ADD activation. The results showed that the NOAA (NMFS, 2018) PTS threshold for all mammals was not exceeded beyond 100m for any of the devices modelled, with the exception of the SaveWave Orcasaver where PTS could potentially occur up to 130m from the device. It was therefore concluded that the risk of injury due to ADD deployment is low for all devices (McGarry *et al*., 2018).

590. There is a risk that using ADDs may add to the degree of disturbance and displacement, however their use in reducing the risk of collision with operational turbines, which theoretically has the potential to result in permanent or fatal injuries, is deemed beneficial compared to the relatively small area of their range over which disturbance and displacement could occur. For example, the Sea Mammal Research Unit (SMRU) assessed the potential for impact on marine mammals from the use of ADDs and concluded that although a disturbing noise source prior to piling could result in an approximately 6% increase in the duration of disturbing sound levels, the benefit of reducing the likelihood of injury was more important than the disturbance for a limited duration (Sparling *et al*., 2015).

591. The mitigation plan to reduce the collision risk with operational turbines will be developed in the pre-construction period, so that it is based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. An outline mitigation and monitoring plan outlining the potential options and approach to be considered and developed in the pre-construction period has be included with the submission (**Document MOR/RHDHV/DOC/0072**). However, as the use ADDs could be considered as part of the mitigation, the potential disturbance effect of ADDs have been assessed.

592. In the JNCC guide to selection of ADDs in industry, which describes the commercially available ADDs and their applications (McGarry *et al*., 2018), the Offshore Renewables Joint Industry Project (ORJIP) review on the effectiveness of ADD for mitigation purposes (Herschel *et al*., 2013; 2014) and a review of the effectiveness of ADDs on minke whale (McGarry *et al*., 2017), the Lofitech device has been shown to be the most consistent and effective device for deterring seals, harbour porpoise and minke whale. The Lofitech device has successfully been used in a number of projects for a range of industries, including for aquaculture projects and the offshore wind industry. Therefore, this device has been used, as an example, in this assessment (**Table 12-73**). The Lofitech device has been designed to have a source noise level of 189 dB, with numerous field measurements confirming the device to have recorded source levels of 179 to 194 dB (Coram *et al*., 2014).

593. Studies have shown the Lofitech device to be effective for harbour porpoise with an immediate response on activation of the device (Brandt *et al*., 2012, 2013; McGarry *et al*., 2018). In tests of the effectiveness of the Lofitech device on harbour porpoise at a site in the German North Sea, the Lofitech device was active for four continuous hours and a total of ten trials were conducted (Brandt *et al*., 2013). During these trials, a significant decline in harbour porpoise detection was observed even at the furthest CPOD at 7.5 km from the source (Brandt *et al*., 2013). Harbour porpoise were not habituated to the device over trials of 4-6 months (Brandt *et al*., 2012). During construction at Dan Tysk offshore windfarm, the Lofitech device was found to deter porpoise between 12 km and up to 18 km (although not statistically significant for the latter). There was also no evidence of reduced effectiveness over the construction period (Dähne *et al*., 2017). The device noise source levels are below the sound level that could result

in PTS onset in harbour porpoise (202 dB re 1µPa SPL_{peak}) and TTS onset (196 dB re 1µPa SPL_{peak}) based on the NOAA criteria (NMFS, 2018).

594. There is no information available on the effectiveness of the Lofitech device on dolphin species. However, studies on the effectiveness of ADDs in captive dolphins has shown startle responses in bottlenose dolphins at ADD source levels of 135 dB re 1µPa RMS (Janik and Götz, 2015). It could therefore be assumed that the deterrence range of bottlenose dolphins from an ADD emitting a sound source level of 190 dB re 1 µPa with a high frequency could be more than 4 km (McGarry *et al*., 2017). However, it should be noted that this is untested.

595. There is very little information on the effect of ADDs on other dolphin species, such as Risso's dolphin and common dolphin. However, as they are classed as mid frequency cetaceans with a typical hearing range of 150 Hz to 160 Hz (NMFS, 2018), they would be expected to have a similar response as bottlenose dolphins. Acoustic devices are used to reduce by-catch of dolphin species. In trials of some of these devices there have been significantly lower detection rates of dolphin vocalisations. Leeny *et al*. (2007) also found during these trials, that continuous and responsive devices caused dolphins to leave the area rapidly.

596. The Lofitech device has been proven to effect minke whale behaviour up to 1 km from the source (McGarry *et al*., 2017). Within 15 minutes of ADD activation, minke whale were shown to travel to a minimum distance of 1.7 km from the ADD location, with a maximum deterrence range of 4.5 km detected. Mean swim speeds of minke whale away from the active device was found to be 15 km/h (± 4.7 km/h) (McGarry *et al*., 2017). This would be the equivalent of 4.2m/s. The device noise source levels are below the sound level that could result in PTS onset in minke whale (219 dB re 1µPa SPL_{peak}) and TTS onset (213 dB re 1µPa SPL_{peak}) based on the NMFS criteria (NMFS, 2018).

597. A number of different trials have shown that the Lofitech device is effective at deterring harbour and grey seals to a distance of 1 km from the device location (Brandt *et al*., 2012; 2013; Harris *et al*., 2014; Gordon *et al*., 2015). There was no habituation of harbour seals in field trials that occurred over several weeks (Gordon *et al*., 2015). However, some trials have indicated a potential deterrent range of 60m to 473m (Götz and Janik 2010; Gordon *et al*., 2015; McGarry *et al*., 2018). The noise source level from the Lofitech device (of a maximum 194 dB re 1 µPa) is also lower than the injury thresholds for seals in water, with PTS onset at 218 dB re 1µPa SPL_{peak} and TTS onset at 212 dB re 1µPa SPL_{peak} (NMFS, 2018).

598. In addition, as a precautionary approach, the assessment has also been based on a potential average disturbance range of approximately 1 km (3.14 km^2) for a range of ADD devices for all species, based on the JNCC guide for the selection and deployment of acoustic deterrent devices (McGarry *et al*., 2018) (**Table 12-72**).

Table 12-72 Summary of ADD deterrence distances from JNCC guide for the selection and deployment of acoustic deterrent devices (McGarry *et al*., 2018)

Species	ADD type	Range of deterrence distances[1]
Harbour porpoise	Lofitech Seal Scarer	300-1,200m
	Ace Aquatech: MMD (High Frequency)	50 – 6,000m

Species	ADD type	Range of deterrence distances[1]
	Ace Aquatech: Universal Scrammer	Likely avoidance between 200m and 1.2 km. Potential exclusion up to 6 km
	Terecos Ltd: DSMS-4	301m – 1.2 km
	Seamarco: Fauna Guard – FG Porpoise	Observed efficacy of at least 1,000m
	Airmar dB plus II	200m – 3,500 km
	Aquamark 848	Up to 1,500m
	DDD, DID from STM Products	1.2 to 3 km
Dolphin species	Ace Aquatech: MMMD (Mid Frequency)	50 – 1,000m
	Aquamark 848	Up to 1,500m
	DDD and DID (STM Products) [	1.2 to 3 km
Minke whale	Lofitech	1,000m
	Aquamark 848	Up to 1,500m
Seals	Lofitech Seal Scarer	60 to 473m. Behavioural response when seals within 1 km of sound source.
	Ace Aquatech MMMD (LOW)	50 – 1,000m
	Ace Aquatech: MMMD (High Frequency)	50 – 2,000m
	Ace Aquatech: Universal Scrammer	Between 200m and 1.4 km

[1]These ranges are likely to be influenced by factors such as local propagation characteristics, as well as animal's motivation, previous exposures to device and background noise levels.

599. As outlined in **Appendix 12.4** (**Volume III**), all of the devices are significantly above the background noise in the area and so this should not interfere with the audibility for the target species when in the vicinity of the devices. Although the source noise level, presented as an overall, broadband level, may be lower than the figure presented for a TEC, it must be taken into account that the acoustic frequency produced by each device is critical. For an ADD, to be effective in being audible to a marine mammal, it will operate at a much higher frequency, typically >5,000 Hz, than the dominant frequencies that will be produced by a TEC, and will thus remain clearly audible.

600. Commonly used ADDs, for example as supplied by Lofitech (Seal Scarer) and Ace Aquatech (e.g. the Marine Mammal Mitigation Device (MF) for pinnipeds and cetaceans) have a stated source level of 204 dB and 195 dB respectively, operating at frequency ranges of 10-20 kHz and 8-24 kHz. These are likely to be over 80 dB louder than the TECs at around 10m from the turbine (**Appendix 12.4, Volume III**).

601. As outlined in **Appendix 12.4** (**Volume III**), it is important to note, that audibility of the ADDs should not be considered the same as disturbance or displacement. The differences in the frequencies of typical ambient coastal noise, TEC machinery and an ADD means that there will be negligible interference with ADD audibility within the near vicinity of a TEC, where physical harm from a potential collision could occur. An ADD would therefore still be effective mitigation in the MDZ.

602. The requirements for ADD use has still to be determined during the development of the mitigation plan. Therefore, for this assessment a precautionary indicative example has been assumed in that there could be four ADDs at each of the arrays with a worst-case scenario of up to ten arrays, although a maximum of eight arrays are proposed for the MDZ (**Table 12-73**).

603. However, it is proposed that the ADDs would only be activated when marine mammals are in close proximity to the arrays and therefore not all 40 ADDs would ever be activated at the same time.

Table 12-73 Number of individuals (and % of reference population) that could be disturbed during ADD activation based on Lofitech device and average 1 km (3.24 km²) disturbance range

Potential Impact	One Lofitech device (maximum potential range)	Number of individuals and (% of reference population)			Magnitude
		One ADD (3.14 km²)	Full deployment for up to 10 ADDs (31.4 km²)	Full deployment for up to 40 ADDs (125.6 km²)	
Disturbance of harbour porpoise	Up to 7.5 km (177 km²) 139 individuals (0.13% of MU)	2.46 individuals (based on density estimate of 0.783/ km²) (0.002% of the 104,695 reference population).	24.6 individuals (based on density estimate of 0.783/ km²) (0.02% of the 104,695 reference population).	98 individuals (based on density estimate of 0.783/ km²) (0.09% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of bottlenose dolphin	Up to 4 km (50.3 km²) 1 individual (0.25% of MU)	0.06 individuals (based on density estimate of 0.02/ km²) (0.015% of the reference population of 397 bottlenose dolphin).	0.6 individuals (based on density estimate of 0.02/ km²) (0.15% of the reference population of 397 bottlenose dolphin).	2.5 individuals (based on density estimate of 0.02/ km²) (0.63% of the reference population of 397 bottlenose dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of Risso's dolphin	Up to 4 km (50.3 km²) 1.6 individual (0.02% of MU)	0.1 individuals (based on density estimate of 0.031/ km²) (0.001% of the reference population of 8,794 Risso's dolphin).	1 individual (based on density estimate of 0.031/ km²) (0.01% of the reference population of 8,794 Risso's dolphin).	4 individuals (based on density estimate of 0.031/ km²) (0.04% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of common dolphin	Up to 4 km (50.3 km²) 11 individual (0.02% of MU)	0.69 individuals (based on density estimate of 0.22/ km²) (0.001% of the reference population of 56,556 common dolphin).	7 individuals (based on density estimate of 0.22/ km²) (0.01% of the reference population of 56,556 common dolphin).	28 individuals (based on density estimate of 0.22/ km²) (0.05% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of minke whale	Up to 4.5 km (64 km²) 1 individual (0.004 of MU)	0.05 individuals (based on density estimate of 0.017/ km²)	0.05 individuals (based on density estimate of 0.017/ km²)	2 individuals (based on density estimate of 0.017/ km²)	Temporary effect with negligible / very low magnitude

Potential Impact	One Lofitech device (maximum potential range)	Number of individuals and (% of reference population) One ADD (3.14 km^2)	Full deployment for up to 10 ADDs (31.4 km^2)	Full deployment for up to 40 ADDs (125.6 km^2)	Magnitude
		(0.0002% of the reference population of 23,528 minke whale).	(0.0002% of the reference population of 23,528 minke whale).	(0.01% of the reference population of 23,528 minke whale).	(less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of grey seal	Up to 1 km (3.14 km^2) 0.49 individuals (0.008% of MU)	0.49 individuals (based on density estimate of 0.155/ km^2) (0.008% of the reference population of 6,000 grey seal).	5 individuals (based on density estimate of 0.155/ km^2) (0.08% of the reference population of 6,000 grey seal).	19.5 individuals (based on density estimate of 0.155/ km^2) (0.32% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of harbour seal	Up to 1 km (3.14 km^2) 0.002 individuals (0.004% of MU)	0.002 individuals (based on density estimate of 0.0005/ km^2) (0.004% of the reference population of 50 harbour seal).	0.02 individuals (based on density estimate of 0.0005/ km^2) (0.04% of the reference population of 50 harbour seal).	0.06 individuals (based on density estimate of 0.0005/ km^2) (0.13% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

604. The duration of the ADD activation has also still to be determined, therefore as a precautionary approach the assessment has been based on possible 10 and 20 minute activation and the distance marine mammals could be disturbed based on them swimming away for the ADD during this activation time (**Table 12-74**). For minke whale the average swimming speed of 3.25m/s has been used (Blix and Folkow, 1995) and for all other species an average marine mammal swimming speed of 1.5m/s (Otani *et al*., 2000) has been assumed.

Table 12-74 Number of individuals (and % of reference population) that could be disturbed during ADD activation for 10 and 20 minutes

Potential Impact	Number of individuals and (% of reference population)		Magnitude
	10 minute ADD activation	20 minute ADD activation	
Disturbance of harbour porpoise (1.5m/s swim speed)	2 individuals (2.54 km^2; based on density estimate of 0.783/ km^2) (0.002% of the 104,695 reference population).	8 individuals (10.18 km^2; based on density estimate of 0.783/ km^2) (0.008% of the 104,695 reference population).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of bottlenose dolphin	0.05 individuals (2.54 km^2; based on density estimate of 0.02/ km^2) (0.01% of the reference	0.2 individuals (10.18 km^2; based on density estimate of 0.02/ km^2) (0.05% of the reference	Temporary effect with negligible / very low magnitude (less than 1% of the reference population

Potential Impact	Number of individuals and (% of reference population)		Magnitude
	10 minute ADD activation	20 minute ADD activation	
(1.5m/s swim speed)	population of 397 bottlenose dolphin).	population of 397 bottlenose dolphin).	anticipated to be exposed to effect).
Disturbance of Risso's dolphin (1.5m/s swim speed)	0.08 individuals (2.54 km^2; based on density estimate of 0.031/ km^2) (0.001% of the reference population of 8,794 Risso's dolphin).	0.32 individuals (10.18 km^2; based on density estimate of 0.031/ km^2) (0.004% of the reference population of 8,794 Risso's dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of common dolphin (1.5m/s swim speed)	0.56 individuals (2.54 km^2; based on density estimate of 0.22/ km^2) (0.001% of the reference population of 56,556 common dolphin).	2.24 individuals (10.18 km^2; based on density estimate of 0.22/ km^2) (0.003% of the reference population of 56,556 common dolphin).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of minke whale (3.25m/s swim speed)	0.2 individuals (11.95 km^2; based on density estimate of 0.017/ km^2) (0.001% of the reference population of 23,528 minke whale).	0.81 individuals (47.78 km^2; based on density estimate of 0.017/ km^2) (0.001% of the reference population of 23,528 minke whale).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of grey seal (1.5m/s swim speed)	0.39 individuals (2.54 km^2; based on density estimate of 0.155/ km^2) (0.01% of the reference population of 6,000 grey seal).	1.6 individuals (10.18 km^2; based on density estimate of 0.155/ km^2) (0.03% of the reference population of 6,000 grey seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).
Disturbance of harbour seal (1.5m/s swim speed)	0.001 individuals (2.54 km^2; based on density estimate of 0.0005/ km^2) (0.003% of the reference population of 50 harbour seal).	0.005 individuals (10.18 km^2; based on density estimate of 0.0005/ km^2) (0.01% of the reference population of 50 harbour seal).	Temporary effect with negligible / very low magnitude (less than 1% of the reference population anticipated to be exposed to effect).

605. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect (negligible / very low for all species), the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for disturbance as a result of ADDs has been assessed as **negligible** (**Table 12-75**).

Table 12-75 Assessment of impact significance for possible disturbance of marine mammals from underwater noise during ADD activation at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance during ADD activation	Harbour porpoise	Low	Negligible / very low	Negligible	No mitigation required.	Negligible
	Bottlenose dolphin		Negligible / very low	Negligible		Negligible
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible / very low	Negligible		Negligible

12.6.4.4.1. Mitigation

606. No further mitigation measures are required or proposed.

12.6.4.4.2. Residual Impact

607. The residual impact would remain negligible.

12.6.4.5. Collision Risk with Tidal Devices

608. There is considerable uncertainty regarding the collision risk of marine mammals with all tidal turbine types. The moving rotors of tidal energy devices pose a potential collision risk for marine mammals. However, there is currently limited understanding and empirical data relating interactions between marine mammals with tidal devices and there have been no recorded incidents at any operational tidal arrays, including the following projects in the UK:

- Several years of operation of the SeaGen tidal turbine (Strangford Lough) 1.4MW tidal device;
- Ongoing monitoring of multiple deployments of single tidal devices in the Falls of Warness (EMEC, Orkney) test site since 2007; and
- Ongoing monitoring of Phase 1a (6MW) of the MeyGen (Caithness) array, the full phase 1 (86MW) of which is now consented.

609. SeaGen as it was deployed in 2008 and there were no marine mammal collision incidents reported during its operational monitoring. Although the SeaGen device has now been removed, data from its monitoring programmes are still being analysed. The European Marine Energy Centre (EMEC) at Orkney has tested many different devices and no incidents involving collisions with marine mammals have been recorded (SLR, 2015).

610. There is an absence of data to determine the ability of animals to avoid coming into contact with devices, either through close-range evasion, where animals take last minute evasive action, or through avoidance, which may operate at a wider scale with animals avoiding the area the devices are located in (Sparling and Smith, 2019). Data from telemetry studies around the SeaGen device in Strangford Lough, Northern Ireland, suggest that harbour seal may be exhibiting a degree of avoidance, with peaks in transit approximately 250m either side of the device (Sparling *et al*., 2016).

611. There is also uncertainty associated with the potential for a collision to result in fatality, and the potential physical effect of collision impacts on marine mammals. Thompson *et al.* (2016) and Onoufriou *et al*. (2019), carried out empirical tests with grey seal carcasses and concluded that collisions at blade speeds of 5.2 ms^{-1} or less did not result in any significant muscle or skeletal

damage and would be unlikely to result in serious injury or mortality. Incorporating this into the collision risk model (CRM) resulted in a reduction of predicted collision risk across a range of simulations of between 20% and 75%, depending on the proportion of predicted collisions which are below this speed. Above this speed, the probability of death or serious injury will increase with rotor speed, as will the likelihood of a collision. Therefore, rotor speeds and the relationship between rotor speed and current speed are clearly important factors. However, rotor speeds vary widely by device type and size. The size of moving parts, and therefore the area swept by them, is also an important determinant of the risk of collision. Larger blades sweep a larger area, putting a higher proportion of animals at risk of collision. However, larger blades are also likely to be slower than smaller blades and therefore collision probability will be lower for a given passage rate and animal speed. The variety in collision probability as a result of variation in different turbine parameters is therefore difficult to predict (Sparling and Smith, 2019).

612. The position of the devices in the water column will also have a significant effect on the predicted collision risk (Sparling and Smith, 2019). Therefore, the depth distribution of the marine mammals using a particular site is an important consideration and will often vary by species and potentially between sites. Many marine mammals are benthic foragers and divide their time primarily between the surface to breathe, and the seabed to feed, with relatively less time spent mid-water. For example, a study of grey seal juveniles tagged at Anglesey, Bardsey Island and Ramsey Sound found that tagged animals spent the majority of their time either at the surface or at the bottom of a dive with little time spent in the mid water depths (Thompson, 2012). Whereas other species may spend considerable time in other parts of the water column. For example, studies indicate that bottlenose dolphins may spent little time in waters deeper than 10m, based on a depth distribution for bottlenose dolphins obtained from a vertical array of hydrophones (Hastie *et al*., 2006) and dolphin dive data from satellite-linked, time–depth recorders (Corkeron and Martin, 2004; Klatsky *et al*., 2007; Sparling and Smith, 2019). Studies also indicate the harbour porpoises spent about half their time within the top 2m of the water column (Teilmann *et al*., 2007, 2013). Therefore, for species that spend a considerable amount of their time near the surface, such as bottlenose dolphins and harbour porpoises, TECs close to the surface would represent the worst-case scenario for collision risk. Whereas, where animals are foraging on the seabed, midwater devices with adequate clearance above and below could represent a lower risk than devices situated close to the seabed or the water surface (Sparling and Smith, 2019).

613. The total number of TECs is also be a major factor in determining collision risk. As outlined by Sparling and Smith (2019), currently there is no way of realistically modelling the collision risk posed by multiple devices, other than simply multiplying the risk for a single device by the total number of devices. However, this is likely to be unrealistic as it is difficult to predict how animals might respond to an array of devices. For example, the probability of avoidance is likely to be modified as a result of a close range encounters with preceding devices. There is the possibility that animals might learn from encountering and avoiding the first device and then subsequently avoid additional devices at a greater distance. However, there could also be the possibility that avoiding one device might bring an animal into the path of a subsequent device with an increased probability of collision, although this will depend on device spacing. Although collision risk may not scale linearly with the number of TECs in an array, given current uncertainty regarding marine mammal behaviour, and a lack of empirical data, most assessments make the assumption that there will be a linear increase in risk with the total number of devices installed.

614. There are a number of different features of tidal devices and arrays which can have an effect on the magnitude of potential collision risk for marine mammals (Sparling and Smith, 2019), including:

- The number and size of Tidal Energy Converters (TEC) moving parts (e.g. for horizontal axial flow designs; number of rotors and rotor dimensions and shape);
- The total number of devices with moving parts;
- The speed of movement of moving parts; and
- The position of TECs in the water column (in relation to the depth distribution of marine mammals).

615. These factors have been taken into account when determining the realistic worst-case parameters for the collision risk assessment, as outlined in **Section 12.6.4.5.1**.

12.6.4.5.1. Parameters used Collision Risk Assessment

12.6.4.5.1.1. CRM and ERM models

616. For the marine mammal collision risk assessment two methods, Encounter Rate Modelling (ERM) and Collision Risk Modelling (CRM), using the Scottish Natural Heritage guidance for assessing collision risk between underwater turbines and marine wildlife (SNH, 2016) and accompanying spreadsheets. This approach was agreed with NRW at the 2nd Marine Mammal TWG in February 2019.

617. The ERM, based on the work by the Scottish Association for Marine Science (SAMS) (Wilson *et al*., 2007), is designed to predict potential encounters with predator and prey. The model considers the volume swept by each rotor blade (predator) and the number of individuals (prey) present within that volume and estimates how many encounters on this basis and scales up to relevant time period. Key device parameters include number of rotors, number of blades, blade depth, blade length, rotation speed.

618. The CRM was originally developed as the "Band Model" to assess collision risk to flying birds with wind turbines. The model considers the number of animals likely to pass through each rotor, and the probability of collision for each such passage and estimates how many collisions on this basis and scales up to relevant time period. Key device parameters include number of rotors, number of blades, blade width, blade length, rotation speed.

619. The difference in the models and the parameters used result in different results for different devices and scenarios. Therefore, the collision risk assessments were conducted using both the ERM and CRM for all marine mammal species.

620. It should be noted, as acknowledged by SNH (2016), that the ERM and CRM methods will provide at best, an order of magnitude estimate of collision risk.

12.6.4.5.1.2. Tidal Devices and Array Scenarios

621. The tidal sector is an emerging industry with a wide range of technology types that are still being developed and optimised. As a result, Morlais may attract a wide spectrum of tidal devices over

the life of the project. The range and flexibility sought within the consent application has been limited by careful consideration of development scenarios designed to rationalise the likely approach to development and to set workable limits on potential impacts. As a result, a series of key design principles have been identified and used to shape the impact assessments undertaken. This approach allows a range or “envelope” of design parameters, and the likely worst case of each parameter, to be defined. This approach is tested in planning law and referred to as the ‘Rochdale Envelope’ approach, often called a Project Design Envelope (PDE).

622. It is important to note that because a wide range of designs at varying scales are currently available (and may be available in the future), the technologies referred to are provided as examples for reference only and are to be considered representative of the range of device types that could be utilised at Morlais. A review of these potential tidal technologies has allowed the identification of realistic worst-case parameters for each device type (as outlined in **Table 12-76**).

623. The worst-case parameters used to define the PDE in terms of the device parameters and the relevant worst-case scenarios for the Project have been used in the impact assessments.

624. The device types outlined represent the device type parameters which fall within the PDE. There are a number of novel device types available. The device types included in this assessment are deemed to represent the most suitable parameters for deployment at Morlais.

Table 12-76 Tidal device parameters used in marine mammal collision risk (ERM and CRM) assessments

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b	7a
Position in water column		**Surface**	**Surface**	**Mid-water**	**Surface**	**Surface**	**Seabed**	**Seabed**	**Seabed**	**Seabed**	**Surface**
Description		**Twin-rotor floating**	**Multiple-rotor buoyant platform**	**Multi-rotor buoyant mid water**	**Multiple-rotor buoyant platform**	**Spar buoy**	**Seabed mounted single rotor**	**Seabed mounted single rotor**	**Seabed mounted single rotor**	**Three-rotor seabed mounted platform**	**Cross-flow multi-rotor floating**
Parameter	**Unit**										
Rotor tip min depth*	m	3.2	5	10	5	6	23	14	26	30	1
No. of rotors	n	2	5	5	20	1	1	1	1	3	2
Rotor radius	m	10	5	5	2.5	13.5	7.5	13	5	5	2.5
No. of blades	n	2	2	2	3	2	6	3	2	3	3
Blade "depth" (front to back, side view)	m	0.84	0.25	0.25	0.09	0.4	0.3	0.4	0.25	0.25	0.064
Blade "width" (side to side, front view)	m	2	1.1	1.1	0.2	0.2	0.2	0.2	0.8	0.8	N/A
Rotation speed	rpm	8.71	18	18	26.7	10.1	7.5	7.5	22	22	13.6
Mean tangential blade speed	m/s	4.56	4.71	4.71	3.5	7.14	2.95	5.11	5.76	5.76	1.78
% time not in operation	%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%

Tidal device category		**1**	**2a**	**2b**	**3**	**4**	**5a**	**5b**	**6a**	**6b**	**7a**
Position in water column		**Surface**	**Surface**	**Mid-water**	**Surface**	**Surface**	**Seabed**	**Seabed**	**Seabed**	**Seabed**	**Surface**
Description		**Twin-rotor floating**	**Multiple-rotor buoyant platform**	**Multi-rotor buoyant mid water**	**Multiple-rotor buoyant platform**	**Spar buoy**	**Seabed mounted single rotor**	**Seabed mounted single rotor**	**Seabed mounted single rotor**	**Three-rotor seabed mounted platform**	**Cross-flow multi-rotor floating**
Parameter	**Unit**										
Mean current speed	m/s	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
Mean blade speed relative to water	n	4.81	4.95	4.95	3.81	7.30	3.31	5.33	5.96	5.96	2.34
Blade pitch at blade tip	degrees	2.4	5	5	0	5	5	5	5	0	N/A
Blade profile	n	Generic	Generic	Generic	Generic	Generic	Generic	Generic	Generic	Generic	N/A
Median water depth	m	42.5	40	40	30	45	43	43	40	40	40

*in median water depth
N/A = not applicable / required for ERM

12.6.4.5.1.3. Marine Mammal Parameters

625. The density estimates and reference populations used in the assessments are presented in **Table 12-22**. These were agreed with NRW at the 2nd marine mammal TWG meeting on the 19th February 2019.

626. **Table 12-77** outlines the marine mammal dimensions, based on the SNH guidance (SNH, 2016), used for the collision risk assessment. The SNH guidance (SNH, 2016) does not provide data for dolphin species, therefore for bottlenose dolphin, Risso's dolphin and common dolphin these have been determined based on Cetacean Stranding's Investigation Programme (CSIP) strandings records from Wales and data collected by Marine Environmental Monitoring (1994-2017). Further details are provided in **Appendix 12.2** (**Volume III**).

Table 12-77 Marine mammal dimensions used in the Morlais collision risk assessments

Species	Length (m)	Effective radius/body width (m)	Source
Harbour porpoise	1.48m	0.32m	SNH (2016); Thompson (2015)
Bottlenose dolphin	2.57m	0.64m	Calculated from Welsh strandings data (1994-2017)
Risso's dolphin	2.36m	0.59m	Calculated from Welsh strandings data (1994-2017)
Common dolphin	1.77m	0.44m	Calculated from Welsh strandings data (1994-2017)
Minke whale	8.8m	2.2m	SNH (2016); Horwood (1990)
Grey seal	1.86m	0.42m	SNH (2016); Thompson (2015)
Harbour seal	1.41m	0.34m	SNH (2016)

627. **Table 12-78** outlines the marine mammal swim speeds and dive profiles, based on the SNH guidance (SNH, 2016) used for the Morlais collision risk assessments. The SNH guidance (SNH, 2016) does not provide data for dolphin species, therefore for bottlenose dolphin these have been determined based on other sources, where available. Currently there is no or limited suitable data for Risso's and common dolphin, so where required values for bottlenose dolphin have been used. Further details are provided in **Appendix 12.2** (**Volume III**).

Table 12-78 Marine mammal swim speeds and dive profile used in the Morlais collision risk assessments

Species	Mean swim speed (m/s)	Mean dive time (s)	Mean surface time (s)	Depth distribution type / dive profile	Source
Harbour porpoise	1.4m/s	26.2s	3.9s	Harbour porpoise	SNH (2016); Westgate *et al*. (1995); Otani *et al*. (2000)
Bottlenose dolphin	1.8m/s	25.8s	3.7s	Uniform	Skrovan *et al*. (1999); Mate *et al*. (1995)
Risso's dolphin	1.7m/s	25.8s	3.7s	Uniform	N/A based on BND parameters
Common dolphin	1.7m/s	25.8s	3.7s	Uniform	N/A based on BND parameters

Species	Mean swim speed (m/s)	Mean dive time (s)	Mean surface time (s)	Depth distribution type / dive profile	Source
Minke whale	2.1m/s	87s	3.5s	Uniform	SNH (2016); Williams (2009); Stern (1992)
Grey seal	1.8m/s	297s	165s	Grey seal	SNH (2016); Thompson (2015); Beck *et al*. (2000)
Harbour seal	1.8m/s	180s	39.5s	Harbour seal	SNH (2016); Thompson (2015); Thompson *et al.* (2014); Chudzinska (2009)

12.6.4.5.1.4. Avoidance Rates

628. As outlined in **Section 12.6.4.1**, underwater noise from operational turbines will be detected by marine mammals and has the potential to cause disturbance. However, given the potential for masking of the devices operational noise due to high background noise levels, 100% avoidance behaviour cannot be assumed to occur in response to tidal device noise.

629. EMEC (2014) assumed avoidance rates of 98% for harbour porpoise, 95-98% for minke whale, 98% for harbour and grey seal in the collision risk modelling at the Falls of Warness tidal site. Band (2015) recommends presenting collision risk results using a range of avoidance rates 0%, 50%, 95%, 98% and 99%.

630. Avoidance rates of 0%, 50%, 90%, 95%, 98% and 99% have been presented for all species in **Appendix 12.2** (**Volume III**). However, the assessment of the potential impacts and effects have been based on the avoidance rates in **Table 12-79**.

Table 12-79 Marine mammal avoidance rates used in the Morlais collision risk assessments

Species	Avoidance rate
Harbour porpoise	98%
Bottlenose dolphin	98%
Risso's dolphin	98%
Common dolphin	98%
Minke whale	98%
Grey seal	98%
Harbour seal	98%

12.6.4.5.2. Collision Risk Assessments

631. The indicative scenarios conducted for the maximum number of each type of device combined where the predicted collision risk is less than one bottlenose dolphin, have been conducted for each species, with no mitigation. **Table 12-80** and **Table 12-81** provides indicative scenarios for the maximum number of each type of device combined for collision risk of less than one bottlenose dolphin, using the ERM and CRM (number of individuals per year and percentage of reference population), respectively, based on 98% avoidance.

632. The assessments are based on the indicative scenarios for the combination of different types of devices where the collision risk is predicted to be less than one bottlenose dolphin (based on the scenarios with the current maximum MW). Each stage of deployment would only progress based on updated assessments and that the regular reviewing of the monitoring and mitigation indicated that there was no increased collision risk.

633. The approach will be to deploy to a level where the risk is less than one bottlenose dolphin. This deployment will then be monitored with mitigation, such as the use of ADDs if animals come too close to the tidal devices and arrays. The next phase of deployment would only proceed when a review of the monitoring and requirements for mitigation (e.g. how often ADDs were activated), indicates that there is no increased collisions risk. This would be done through the adaptive management and mitigation plan (EMMP) and in consultation with NRW. Therefore, the assessments, including the in-combination assessment, is based on the scenarios for less than one bottlenose dolphin, as this would be the worst-case scenario.

634. **Section 12.6.4.5.3** outlines the proposed monitoring and mitigation for the phased deployments.

635. It is important to note that the output of the devices (MW) used in the assessments are indicative and have been based on the current minimum rating, as a worst-case scenario and prior to deployment it is expected that the rating (MW) for the devices deployed would be higher, although the other parameters are unlikely to change. Further assessments will be conducted prior to deployment as part of the adaptive management and mitigation plan (EMMP; **Document MOR/RHDHV/DOC/0072**).

636. In addition to the indicative scenarios conducted for the maximum number of each type of device combined where the predicted collision risk is less than one bottlenose dolphin in **Table 12-82**, **Table 12-83** outlines the maximum number of each type of device for one device type only, where the predicted collision risk is less than one bottlenose dolphin. Further details on the assessment of these scenarios for the different species are presented in **Appendix 12.2** (**Volume III**).

637. Indicative assessments for 30MW and 40MW of each type of device and an indicative 240MW scenario are also presented in **Appendix 12.2** (**Volume III**), however, these would only be developed once the monitoring and mitigation indicates that the collision risk would be less than one bottlenose dolphin.

Table 12-80 ERM assessment with 98% avoidance for maximum number (and MW) of each type of device combined for collision risk of less than one bottlenose dolphin (number of individuals / year and % of reference population)

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a	Total
Number (MW)	**4 (8MW)**	**1 (1.5MW)**	**1 (1.25MW)**	**0**	**1 (1MW)**	**2 (2MW)**	**1 (1.5MW)**	**1 (0.3MW)**	**1 (1.2MW)**	**0**	**12 (16.75MW)**
Bottlenose dolphin	0.39	0.10	0.10	0	0.07	0.11	0.08	0.02	0.11		0.99 (0.25%)
Harbour porpoise	13.7	2.8	2.3	0	1.6	0.8	1.0	0.1	0.37		22.76 (0.02%)
Risso's dolphin	0.56	0.14	0.14	0	0.11	0.16	0.12	0.03	0.16		1.42 (0.02%)
Common dolphin	3.34	0.78	0.78	0	0.6	0.89	0.66	0.19	0.85		8.08 (0.01%)
Minke whale	0.95	0.34	0.34	0	0.2	0.35	0.22	0.08	0.36		2.84 (0.01%)
Grey seal	2.17	0.47	0.47	0	0.34	0.4	0.32	0.08	0.35		4.6 (0.08%)
Harbour seal	0.006	0.001	0.001	0	0.001	0.002	0.001	0.0004	0.001		0.01 (0.03%)
Magnitude for each species	Potential permanent effect with medium magnitude for combination of devices (0.01-1% of the reference population anticipated to be exposed to effect).										

Table 12-81 CRM assessment with 98% avoidance for maximum number (and MW) of each type of device combined for collision risk of less than one bottlenose dolphin (number of individuals / year and % of reference population)

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a*	Total
Number (MW)	**3 (6MW)**	**1 (1.5MW)**	**1 (1.25MW)**	**0**	**1 (1MW)**	**1 (1MW)**	**1 (1.5MW)**	**2 (0.6MW)**	**3 (3.6MW)**	**0**	**13 (16.45MW)**
Bottlenose dolphin	0.37	0.09	0.09	0	0.11	0.04	0.10	0.04	0.16		0.99 (0.25%)
Harbour porpoise	11.28	2.37	1.96	0	2.12	0.25	1.22	0.15	0.35		19.69 (0.02%)
Risso's dolphin	0.54	0.13	0.13	0	0.15	0.05	0.15	0.05	0.23		1.41 (0.02%)

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a*	Total
Number (MW)	**3 (6MW)**	**1 (1.5MW)**	**1 (1.25MW)**	**0**	**1 (1MW)**	**1 (1MW)**	**1 (1.5MW)**	**2 (0.6MW)**	**3 (3.6MW)**	**0**	**13 (16.45MW)**
Common dolphin	2.89	0.67	0.67	0	0.82	0.27	0.8	0.27	1.2		7.6 (0.01%)
Minke whale	0.67	0.18	0.18	0	0.18	0.07	0.18	0.07	0.32		1.8 (0.008%)
Grey seal	1.89	0.39	0.39	0	0.47	0.12	0.39	0.11	0.5		4.3 (0.07%)
Harbour seal	0.005	0.001	0.001	0	0.002	0.0005	0.001	0.001	0.001		0.01 (0.03%)
Magnitude for each species	Potential permanent effect with medium magnitude for combination of devices (0.01-1% of the reference population anticipated to be exposed to effect).										

*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included

Table 12-82 ERM assessment with 98% avoidance for maximum number (and MW) for each type of device for collision risk of less than one bottlenose dolphin (number of individuals / year and % of reference population)

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a
Number (MW)	10 (20MW)	9 (13.5MW)	9 (11.25MW)	4 (4MW)	13 (13MW)	17 (17MW)	12 (18MW)	40 (12MW)	9 (10.8MW)	69 (6.9MW)
Bottlenose dolphin	0.97	0.91	0.91	0.93	0.95	0.96	0.97	0.97	0.99	0.99

Table 12-83 CRM assessment with 98% avoidance for maximum number (and MW) for each type of device for collision risk of less than one bottlenose dolphin (number of individuals / year and % of reference population)

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b
Number (MW)	7 (14MW)	11 (16.5MW)	11 (13.75MW)	10 (10MW)	9 (9MW)	27 (27MW)	9 (13.5MW)	55 (16.5MW)	18 (21.6MW)
Bottlenose dolphin	0.87	0.97	0.97	0.99	0.95	0.96	0.92	0.97	0.95

Table 12-84 Number of individuals (and % of reference population) that could be at risk of collision with operational tidal devices at Morlais (based on scenarios for less than one bottlenose dolphin)

Species	Magnitude (ERM and CRM)
Harbour porpoise	20-23 individuals (0.02% of MU). Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
Bottlenose dolphin	0.99 individuals (0.25% of MU). Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
Risso's dolphin	1.4 individuals (0.02% of MU). Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
Common dolphin	8 individuals (0.01% of MU) Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
Minke whale	2-3 individuals (0.01%) Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
Grey seal	4-5 individuals (0.08% of MU) Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
Harbour seal	0.01 individuals (0.03% of MU) Potential permanent effect with medium magnitude (0.01-1% of the reference population anticipated to be exposed to effect).

638. As for increased collision risk with vessels, the sensitivity has been assessed as low for all marine mammal species. This has been determined based on no incidents reported for marine mammals with any operational tidal devices, the ability of marine mammal to detect the physical structures of the devices before they encounter the blades and the underwater noise generated by the operational devices, even with high ambient noise levels. The sensitivity classification of the Welsh marine mammal populations from Sparling *et al*. (2015), as outlined in **Section 12.5.11** and **Table 12-23** has also been included for context.

639. Taking into account the sensitivity and the potential magnitude of the effect for the different scenarios, the impact significance for any permanent impacts on harbour porpoise, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal has been assessed as **minor (not significant)** (**Table 12-85**).

640. The number of animals that can be 'removed' from a population varies but is largely dependent on the growth rate of the population; populations with low growth rates can

sustain the removal of a smaller proportion of the population. The JNCC *et al*. (2010) draft EPS guidance provides some indication on how many animals may be removed from a population without causing detrimental effects to the population at FCS.

641. JNCC *et al*. (2010) draft EPS guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth would be halted.

642. The collision risk assessments have been based on the worst-case scenarios, does not take into account the proposed phased deployment, monitoring and mitigation measures and assumes that all encounter or collisions would be fatal.

643. Taking this into account, along with the JNCC *et al*. (2010) draft EPS guidance, it is therefore unlikely that the potential collision risk would result in any significant population effects for bottlenose dolphin, harbour porpoise, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.

644. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra, 2003; ASCOBANS, 2015). This threshold relates to impacts from fisheries by-catch on harbour porpoise where the impact on the harbour porpoise is permanent, i.e. up to 1.7% of the population may be caught as by-catch before a population decline is inevitable.

645. The percentage of the reference population that could be at risk of collision with operational tidal devices at Morlais, based on scenarios for less than one bottlenose dolphin scenarios, is considerably less than 1.7% for bottlenose dolphin, harbour porpoise, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal, with a maximum of 0.25% or less of the reference population for bottlenose dolphin (**Table 12-84**).

646. As outlined in **Section 12.6.4.5.5**, the potential population level effects of collision risk with operational tidal turbines on marine mammals have been assessed in **Appendix 12.2** (**Volume III**). The result of the PVA indicate that population trajectories of the baseline and collision risk scenarios of 1, 2 and 3 animals are very similar, with only a potential for a decline when more than three adults per year are removed from the population of 397 bottlenose dolphins in the Irish Sea MU.

Table 12-85 Assessment of impact significance for collision risk with operational turbines at MDZ

Potential Impact	Receptor	Sensitivity (sensitivity of Welsh population)	Magnitude	Significance	Mitigation	Residual Impact
Collision risk for less than one bottlenose dolphin scenarios	Harbour porpoise	Low (Low)	Medium	Minor	Phased deployment, monitoring and mitigation (EMMP)	Minor (not significant)
	Bottlenose dolphin	Low (High)	Medium	Minor		Minor (not significant)
	Risso's dolphin	Low (Low)	Medium	Minor		Minor (not significant)
	Common dolphin	Low (Low)	Medium	Minor		Minor (not significant)
	Minke whale	Low (Low)	Medium	Minor		Minor (not significant)
	Grey seal	Low (Low)	Medium	Minor		Minor (not significant)
	Harbour seal	Low (Low)	Medium	Minor		Minor (not significant)

12.6.4.5.3. Mitigation

647. As outlined in **Section 12.6.2**, the deployment, monitoring and adaptive management plan will be developed in the pre-construction period and based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design.

648. This plan will consider the most suitable and effective monitoring and mitigation measures to, detect marine mammals in and around the arrays (for example, using remotely monitored PAM, underwater cameras, autonomous recorders, and / or high definition (HD) and thermal imaging camera systems). There would also be the use of active sonar to detect marine mammals in close proximity to the arrays / devices to trigger mitigation measures, such as the automatic activation of ADDs to deter marine mammals from a predetermined mitigation zone around the arrays / devices.

649. The approach would be based on deployment, monitoring and adaptive management, with regular reviews of the installation at appropriate increments directly related to collision risk to marine mammals, specially bottlenose dolphin, to ensure that in that no more than one bottlenose dolphin could be at risk.

12.6.4.5.4. Residual Impacts

650. With the effective and appropriate mitigation proposed any risk of collisions will be greatly reduced. As a precautionary approach the residual impacts have been assessed as minor (not significant) for most species and a very precautionary minor to moderate for bottlenose dolphin and the 30MW and 240MW scenarios. Although is expected to be lower, taking into account that bottlenose dolphins have not been

recorded in the MDZ and are more likely to move along the coast than through the MDZ array area.

12.6.4.5.5. Assessment of Potential Population Level Effects

651. The potential population level effects of collision risk with operational tidal turbines on marine mammals have been assessed in **Appendix 12.3**.

652. The potential population effects have been assessed in a separate appendix as this will continue to be updated and developed as part of the mitigation and monitoring plan (**Document MOR/RHDHV/DOC/0072**).

12.6.4.6. Increased Collision Risk with Vessels

653. Although impacts will be less than during construction, as a worst-case scenario assessment has been based on assessment for construction in **Section 12.6.3.6**.

654. The potential for increased collision risk with vessels has been based on up to 16 vessels on site at any one time, with up to 16 vessel movements to and from the site per day. The maximum area of potential risk has been estimated based on construction vessels in indicative examples of the two largest potential deployment areas (3 km^2 and 3 km^2); plus, vessels in ECC area (4.75 km^2). In addition, increased collision risk has also been estimated based on the potential vessel route area to and from Holyhead Harbour, based on a precautionary 250m buffer either side of the vessels (**Table 12-86**).

Table 12-86 Estimated number of individuals (and % of reference population) that could be at increased collision risk with vessels at MDZ

Species	**Increased collision risk (5-10% of individuals in area at increased risk)**			
	Two indicative deployment areas and cable corridor (10.75 km^2) area.	**Vessel route to Holyhead Port (4.34 km^2)**	**Number of individuals (% of reference population) at potential increased risk in total area (15.09 km^2)**	**Magnitude**
Harbour porpoise	0.42-0.84 individuals (based on density estimate of 0.783/ km^2) (0.0004-0.008% of the 104,695 reference population).	0.17-0.34 individuals (based on density estimate of 0.783/ km^2) (0.0002-0.0003% of the 104,695 reference population).	0.59-1.18 individuals (0.0006-0.0011% of MU)	Potential permanent effect with negligible to low magnitude (0.01% or less of the reference population anticipated to be exposed to effect).
Bottlenose dolphin	0.011-0.022 individuals (based on density estimate of 0.02/ km^2)	0.0043-0.009 individuals (based on density estimate of 0.02/ km^2) (0.0011-0.0022% of the reference	0.015-0.031 individuals (0.0038-0.0076% of MU)	Potential permanent effect with low magnitude (between 0.001% and 0.01% of the

Species	Increased collision risk (5-10% of individuals in area at increased risk)			
	Two indicative deployment areas and cable corridor (10.75 km²) area.	**Vessel route to Holyhead Port (4.34 km²)**	**Number of individuals (% of reference population) at potential increased risk in total area (15.09 km²)**	**Magnitude**
	(0.003-0.0054% of the reference population of 397 bottlenose dolphin)	population of 397 bottlenose dolphin)		reference population anticipated to be exposed to effect).
Risso's dolphin	0.017-0.033 individuals (based on density estimate of 0.031/ km²) (0.0002-0.0004% of the reference population of 8,794 Risso's dolphin).	0.007-0.014 individuals (based on density estimate of 0.031/ km²) (0.0001-0.0002% of the reference population of 8,794 Risso's dolphin).	0.024-0.047 individuals (0.0003-0.0005% of MU)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
Common dolphin	0.12-0.24 individuals (based on density estimate of 0.22/ km²) (0.0002-0.0004% of the reference population of 56,556 common dolphin).	0.05-0.096 individuals (based on density estimate of 0.22/ km²) (0.0001-0.0002% of the reference population of 56,556 common dolphin).	0.17-0.336 individuals (0.0003-0.0006% of MU)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
Minke whale	0.009-0.02 individuals (based on density estimate of 0.017/ km²) (0.00004-0.0001% of the reference population of 23,528 minke whale).	0.004-0.007 individuals (based on density estimate of 0.017/ km²) (0.00002-0.00003% of the reference population of 23,528 minke whale).	0.013-0.027 individuals (0.0001-0.0001% of MU)	Potential permanent effect with negligible / very low magnitude (less than 0.001% of the reference population anticipated to be exposed to effect).
Grey seal	0.083-0.17 individuals (based on density estimate of 0.155/ km²) (0.0014-0.003% of the reference population of 6,000 grey seal).	0.034-0.067 individuals (based on density estimate of 0.155/ km²) (0.0006-0.0011% of the reference population of 6,000 grey seal).	0.117-0.237 individuals (0.0019%-0.0039% of MU)	Potential permanent effect with negligible to low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Harbour seal	0.0003-0.0005 individuals (based on density estimate of 0.0005/ km²) (0.0005-0.0011% of the reference	0.0001-0.0002 individuals (based on density estimate of 0.0005/ km²) (0.0002-0.0004% of the reference	0.0004-0.0007 individuals (0.0008-0.0015% of MU)	Potential permanent effect with negligible to low magnitude (0.01% or less of the reference population

Species	Increased collision risk (5-10% of individuals in area at increased risk)			
	Two indicative deployment areas and cable corridor (10.75 km^2) area.	**Vessel route to Holyhead Port (4.34 km^2)**	**Number of individuals (% of reference population) at potential increased risk in total area (15.09 km^2)**	**Magnitude**
	population of 50 harbour seal).	population of 50 harbour seal).		anticipated to be exposed to effect).

655. Taking into account the low sensitivity of all marine mammal species to increased collision risk with vessels and the potential magnitude of the effect (negligible or low for all species), the impact significance for any permanent impact on harbour porpoise, bottlenose dolphin, grey seal and harbour seal has been assessed as **minor (not significant)** and **negligible** for Risso's dolphin, common dolphin and minke whale (**Table 12-87**).

12.6.4.6.1. Mitigation

656. Where possible, all vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. No further mitigation is proposed.

12.6.4.6.2. Residual Impact

657. The residual impact would remain negligible or minor (not significant).

Table 12-87 Assessment of impact significance for increased collision risk with vessels at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Increased collision risk with vessels	Harbour porpoise	Low	Negligible to low	Negligible to minor (not significant)	No mitigation is required or proposed	Negligible to minor (not significant)
	Bottlenose dolphin		Low	Minor (not significant)		Minor (not significant)
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Negligible to low	Negligible to minor (not significant)		Negligible to minor (not significant)

12.6.4.7. Potential Overall Collision Risk for Operational Turbines and Vessels

658. As a precautionary approach the number of marine mammals (and percentage of the reference populations) has been assessed for the potential collision risk with operational turbines (**Section 12.6.4.5.2**) and possible increased collision risk with vessels (**Section 12.6.4.6**).

659. The assessment has been based on the worst-case scenario that there could be up to 16 vessels on site at the same time as the scenario for less than one bottlenose dolphin (**Table 12-88**). However, it is highly unlikely that 16 vessels would be on site during operation, also when vessels are on site during operation this is likely to be for maintenance and repowering activities, which would result in a number of devices to be non-operational during these activities.

Table 12-88 Estimated number of individuals (and % of reference population) that could be at increased collision risk with vessels and operational tidal devices at MDZ (based on scenarios for less than one bottlenose dolphin)

Species	**Number of individuals (% of reference population)**			**Magnitude**
	Increased collision risk with vessels (5-10% of individuals in total area; 15.09 km^2)	**Collision risk for one bottlenose dolphin scenario (ERM and CRM)**	**Total (maximum based on worst-case scenario)**	
Harbour porpoise	0.59-1.18 individuals (0.0006-0.0011% of MU)	20-23 individuals (0.02% of MU).	Up to 25 individuals (0.024%)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Bottlenose dolphin	0.015-0.031 individuals (0.0038-0.0076% of MU)	0.99 individuals (0.25% of MU)	Up to 1 individual (0.25% of MU)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Risso's dolphin	0.024-0.047 individuals (0.0003-0.0005% of MU)	1.4 individuals (0.02% of MU)	Up to 1.5 individuals (0.02% of MU)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).

Species	Number of individuals (% of reference population)			Magnitude
	Increased collision risk with vessels (5-10% of individuals in total area; 15.09 km^2)	**Collision risk for one bottlenose dolphin scenario (ERM and CRM)**	**Total (maximum based on worst-case scenario)**	
Common dolphin	0.17-0.336 individuals (0.0003-0.0006% of MU)	8 individuals (0.01% of MU)	Up to 9 individuals (0.02% of MU)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Minke whale	0.013-0.027 individuals (0.0001-0.0001% of MU)	2-3 individuals (0.01%)	Up to 3 individuals (0.01% of MU)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Grey seal	0.117-0.237 individuals (0.0019%-0.0039% of MU)	4-5 individuals (0.08% of MU)	Up to 5 individuals (0.08% of MU)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Harbour seal	0.0004-0.0007 individuals (0.0008-0.0015% of MU)	0.01 individuals (0.03% of MU)	Less than 1 individual (0.03% of MU)	Potential permanent effect with **medium** magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).

660. Taking into account the sensitivity and the potential magnitude of the effect the impact significance for any permanent impacts on harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal has been assessed as **minor (not significant)**, without mitigation (**Table 12-89**).

661. As outlined in **Section 12.6.4.5.5**, the potential population level effects of collision risk with operational tidal turbines on marine mammals have been assessed in **Appendix 12.2** (**Volume III**). The result of the PVA indicate that population trajectories of the baseline and collision risk scenarios of 1, 2 and 3 animals are very similar, with only a

potential for a decline when more than three adults per year are removed from the population of 397 bottlenose dolphins in the Irish Sea MU.

12.6.4.7.1. Mitigation

662. As outlined in **Section 12.6.2** and **12.6.4.5.3**.

12.6.4.7.2. Residual Impacts

663. With the effective and appropriate mitigation proposed any risk of collisions will be greatly reduced. As a precautionary approach the residual impacts have been assessed as minor (not significant) for all species.

Table 12-89 Assessment of impact significance for potential overall collision risk with vessels and operational turbines at MDZ (based on scenarios for less than one bottlenose dolphin)

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Maximum overall collision risk with vessels and operational turbines	Harbour porpoise	Low	Medium	Minor	Phased deployment, monitoring and mitigation	Minor (not significant)
	Bottlenose dolphin		Medium	Minor		Minor (not significant
	Risso's dolphin		Medium	Minor		Minor (not significant)
	Common dolphin		Medium	Minor		Minor (not significant)
	Minke whale		Medium	Minor		Minor (not significant)
	Grey seal		Medium	Minor		Minor (not significant)
	Harbour seal		Medium	Minor		Minor (not significant)

12.6.4.8. Potential Entanglement with Moorings

664. To date, there have been no recorded instances of marine mammal entanglement from mooring systems of renewable devices (Sparling *et al*., 2013; Isaacman and Daborn, 2011), or for anchored floating production, storage and offloading (FPSO) vessels in the oil and gas industry (Benjamins *et al*., 2014) with similar mooring lines.

665. The level of risk to become entangled varies with species (Benjamins *et al*., 2014), these factors include:

- Body size;
- Flexibility of movement;
- The ability to detect mooring lines and ropes; and
- The feeding ecology of the species.

666. Toothed whales have a lower risk than baleen whales, primarily due to their small size and manoeuvrability. Seal species have a similar risk level to small toothed cetaceans, with an increase in manoeuvrability.

667. Benjamins *et al*. (2014) provides a qualitative assessment of relative entanglement risk across different marine megafauna groups, taking into account both biological risk factors such as animal size, sensory capabilities and foraging methods, and physical risk factors such as mooring flexibility, pre-tension and footprint. **Table 12-90** summarises the results of this assessment.

Table 12-90 Relative risk assessment for marine mammals and mooring scenarios relevant to the Morlais site (based on biological and physical risk parameters; Benjamins *et al*., 2014)

Species	Catenary & chain	Taut & accessory buoy
Harbour porpoise	Low	Low
Bottlenose dolphin	Low	Low
Risso's dolphin	Low	Low
Common dolphin	Low	Low
Minke whale	High	High
Grey seal	Low	Low
Harbour seal	Low	Low

668. Taking into account that there have been no recorded instances of marine mammal entanglement from mooring systems of renewable devices or similar mooring lines, the sensitivity of marine mammals to potential entanglement at the MDZ is assessed to be low.

669. In addition, the tidal devices and moorings would be regular checked (approximately 15 times annually for both planned and unplanned maintenance activities), this would ensure that there was no material such as discarded nets, ropes or other debris which could increase the risk of entanglement for marine mammals or interfere with the optimal operation of the tidal devices.

670. As a precautionary approach, the potential magnitude of effect has been based on the on the relative risk assessment for marine mammals by Benjamins *et al*. (2014) for the mooring scenarios which most represent those likely to be used at MDZ (i.e. catenary & chain and taut & accessory buoy) (**Table 12-90**).

671. The impact significance for the possible entanglement with mooring lines disturbance has been assessed as minor for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, grey and harbour seal and minor to moderate for minke whale (**Table 12-91**).

12.6.4.8.1. Mitigation

672. The mitigation and monitoring measures to reduce the risk of collision with operational turbines would also reduce the risk of entablement with mooring lines.

12.6.4.8.2. Residual Impact

673. As a precautionary approach the residual impacts have been assessed as minor (not significant) for all species.

Table 12-91 Assessment of impact significance for possible entanglement of marine mammals with mooring lines at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Entanglement with mooring lines	Harbour porpoise	Low	Low	Minor	Phased deployment, monitoring and mitigation	Minor (not significant)
	Bottlenose dolphin		Low	Minor		Minor (not significant)
	Risso's dolphin		Low	Minor		Minor (not significant)
	Common dolphin		Low	Minor		Minor (not significant)
	Minke whale		Low to High	Minor to Moderate		Minor (not significant)
	Grey and harbour seal		Low	Minor		Minor (not significant)

12.6.4.9. Potential Electromagnetic Field (EMF) Effects

674. Potential pathways for effects from electromagnetic fields (EMF) would be from the presence of cables within the MDZ and ECC.

675. Normandeau *et al*. (2011) modelled expected magnetic fields using design characteristics taken from a range of undersea cable projects. For eight of the ten AC cables modelled it was found that the intensity of the magnetic field (B) was approximately a direct function of voltage (ranging from 33kV to 345kV) although separation between the cables and burial depth also influenced field strengths. Similarly, the modelling carried out for nine DC cables also found that the B field was a function of voltage (ranging from 75 to 500kV) and cable configuration. For both AC and DC cables, the predicted B fields were strongest directly over the cables and decreased rapidly with vertical and horizontal distance from the cables (**Table 12-92**).

Table 12-92 Averaged magnetic field strength values from AC and DC cables buried 1m (Normandeau *et al*., 2011)

Distance (m) below seabed	Magnetic Fields Strength (μT)					
	Horizontal distance (m) from cable					
	0m AC	0m DC	4m AC	4m DC	10m AC	10m DC
0	7.85	78.27	1.47	5.97	0.22	1.02
5	0.35	2.73	0.29	1.92	0.14	0.75
10	0.13	0.83	0.12	0.74	0.08	0.46

676. Although it is assumed that marine mammals are capable of detecting small differences in magnetic field strength, this is unproven and is based on circumstantial information. There is also, at present, no evidence to suggest that existing subsea cables have influenced cetacean or seal movements. For example, harbour porpoise move in and out of the Baltic Sea with several crossings over operating subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration pattern. There is no evidence that pinnipeds respond to electromagnetic fields (Gill *et al*., 2005).

677. In addition, data from operational windfarms show no evidence of exclusion of marine mammals, such as harbour porpoise or seals (for example, Diederichs *et al*., 2008; Lindeboom *et al*., 2011; Marine Scotland, 2012; McConnell *et al*., 2012; Russell *et al*., 2014; Scheidat *et al*., 2011; Teilmann *et al*., 2006; Tougaard *et al*., 2005, 2009a, 2009b).

678. Therefore, harbour porpoise, bottlenose dolphin, Risso’s dolphin, common dolphin, minke whale, grey and harbour seal have been assessed as having negligible sensitivity to any potential EMF effects.

679. The number of harbour porpoise, bottlenose dolphin, Risso’s dolphin, common dolphin, minke whale, grey seal and harbour seal that could be affected by any potential EMF effects have been assessed based on the cable area (0.042 km^2; **Table 12-25**) in the MDZ and ECC (**Table 12-93**).

Table 12-93 Number of individuals (and % of reference population) that could be affected by any potential EMF effects

Species	Maximum number of individuals and (% of reference population)	Magnitude
Harbour porpoise	0.03 individuals (based on density estimate of 0.783/ km^2) (0.00003% of the 104,695 reference population).	Long-term effect with negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Bottlenose dolphin	0.001 individuals (based on density estimate of 0.02/ km^2) (0.0002% of the reference population of 397 bottlenose dolphin).	Long-term effect with negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Risso’s dolphin	0.001 individuals (based on density estimate of 0.031/ km^2) (0.00001% of the reference population of 8,794 Risso’s dolphin).	Long-term effect with negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Common dolphin	0.01 individuals (based on density estimate of 0.22/ km^2) (0.00002% of the reference population of 56,556 common dolphin).	Long-term effect with negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Minke whale	0.001 individuals (based on density estimate of 0.017/ km^2) (0.000003% of the reference population of 23,528 minke whale).	Long-term effect with negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Grey seal	0.01 individuals (based on density estimate of 0.155/ km^2)	Long-term effect with negligible magnitude (less than 0.01% of the

Species	Maximum number of individuals and (% of reference population)	Magnitude
	(0.0001% of the reference population of 6,000 grey seal).	reference population anticipated to be exposed to effect).
Harbour seal	0.00002 individuals (based on density estimate of 0.0005/ km^2) (0.00004% of the reference population of 50 harbour seal).	Long-term effect with negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).

680. The magnitude of the potential for any EMF effects is assessed as **negligible** for all species, with less than 0.01% of all relevant reference populations anticipated to be exposed to the long-term effect (**Table 12-35**).

681. Taking into account the negligible sensitivity of all marine mammal species and the potential negligible magnitude of the effect, the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any long-term effects over the duration of the Project has been assessed as **negligible** (**Table 12-94**).

12.6.4.9.1. Mitigation

682. No mitigation measures are required or proposed.

12.6.4.9.2. Residual Impact

683. The residual impact would remain negligible.

Table 12-94 Assessment of impact significance for possible EMF on marine mammals

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
EMF effects	Harbour porpoise	Negligible	Negligible	Negligible	No mitigation required.	Negligible
	Bottlenose dolphin		Negligible	Negligible		Negligible
	Risso's dolphin		Negligible	Negligible		Negligible
	Common dolphin		Negligible	Negligible		Negligible
	Minke whale		Negligible	Negligible		Negligible
	Grey and harbour seal		Negligible	Negligible		Negligible

12.6.4.10. Potential Barrier Effects

684. The physical presence of the tidal array could have the potential to create a physical barrier, preventing movement or migration of marine mammals between important

feeding and / or breeding areas, or potentially increasing swimming distances if marine mammals avoid the site and go around it.

685. As outlined in **Chapter 4, Project Description**, the final array layout will be identified post consent, following the berth selection and allocation process. The final detailed device locations will be developed based on further site investigation works conducted post-consent to determine detailed construction constraints. However, the assessment has been based on indicative spacings and potential area of the tidal arrays.

686. Seabed mounted devices may have a spacing of 70m to 150m between centres of devices perpendicular to the flow and 180m to 250m parallel to the flow. Such spacings may need to be modified to allow for seabed conditions, and this could alter spacings considerably, resulting in larger spacings.

687. Floating tidal devices sharing moorings may require up to 150m between structure centres perpendicular to the flow and 250m parallel to the flow.

688. Each device could move by up to 80m (±40m) in the direction parallel to the flow and 60m (±30m) in the direction perpendicular to the flow. Therefore, the overall surface area covered by device movement (including device yawing) is up to 4,800m^2 for a single floating device.

689. This equates to a maximum area taken up by all arrays, including spaces between devices (i.e. not the seabed footprint) of up to 12.5 km^2 for the full 240MW capacity project (**Table 12-25**).

690. As illustrated by the three indicative layouts (each totalling 240MW), each with a different combination of device arrays (sub-categories) in different locations, as outlined in **Chapter 4, Project Description**, there would be space between the different deployment areas and the rows of tidal arrays in each deployment areas.

691. The number of harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal that could be at risk of potential barrier effects has been based on the maximum area of 12.5 km^2 (**Table 12-95**).

692. As for underwater noise, the sensitivity of marine mammals to any disturbance or displacement has been assessed as low.

693. The magnitude of the potential impact is assessed as low or negligible with less than 0.01% or 1% of all relevant reference populations anticipated to be exposed to the long-term effect (**Table 12-95**).

Table 12-95 Number of individuals (and % of reference population) that could be impacted by any potential barrier effects from the physical presence of the tidal arrays

Species	Maximum number of individuals and (% of reference population)	Magnitude
Harbour porpoise	Up to 10 individuals (based on density estimate of 0.783/ km^2) (0.01% of the 104,695 reference population).	Long-term effect with low magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Bottlenose dolphin	0.25 individuals (based on density estimate of 0.02/ km^2) (0.063% of the reference population of 397 bottlenose dolphin).	Long-term effect with low magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Risso's dolphin	0.4 individuals (based on density estimate of 0.031/ km^2) (0.005% of the reference population of 8,794 Risso's dolphin).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Common dolphin	Up to 3 individuals (based on density estimate of 0.22/ km^2) (0.005% of the reference population of 56,556 common dolphin).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Minke whale	0.2 individuals (based on density estimate of 0.017/ km^2) (0.0009% of the reference population of 23,528 minke whale).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Grey seal	Up to 2 individuals (based on density estimate of 0.155/ km^2) (0.03% of the reference population of 6,000 grey seal).	Long-term effect with low magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Harbour seal	0.006 individuals (based on density estimate of 0.0005/ km^2) (0.012% of the reference population of 50 harbour seal).	Long-term effect with low magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).

694. There is unlikely to be any potential barrier effects that could significantly affect the movements of marine mammals in or through the MDZ and ECC area. The maximum area for disturbance and any displacement from any barrier effects is relatively small in relation to the marine mammal MUs.

695. The potential for displacement is also unlikely to result in any significant increase in energy expenditure that could be required by harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal to avoid the area.

696. Taking into account the low sensitivity to any disturbance or displacement (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of effect, the impact significance (based on the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any potential barrier effects for harbour porpoise, bottlenose dolphin, grey seal and harbour seal has been assessed as minor and for Risso's dolphin, common dolphin and minke whale as negligible (**Table 12-96**).

12.6.4.10.1. Mitigation

697. The proposed phased development and monitoring measures to reduce the risk of collision with operational turbines would also allow the potential for any displacement effects, e.g. changes in use of the site or movements in and around the site, to be assessed, and if required, be taken into account for the installation of subsequent arrays.

12.6.4.10.2. Residual Impact

698. As a precautionary approach the residual impact would remain negligible or minor (not significant).

Table 12-96 Assessment of impact significance for any disturbance and displacement for any barrier effects at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Barrier effects	Harbour porpoise	Low	Low	Minor	None required or proposed	Minor (not significant)
	Bottlenose dolphin		Low	Minor		Minor (not significant)
	Risso's dolphin		Negligible / very low	Negligible		Negligible
	Common dolphin		Negligible / very low	Negligible		Negligible
	Minke whale		Negligible / very low	Negligible		Negligible
	Grey and harbour seal		Low	Minor		Minor (not significant)

12.6.4.11. Potential Changes in Water Quality

699. During the operational phase of the project there is a potential risk to water quality via accidental spillage or release of materials such as grease and oils during maintenance work, from vessels or during any major cable repair works and/or repowering activities.

700. As outlined for construction, Menter Môn is committed to the use of best practice and pollution prevention guidelines at all times. An MPCP would be in place and agreed with NRW in line with the IPPC Directive such that any potential risk is minimised. Any permitted discharges would be small volumes, intermittent and dilute and disperse quickly.

701. As for the construction phase, if any such substances were accidentally released/leaked, quantities would likely be small due to relatively small amounts being present in individual devices. Due to the dynamic nature of the tidal and wave regime in and around the MDZ, lateral and vertical dispersion rates of any spilled substances would be expected to be high. For the assessment in **Chapter 8, Marine Water and**

Sediment Quality, the magnitude of this potential effect was considered to be low, as it is not anticipated to significantly affect local water quality and would also be temporary in nature (established controls would prevent further spillage/leakage once an event was detected. Therefore, any changes to water quality was assessed as a minor adverse impact.

702. During the operational phase of the project repowering of devices will occur. As a worst-case scenario, it has been assumed that up to 50 % of all devices will be replaced (repowered) over the lifetime of the project. In addition, it has been assumed that there would be up to 10 cable repair events, totalling up to 7,500m of cable disturbance.

703. These activities will create similar effects as previously assessed for the construction phase. The potential removal and re-installation of seabed mounted devices and/or seabed anchor systems for floating devices coupled with potential cable de-burial and re-burial in sedimentary areas will all result in creation of localised sediment plumes and subsequent deposition. The magnitude of this effect will be less than for the main construction phase due to a lower amount of seabed disturbance via these operational phase activities. Therefore, for assessment in **Chapter 8, Marine Water and Sediment Quality**, the magnitude was assessed as negligible, resulting in a negligible impact.

704. As outlined in **Chapter 8, Marine Water and Sediment Quality**, placing any structure on the seabed has the potential to result in scour around the structure, leading in turn to mobilisation of any available sediment in the area around the structure via plumes.

705. In areas of the MDZ where the sea bed is comprised of bare bedrock or where this is covered with boulders, cobbles or gravels there is unlikely to be any scouring effects, therefore there will be no change in suspended sediment concentrations. Where devices are placed in areas of the MDZ characterised by sands (e.g. southwest section and in the vicinity of the sand ridge in the north) there is potential for locally accelerated flows around foundations to increase suspended sediment concentrations, but since flows in these areas are very high in the baseline conditions, this will unlikely to result in any significant change from the current conditions. Therefore, given the nature of the sea bed morphology, comprised mostly of exposed bedrock, the potential for adverse effects of this nature is extremely limited.

706. For the majority of the site, where sediment cover is absent/limited, **Chapter 8, Marine Water and Sediment Quality** assessed the magnitude of this effect to be negligible, with a negligible impact.

707. In areas where there is some sediment cover and, thus where scour may occur, the magnitude of effect was assessed to be low, resulting in a minor adverse impact.

708. As for construction, taking into account the negligible sensitivity of all marine mammal species to any changes in water quality and the potential magnitude of the effect (negligible or low), the impact significance for any temporary impact on harbour

porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale grey seal and harbour seal has been assessed as negligible (**Table 12-97**).

12.6.4.11.1. Mitigation

709. As outlined for construction and in **Chapter 8, Marine Water and Sediment Quality**, mitigation would include adherence to project-specific Environmental Management Plans (EMPs) and Marine Pollution Contingency Plans (MPCP). No further mitigation for marine mammals in proposed.

12.6.4.11.2. Residual Impact

710. The residual impact would remain negligible.

Table 12-97 Assessment of impact significance for any changes in water quality during operation

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Change in water quality due to sediment plumes generated by repowering and/or cable repair works	Harbour porpoise	Negligible	Negligible	Negligible	EMP and MPCP	Negligible
	Bottlenose dolphin		Negligible	Negligible		Negligible
	Risso's dolphin		Negligible	Negligible		Negligible
	Common dolphin		Negligible	Negligible		Negligible
	Minke whale		Negligible	Negligible		Negligible
	Grey and harbour seal		Negligible	Negligible		Negligible
Change in water quality due to sediment plumes produced via scour around seabed mounted project infrastructure	Harbour porpoise	Negligible	Negligible to Low	Negligible		Negligible
	Bottlenose dolphin		Negligible to Low	Negligible		Negligible
	Risso's dolphin		Negligible to Low	Negligible		Negligible
	Common dolphin		Negligible to Low	Negligible		Negligible
	Minke whale		Negligible to Low	Negligible		Negligible
	Grey and harbour seal		Negligible to Low	Negligible		Negligible
Change in water quality due to accidental	Harbour porpoise	Negligible	Low	Negligible		Negligible
	Bottlenose dolphin		Low	Negligible		Negligible

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
spillages/leaks from operational devices	Risso's dolphin		Low	Negligible		Negligible
	Common dolphin		Low	Negligible		Negligible
	Minke whale		Low	Negligible		Negligible
	Grey and harbour seal		Low	Negligible		Negligible

12.6.4.12. Potential Changes in Prey Availability

711. In **Chapter 10, Fish and Shellfish Ecology**, the potential impacts assessed for the operational and maintenance phase were

- Underwater Noise;
- Long-term habitat loss via placement of project infrastructure (project footprint);
- Barrier Effects;
- Collision Risk;
- Electromagnetic Fields; and
- Repowering.

12.6.4.12.1. Prey Impacts from Underwater Noise of Operational Turbines

712. The underwater noise assessment in **Chapter 10, Fish and Shellfish Ecology** was based on the modelling conducted for operational noise for the PTEC project, for 24m rotor (worst case scenario for the PTEC project). The largest range at which a behavioural reaction was predicted (i.e. levels of 75 dB_{ht} are reached) was 36m, for cod species. The largest range at which a startle response was predicted (i.e. levels of 90 dB_{ht} are reached) was 3m, also for cod.

713. These ranges are less than those predicted for marine mammal species (**Table 12-64**), therefore there will be no further impact on marine mammals as a result of any changes in prey availability due to underwater noise from operational turbines, as marine mammals will be displaced from the area that any changes in prey distribution could occur.

12.6.4.12.2. Prey Impacts from Permanent Habitat Loss

714. As outlined in **Chapter 10 Fish and Shellfish Ecology** and in **Table 12-25**, the worst-case scenario for permanent habitat loss would be up to 2.18 km^2, based on area for Gravity Base Structures (GBS) (74,790m^2), swept area of catenary cables (2,055,000m^2), export cable footprint (cables and protection systems; 11,745m^2), array

cable footprint (cables and protection systems; 30,040m^2), additional cable protection material (4,860m^2), cable tails (120m^2), trench for 9 x landfall cables (7,400m^2), footprint of navigation marker buoys (540m^2), footprint of Acoustic Doppler Current Profiler (ADCP) moorings (280m^2), footprint of seabed mounted environmental monitoring units (112m^2) and footprint of mooring for floating environmental monitoring units (45m^2).

715. The magnitude of the potential displacement due to changes in prey availability as a result of permanent habitat loss is assessed as **negligible / very low** for all species, with less than 1% of all relevant reference populations anticipated to be exposed to the effect (**Table 12-98**).

Table 12-98 Number of individuals (and % of reference population) that could be impacted by any changes of prey availability as a result of permanent habitat loss at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)	Magnitude
Displacement of harbour porpoise due to changes in prey availability	1.71 individuals (based on density estimate of 0.783/ km^2) (0.0016% of the 104,695 reference population).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Displacement of bottlenose dolphin due to changes in prey availability	0.04 individuals (based on density estimate of 0.02/ km^2) (0.011% of the reference population of 397 bottlenose dolphin).	Long-term effect low magnitude (between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Displacement of Risso's dolphin due to changes in prey availability	0.07 individuals (based on density estimate of 0.031/ km^2) (0.0008% of the reference population of 8,794 Risso's dolphin).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Displacement of common dolphin due to changes in prey availability	0.48 individuals (based on density estimate of 0.22/ km^2) (0.00085% of the reference population of 56,556 common dolphin).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Displacement of minke whale due to changes in prey availability	0.04 individuals (based on density estimate of 0.017/ km^2) (0.0016% of the reference population of 23,528 minke whale).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Displacement of grey seal due to changes in prey availability	0.34 individuals (based on density estimate of 0.155/ km^2) (0.006% of the reference population of 6,000 grey seal).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Displacement of harbour seal due to changes in prey availability	0.001 individuals (based on density estimate of 0.0005/ km^2) (0.002% of the reference population of 50 harbour seal).	Long-term effect with negligible / very low magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).

716. The assessment in **Chapter 10, Fish and Shellfish Ecology**, determined that the potential impacts of permanent habitat loss on prey species would result in a low magnitude of the effect, coupled with the medium sensitivity of the receptors, the

impact significance was assessed as minor adverse. No mitigation measures were considered to be required.

12.6.4.12.3. Prey Impacts from Barrier Effects

717. Barrier effects to the movements of fish and shellfish through the water column can arise during the Project due to the presence of tidal devices and associated infrastructure, including mooring chains and catenaries. The worst-case scenario (arising during full site deployment) assessed in **Chapter 10, Fish and Shellfish Ecology** was for the swept area of TEC's of 84,500m^2 based on seabed-mounted multiple rotor platform device types with rotors up to 27m in diameter. However, the assessment found it unlikely to present a complete barrier to fish due to the separation distance (70m distance in the shortest dimension).

718. The assessment in **Chapter 10, Fish and Shellfish Ecology**, determined that the potential impacts of any barrier effects on prey species would result in a medium magnitude of the effect and coupled with the low sensitivity of the receptor there is a minor adverse impact. No mitigation measures were considered to be required.

719. For marine mammals, the potential magnitude for any changes in prey availability is considered to be low, taking into marine sensitivity to changes in prey availability, the impact significance has been assessed as minor (not significant) for all species (**Table 12-99**).

12.6.4.12.4. Prey Impacts from Collision Risk

720. Collision risks can arise from fish coming into contact with the operational tidal devices. The area within which collision risk could occur is equivalent to the maximum swept area (84,500m^2).

721. As outlined in **Chapter 10, Fish and Shellfish Ecology**, it can be assumed that if fatal collisions do occur, it is likely to only be to a small proportion of individuals and not result in a population level effect. The loss of individuals, in the context of the total loss of individuals for a population, are considered to be within the natural levels of mortality due to other factors, therefore the magnitude of the effect at a population was considered to be very low/negligible.

722. Therefore, the combination of a low sensitivity and a very low/negligible magnitude results in a negligible impact significance. However, due to the uncertainty over this assessment, the impact significance was augmented to minor adverse as a precautionary measure.

723. For marine mammals, the potential magnitude for any changes in prey availability is considered to be low, taking into marine sensitivity to changes in prey availability, the impact significance has been assessed as minor (not significant) for all marine mammal species (**Table 12-99**).

12.6.4.12.5. Prey Impacts from Electromagnetic Fields

724. The potential impact of EMF on prey would be the same as those assessed for marine mammals in **Section 12.6.4.9**.

725. The assessment in **Chapter 10, Fish and Shellfish Ecology**, has determined that the potential impacts of any EMF effects on prey species would result in a low magnitude of the effect and coupled with the low sensitivity of the receptor there is a minor adverse impact. No mitigation measures were considered to be required, other than the proposed cable protection.

726. For marine mammals, the potential magnitude for any changes in prey availability is considered to be low, taking into marine sensitivity to changes in prey availability, the impact significance has been assessed as minor (not significant) for all marine mammal species (**Table 12-99**).

12.6.4.12.6. Prey Impacts from Repowering

727. The potential impacts would be the same or less than those assessed for construction in **Sections 12.6.3.8.1**, **12.6.3.8.2** and **12.6.3.8.3**.

728. For marine mammals, the potential magnitude for any changes in prey availability is considered to be negligible / very low, taking into marine sensitivity to changes in prey availability, the impact significance has been assessed as negligible to minor (not significant) for marine mammal species (**Table 12-99**).

12.6.4.12.7. Mitigation

729. No mitigation measures are required or proposed.

12.6.4.12.8. Residual Impact

730. The residual impact would remain negligible or minor (not significant), as detailed in Table 12.99, below.

Table 12-99 Assessment of impact significance for any displacement as a result of any changes to prey availability during operation at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Displacement due to underwater noise impact on prey species	Harbour porpoise	Low to medium	Negligible / very low	Negligible to Minor (not significant)	None required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Negligible / very low	Negligible		Negligible
	Risso's dolphin	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
	Common dolphin	Low	Negligible / very low	Negligible		Negligible
	Minke whale	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Negligible / very low	Negligible		Negligible
Displacement due to permanent habitat loss impact on prey species	Harbour porpoise	Low to medium	Negligible / very low	Negligible to Minor (not significant)	None required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Low	Minor (not significant)		Negligible
	Risso's dolphin	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Negligible / very low	Negligible		Negligible
	Minke whale	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Negligible / very low	Negligible		Negligible
Displacement due to changes in prey availability from barrier effects	Harbour porpoise	Low to medium	Low	Minor (not significant)	None required or proposed	Minor (not significant)
	Bottlenose dolphin	Low	Low	Minor (not significant)		Minor (not significant)
	Risso's dolphin	Medium	Low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Low	Minor (not significant)		Minor (not significant)
	Minke whale	Medium	Low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Low	Minor (not significant)		Minor (not significant)
Displacement due to changes in prey availability from collision risk	Harbour porpoise	Low to medium	Low	Minor (not significant)	None required or proposed	Minor (not significant)
	Bottlenose dolphin	Low	Low	Minor (not significant)		Minor (not significant)
	Risso's dolphin	Medium	Low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Low	Minor (not significant)		Minor (not significant)
	Minke whale	Medium	Low	Minor (not significant)		Minor (not significant)

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
	Grey and harbour seal	Low	Low	Minor (not significant)		Minor (not significant)
Displacement due to changes in prey availability from EMF	Harbour porpoise	Low to medium	Low	Minor (not significant)	None required or proposed	Minor (not significant)
	Bottlenose dolphin	Low	Low	Minor (not significant)		Minor (not significant)
	Risso's dolphin	Medium	Low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Low	Minor (not significant)		Minor (not significant)
	Minke whale	Medium	Low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Low	Minor (not significant)		Minor (not significant)
Displacement due changers in prey availability from repowering	Harbour porpoise	Low to medium	Negligible / very low	Negligible to Minor (not significant)	None required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Negligible / very low	Negligible		Negligible
	Risso's dolphin	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Common dolphin	Low	Negligible / very low	Negligible		Negligible
	Minke whale	Medium	Negligible / very low	Minor (not significant)		Minor (not significant)
	Grey and harbour seal	Low	Negligible / very low	Negligible		Negligible

12.6.4.13. Overall Potential Disturbance During Operation

731. The overall maximum area of possible disturbance during ADD activation in-combination with the underwater noise from the operational turbines would be the same area as assessed for ADDs, for example, up to 31.4 km^2 if ten ADDs were activated at the same time (**Table 12-73**), as the area of disturbance would be greater than the area of potential disturbance for underwater noise from operational turbines for the full deployment of up to 11.7 km^2 for harbour porpoise, 0.28 km^2 for dolphin species, 5 km^2 for minke whale and 0.18 km^2 for seals (**Table 12-66**).

732. As a precautionary approach the maximum area of potential disturbance has been assessed for underwater water noise from operational turbines for the full deployment (240MW; **Table 12-66**) at the same time as underwater water noise from any maintenance, repowering and vessels, based on the worst-case scenarios and

maximum potential impact ranges for two drilling activities, two cable laying activities, two cable protection activities and up to 16 vessels (**Table 12-53**). However, during maintenance and repowering activities it is likely that a number of devices or array(s) would be none operational.

733. The magnitude of the long-term effect for the overall potential disturbance is assessed as low for harbour porpoise and very low / negligible for all other species (**Table 12-100**).

Table 12-100 Maximum number of individuals (and % of reference population) that could be disturbed as a result of underwater from maintenance, repowering, vessels and operational tidal devices at MDZ

Potential Impact	Maximum number of individuals and (% of reference population)			Magnitude
	Maintenance, repowering and vessels	Full deployment* (possible strong avoidance ($90dB_{ht}$))	Total (maximum based on worst-case scenario)	
Disturbance of harbour porpoise	6.2 individuals in 7.89 km^2 (based on density estimate of 0.783/ km^2) (0.006% of the 104,695 reference population).	9.2 individuals in 11.7 km^2 (0.009% of MU)	15.4 individuals in 19.59 km^2 (0.015% of MU)	Long term effect with low magnitude (with between 0.01% and 1% of the reference population anticipated to be exposed to effect).
Disturbance of bottlenose dolphin	0.002 individuals in 0.12 km^2 (based on density estimate of 0.02/ km^2) (0.0006% of the reference population of 397 bottlenose dolphin).	0.006 individuals in 0.28 km^2 (0.0015% for MU)	0.008 individuals in 0.4 km^2 (0.002% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of Risso's dolphin	0.004 individuals in 0.12 km^2 (based on density estimate of 0.031/ km^2) (0.00004% of the reference population of 8,794 Risso's dolphin).	0.009 individuals in 0.28 km^2 (0.0001% for MU)	0.013 individuals in 0.4 km^2 (0.00015% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).

Potential Impact	Maximum number of individuals and (% of reference population)			Magnitude
	Maintenance, repowering and vessels	Full deployment* (possible strong avoidance ($90dB_{ht}$))	Total (maximum based on worst-case scenario)	
Disturbance of common dolphin	0.03 individuals in 0.12 km² (based on density estimate of 0.22/ km²) (0.00005% of the reference population of 56,556 common dolphin).	0.06 individuals in 0.28 km² (0.0001% for MU)	0.09 individuals in 0.4 km² (0.00016% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of minke whale	0.45 individuals in 26.35 km² (based on density estimate of 0.017/ km²) (0.0019% of the reference population of 23,528 minke whale).	0.0085 individuals in 5 km² (0.0004% for MU)	0.9 individuals in 31.35 km² (0.004% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of grey seal	0.08 individuals in 0.52 km² (based on density estimate of 0.155/ km²) (0.001% of the reference population of 6,000 grey seal).	0.03 individuals in 0.18 km² (0.0005% for MU)	0.11 individuals in 0.7 km² (0.0018% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).
Disturbance of harbour seal	0.0003 individuals in 0.52 km² (based on density estimate of 0.0005/ km²) (0.0005% of the reference population of 50 harbour seal).	0.00009 individuals in 0.18 km² (0.00018% for MU)	0.00039 individuals in 0.7 km² (0.0008% of MU)	Long-term effect with very low / negligible magnitude (less than 0.01% of the reference population anticipated to be exposed to effect).

734. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact; **Table 12-6**) and the potential magnitude of the effect, the impact significance (based in the impact significance matrix (**Table 12-9**) and as defined in **Table 12-10**) for any possible long-term disturbance in harbour porpoise has been assessed as **minor (not significant)** and **negligible** for bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal (**Table 12-101**).

Table 12-101 Assessment of impact significance for long-term disturbance of marine mammals from underwater noise from maintenance, repowering, vessels and operational tidal devices at MDZ

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance from maintenance, repowering, vessels and operational tidal devices	Harbour porpoise	Low	Low	Minor	No mitigation required or proposed.	Minor (not significant)
	Bottlenose dolphin		Very low / negligible	Negligible		Negligible
	Risso's dolphin		Very low / negligible	Negligible		Negligible
	Common dolphin		Very low / negligible	Negligible		Negligible
	Minke whale		Very low / negligible	Negligible		Negligible
	Grey and harbour seal		Very low / negligible	Negligible		Negligible

12.6.4.13.1. Mitigation

735. No mitigation measures are required or proposed.

12.6.4.13.2. Residual Impact

736. The residual impact would remain minor (not significant) for harbour porpoise and negligible for all other species for the potential overall disturbance from maintenance, repowering, vessels and operational turbines.

12.6.5. Assessment of Potential Impacts During Decommissioning

12.6.5.1. Underwater Noise and Disturbance

737. Decommissioning would most likely involve the removal of the accessible installed components comprising: all of the tidal device components; part of the foundations (those above seabed level); and the sections of the array cables close to the offshore structures, as well as sections of the export cables. The process for removal of foundations is generally the reverse of the installation process. There would be no drilling, but foundations may be cut to an appropriate level.

738. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of drilling noise which would not occur).

739. For this assessment it is assumed that the potential impacts from underwater noise during decommissioning would be comparable or less than those assessed for drilling (**Section 12.6.3.1**), other construction activities (**Section 12.6.3.2**), vessels (**Section 12.6.3.3**) and potential barrier effects (**Section 12.6.3.4**).

12.6.5.2. Disturbance at Seal Haul-Out Sites

740. For this assessment, it is assumed that the potential impacts from any disturbance at seal haul-out sites during decommissioning would be comparable or less than those assessed for construction (**Section 12.6.3.5**).

12.6.5.3. Possible Increased Collision Risk with Vessels

741. For this assessment, it is assumed that the potential impacts from possible increased collision risk with vessels during decommissioning would be comparable or less than those assessed for construction (**Section 12.6.3.6**).

12.6.5.4. Potential Changes in Water Quality

742. For this assessment, it is assumed that the potential impacts from any changes in water quality during decommissioning would be comparable or less than those assessed for construction (**Section 12.6.3.7**).

12.6.5.5. Potential Changes in Prey Availability

743. For this assessment, it is assumed that the potential impacts from potential changes in prey availability during decommissioning would be comparable or less than those assessed for construction (**Section 12.6.3.8**).

12.6.5.6. Mitigation

744. It is proposed the MMMPs would be prepared for decommissioning activities that could have potential underwater noise impacts, such as the removal of tidal devices and cables. These MMMPs would be similar to those proposed in **Sections 12.6.3.1.2.1.1** and **12.6.3.2.2.1.1**.

745. To reduce any potential impacts from changes in water quality, mitigation would include adherence to project-specific EMPs and MPCPs.

12.6.5.7. Residual Impacts

746. The residual impact would be the same as for construction, negligible or minor adverse.

12.6.6. Assessment of Potential Cumulative Impacts

12.6.6.1. Screening for Cumulative Impacts

747. The potential effects from the Project that were screened in for assessment for the project alone were further screened for the potential for cumulative effects with other projects. This process is detailed in **Table 12-102**.

Table 12-102 Cumulative Impact Assessment screening for marine mammals

Impact	Potential for Cumulative Impact	Confidence of Prediction	Justification
Underwater noise and disturbance	Yes	High	There is the potential for cumulative impacts from underwater noise, such as construction activities and vessels from other projects which could have a cumulative impact on marine mammals. A number of projects have been identified that have the potential for cumulative impacts and therefore a more detailed assessment will be carried out for construction, operation and decommissioning impacts of other projects. There is no potential for cumulative impacts for auditory injury as MMMPs for each project will reduce the risk of PTS and therefore any potential cumulative impacts.
Potential barrier effects	No	High	It has been identified that there is no potential for cumulative barrier impacts with other projects, based on the location and distances of the projects.
Disturbance at seal haul-out sites	No	High	No projects have been identified that have the potential for cumulative impacts on the seal haul-out site near the MDZ and ECC.
Increased collision risk with vessels	Yes	High	There is the potential for an increased risk of collision with vessels from a number of different projects, and therefore a more detailed assessment will be carried out for construction, operation and decommissioning impacts of other projects.
Potential changes in water quality	No	High	There is no potential for any changes to water quality to impact on marine mammal species in and around the MDZ and ECC, therefore there is no potential for cumulative impacts with other projects.
Potential changes in prey availability from habitat loss	Yes	High	There is the potential for changes to prey availability to impact on marine mammal species from a number of other projects, therefore a more detailed assessment will be carried out for construction, operation and decommissioning impacts of other projects.
Collision risk with tidal devices	Yes	High	It has been identified that there is the potential for collision risk from tidal devices from at least one other project, and therefore a more detailed assessment will be carried out for the operational impacts of other projects.
Potential entanglement with moorings for floating devices	Yes	High	It has been identified that there is the potential for entanglement from the mooring of floating devices from at least one other project, and therefore a more detailed

Impact	Potential for Cumulative Impact	Confidence of Prediction	Justification
			assessment will be carried out for the operational impacts of other projects.
Potential EMF impacts	No	High	It has been identified that there is no potential for EMF impacts to marine mammal species.

748. A number of cumulative impacts have been identified to have the potential to impact on marine mammal species as identified within **Table 12-102**, and are assessed further in the following sections.

12.6.6.2. Projects Considered for Cumulative Impacts

749. The classes of projects that were considered for the cumulative assessment of marine mammals include offshore wind farms, other marine renewable energy projects, marine aggregate extraction, any oil and gas exploration and extraction, port and harbour projects, subsea cables and pipelines. Only those projects that have had their application submitted or approved, are currently being constructed or are in their operational phases have been considered. Some additional projects have been included if there is enough information available prior to their submission. For projects that are operational, only those potential impacts from operational, maintenance and decommissioning activities are considered.

750. The identification of projects included in the cumulative assessment has been based on approved plans, constructed projects, approved but as yet unconstructed projects, projects for which an application has been made, are currently under consideration and may be consented. In addition, other '"foreseeable" projects are included: those for which an application has not been made but have been the subject of consultation by the developer, or those are listed in plans that have clear delivery mechanisms. For such projects, the absence of robust or relevant data could preclude a quantitative cumulative assessment being carried out.

751. Any projects which have been ongoing since the collection of baseline data (e.g. Holyhead Harbour Maintenance Dredging) are considered part of the baseline.

752. The projects identified have only been assessed for those species that are within the identified Management Unit that is included in the assessments. An indication has been made as to which marine mammal species each Project with the potential for cumulative impact has been included for.

753. A summary of projects considered for CIA and their potential for cumulative impacts is presented in **Table 12-103**.

Table 12-103 Summary of projects considered in CIA and potential for cumulative impacts

Project	Status	Species MU area	Distance from Nearest Part of Project (km)	Potential for Cumulative Impacts							
				Underwater noise and disturbance	Collision risk from vessels	Collision risk from tidal devices	Changes in water quality	Changes to prey availability	Potential for entanglement with moored devices	Potential for EMF impacts	Potential for barrier effects
Holyhead Deep Phase I	In April 2017, a Marine Licence was granted for the first 0.5 MW installation.	All	2	Yes	Yes	Yes	No	No	No	No	No
Holyhead Deep Tidal Array	In 2017, scoping report submitted for an 80MW extension to the Holyhead Deep tidal array.	All	2	Yes	Yes	Yes	No	Yes	No	No	No
Holyhead Port Expansion	ES currently being prepared	All	2	Yes	Yes	N/A	No	Yes	No	No	No
Holyhead Waterfront Regeneration	Awarded Outline Planning Permission in 2014, with Reserved Matters.	All	2	Yes	Yes	N/A	No	No	No	No	No
Wylfa Nuclear Power Plant	Project Suspended	All	17	Yes	Yes	N/A	No	Yes	No	No	No
Wylfa Decommissioning	Ongoing (most work on land)	All	17	Yes	Yes	N/A	No	Yes	No	No	No
Amlwch LNG	The existing consent was renewed in 2013, but future plans are unclear and timescales undefined.	All	20.5	Yes	Yes	N/A	No	No	No	No	No

Project	Status	Species MU area	Distance from Nearest Part of Project (km)	Potential for Cumulative Impacts							
				Underwater noise and disturbance	Collision risk from vessels	Collision risk from tidal devices	Changes in water quality	Changes to prey availability	Potential for entanglement with moored devices	Potential for EMF impacts	Potential for barrier effects
North Hoyle Offshore Wind Farm	Operation and Maintenance Activities only.	All	81	Yes	No	N/A	No	No	N/A	No	No
Rhyl Flats Offshore Windfarm	Operation and Maintenance Activities only.	All	59	Yes	Yes	N/A	No	No	N/A	No	No
Gwynt y Môr Offshore Wind Farm	Operations and Maintenance activities only.	All	65	Yes	Yes	N/A	No	No	N/A	No	No
Barrow Offshore Wind Farm	Operations and Maintenance activities only.	All	116	Yes	Yes	N/A	No	No	N/A	No	No
West of Duddon Sands Offshore Wind Farm	Operations and Maintenance activities only.	All	114	Yes	Yes	N/A	No	No	N/A	No	No
Ormonde Offshore Wind Farm	Operations and Maintenance activities only.	All	117	Yes	Yes	N/A	No	No	N/A	No	No
Walney Extension Offshore Wind Farm	Operations and Maintenance activities only.	All	114	Yes	No	N/A	No	No	N/A	No	No
Burbo Bank Extension Offshore Wind Farm	Operations and Maintenance activities only.	All	95	Yes	Yes	N/A	No	No	N/A	No	No

Project	Status	Species MU area	Distance from Nearest Part of Project (km)	Potential for Cumulative Impacts							
				Underwater noise and disturbance	Collision risk from vessels	Collision risk from tidal devices	Changes in water quality	Changes to prey availability	Potential for entanglement with moored devices	Potential for EMF impacts	Potential for barrier effects
Codling Wind Park	Consented.	All	75	Yes	Yes	N/A	No	No	N/A	No	No
Codling Wind Park Extension.	Application submitted.	All	75	Yes	Yes	N/A	No	No	N/A	No	No
Alexandra Basin Redevelopment.	Current status unknown, but the project has been consented.	All	96	Yes	No	N/A	No	No	N/A	No	No
Isle of Man Ferry Terminal.	MLA/2018/00536. Marine Licence App submitted Dec 2018.	All	92	Yes	Yes	N/A	No	No	N/A	No	No
Milford Haven, Maintenance Dredge Pembrokeshire	Application submitted.	All	175	Yes	Yes	N/A	No	Yes	N/A	No	No
Afon Dysynni outfall gravel removal and relocation	Marine Licences issued and valid until 17/10/2021.	All	81	Yes	Yes	N/A	No	Yes	N/A	No	No
Belfast Harbour D3 terminal cruise ship facility	Application submitted, awaiting a decision.	All	163	Yes	Yes	N/A	No	No	N/A	No	No
Disposal of dredge material from the D3 approach channel	Application submitted, awaiting a decision.	All	163	Yes	Yes	N/A	No	No	N/A	No	No

Project	Status	Species MU area	Distance from Nearest Part of Project (km)	Potential for Cumulative Impacts							
				Underwater noise and disturbance	Collision risk from vessels	Collision risk from tidal devices	Changes in water quality	Changes to prey availability	Potential for entanglement with moored devices	Potential for EMF impacts	Potential for barrier effects
Marine Energy Wales marine testing area	Scoping – Issued Nov 2018	All	175	Yes	Yes	Yes	No	No	No	No	No
Argyll Tidal Demonstration	Marine licence secured in 2015, status of works unknown	Grey and harbour seal OSPAR MU only	225	Yes	Yes	Yes	No	No	N/A	No	No
Sound of Islay Demonstration Site	Consented – construction programme not known	Grey and harbour seal OSPAR MU only	268	Yes	Yes	Yes	No	No	N/A	No	No
West of Islay Tidal Energy Park	Consented – construction programme not known	Grey and harbour seal OSPAR MU only	265	Yes	Yes	Yes	No	No	N/A	No	No
Enlli Tidal Energy Scheme, Bardsey Island	Pre-application. An Agreement for Lease was awarded pre-May 2018. The project would include up to 20 100 kW turbines	All	50	Yes	Yes	Yes	No	Yes	Unknown	Yes	Yes

12.6.6.3. Cumulative Impact Assessment

754. The quantitative cumulative impact assessment for marine mammals has been conducted for underwater noise and disturbance (**Table 12-104**), collision risk with tidal devices and vessels (**Table 12-105**) and changes in prey availability as a result of habitat loss (**Table 12-106**).

755. Changes in prey availability as a result of any potential disturbance from underwater noise would be less that areas of potential impact assessed for marine mammals and would therefore have no further potential cumulative impacts.

756. As no instances of entanglement with the mooring systems of renewable energy have been recorded, and the constant tension of the mooring line for the Holyhead Deep Phase I, the impact was concluded to be negligible for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin and grey seal, and low for minke whale. Taking into account the assessment of potential entanglement at MDZ (**Section 12.6.4.8**), there is no predicted cumulative effects.

757. To take into account the movement of grey and harbour seal and locations of the projects in the cumulative impact assessment (i.e. not all located in the South and West England and the Wales MU) the assessments of disturbance from underwater noise and collision risk with tidal devices and vessels have been put into the context of the 40,233 grey seal and 31,549 harbour seal in the wider OSPAR region (based on Russell *et al*., 2017).

Table 12-104 Cumulative impact assessment for potential disturbance of harbour porpoise (HP), bottlenose dolphin (BND), Risso's dolphin (RD), common dolphin (CD), minke whale (MW), grey seal (GS) and harbour seal (HS) from underwater noise (N/A = not available)

Project	**Potential Cumulative Impact**	**Notes**	**Assessment of Cumulative Impact (maximum number of individuals potentially displaced)**						
			HP	BND	RD	CD	MW	GS	HS
Morlais	Underwater noise and disturbance from installation of tidal devices and hubs (two drilling rigs), two cable laying activities, two cable protection activities and up to 16 vessels, plus operational turbine noise for full deployment (240MW).	See **Section 12.6.4.13**	15.4	0.008	0.0013	0.09	0.9	0.11	0.0004
Holyhead Deep Phase I[3]	Underwater noise and potential disturbance from vessels during operation and maintenance	Based on assessment in ES for estimated number of animals experiencing behavioural change as a result of the LARS support vessel noise during operation.	17	0	-	1	1	15	-
	Underwater noise and potential disturbance from operational turbine	For operational noise impacts, the ES concluded that the disturbance range would be less 1m as a result of noise from the turbines.	0	0	0	0	0	0	0
Holyhead Deep Tidal Array – 80MW	Underwater noise and disturbance during installation	Assumed to be the same as assessment in ES for single device that disturbance area could extend out to 375m for pile drilling and out to a maximum of 10,000m for the vibro-hammering.	105.2	1.6	10	6	7.5	49	0.16

[3] https://www.minesto.com/sites/default/files/documents/l100194-s14-eias-001-a01_es_compressed.pdf

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
		For the installation of one DGU piling activities are likely to be limited to approximately 5 days, the ES concluded that there is likely to be very limited interaction between the piling noise and mammals; any changes would likely be undetectable against natural variation and would have no residual impact at the population level. However, as a worst-case scenario the number of marine mammals in the 10 km range (314 km^2 area) has been estimated, based on the density estimates in the ES for HP, BND, CD & MW and the MDZ density estimates for RD, GS and HS, this area would include construction vessels.							
Holyhead Deep Tidal Array – 80MW	Underwater noise and potential disturbance from construction vessels	Assumed to be the same as assessment in ES for single device that disturbance ranges for marine mammals from vessel noise could be 14 km for installation / construction vessel (using DP) and up to 4 km for support vessels. No numbers of individuals provided in the ES. However, the ES concluded that whilst a small number of individual animals may exhibit some form of change	0	0	0	0	0	0	0

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
		in behaviour for the period in which they encounter sound from the installation or support vessels, this number is likely to be small and the main noise sources present for such a short time that any changes would likely be undetectable against natural variation.							
Holyhead Port Expansion	Underwater noise and disturbance	ES not available at time of writing, therefore, no information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Holyhead Waterfront Regeneration	Underwater noise and disturbance	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wylfa Nuclear Power Plant	Underwater noise and disturbance during construction	When the predicted effects of the construction works (e.g. two percussive drilling rigs, the disposal of dredged material and disturbance from vessels) are considered together, on a very precautionary basis, is 1.26 km^2 for harbour porpoise. For RD, CD and MW density estimates for the MDZ used.	3	1	0.04	0.3	0.02	4.5	0.05
Wylfa Decommissioning	Underwater noise and disturbance	No key significant adverse impacts were identified by the ecological assessment	0	0	0	0	0	0	0
Amlwch LNG	Underwater noise and disturbance	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
North Hoyle Offshore Wind Farm[4]	Underwater noise and disturbance during operation and maintenance activities	Due to the low incidence of individuals in the area, and the pre-existing noisy environment, impacts from underwater noise are not considered to be significant.	0	0	0	0	0	0	0
Rhyl Flats Offshore Windfarm	Underwater noise and disturbance during operation and maintenance activities	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gwynt y Môr Offshore Wind Farm[5]	Underwater noise and disturbance during operation and maintenance activities	During the operation and maintenance of the Gwynt y Môr Offshore Wind Farm, there is the potential for disturbance as a result of underwater noise from maintenance activities such as cable re-burial and vessels. However, it is likely to be limited to the wind farm site, short-term and temporary, and therefore there would be a negligible impact only.	0	0	0	0	0	0	0
Barrow Offshore Wind Farm Operation &	Underwater noise and disturbance during operation and maintenance activities	Disturbance and masking effects could occur over the short-term but would be temporary effects only. Given the baseline level of vessel activity in the area, marine mammals will, to	0	0	0	0	0	0	0

[4] https://www.innogy.com/web/cms/mediablob/en/3170702/data/3170690/1/rwe-innogy/rwe-innogy-uk/sites/wind-offshore/in-operation/north-hoyle/environmental-statement/chapter5.pdf
[5] https://tethys.pnnl.gov/sites/default/files/publications/Gwynt-y-Mor-Offshore-Wind-Farm-Technical-Report.pdf

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
Maintenance Activities[6]		some degree, be sensitised to noise from vessels. Therefore, the effects are predicted to be short-term and reversible, with marine mammal activity returning to baseline levels after the vessel has passed / activity ceases. It is considered that there would no additional impacts to marine mammals over and above normal shipping activities.							
West of Duddon Sands Offshore Wind Farm Operation & Maintenance Activities[7, 8]	Underwater noise and disturbance during operation and maintenance activities	As above, it is considered that there would no additional impacts to marine mammals over and above normal shipping activities.	0	0	0	0	0	0	0
Ormonde Offshore Wind Farm[9]	Underwater noise and disturbance during	As above, it is considered that there would no additional impacts to marine	0	0	0	0	0	0	0

6 https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/6gbevdvpjrtve9km9ch4j9ldtss4nd3hapikrj14ukv072rkpk7c1ea2bprufqttfcvbog6qmil4obfptgae6k2c7h4rc8972b5f/cb08835002ff0877454187bec6de5ad5/EOR0680_Barrow+O%2526M+Marine+Licence_Assessment_Rev02_FINAL.pdf?

7 https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/6jpplqea6tc3ulc2c9vb8fm5hqsnjdfc553ajog293hg31acbv426tip6g6gkcanjc2nsjrn9mimli32hb71o5tdu6481e0cqeeq/553dd5a2fac017a8ea96bd524488df58/EOR0680_West+of+Duddon+Sands+O%2526M+Marine+Licence_Assessment_Rev02_FINAL.pdf?

8 https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/i0ft2qro0mii4uff5o4j377070dp4n6c9bmqu14gd2bqfnfodbv5oibvjarpscvnn3n94632mbsu97jkhnsjenuirkgqkv66k9m4/0fc03a8dc4bf2a5f7a97cb89855f8a53/EOR0709_WDS+OFTO+O%2526M+Marine+Licence_Assessment_Rev02.pdf?

9 https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/ejvk69u43qab71irh09f3373dah9h9cd4bhiqa44ts4k2v9bh3jp2ure0m31ng39i57jbdd8172dpmmk4k9egn262qtaroedqfc4/6b6d14cb74d569561df1a3e0b74a882c/EOR0682_Ormonde+O%2526M+Marine+Licence_Assessment_Rev02_FINAL.pdf?

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
	operation and maintenance activities	mammals over and above normal shipping activities.							
Walney Extension Offshore Wind Farm[10]	Underwater noise and disturbance during operation and maintenance activities	As noise associated with the WTGs through operation are temporary, of a low level and area localised in nature, the impact was assessed to be negligible. Due to the low level of noise associated with maintenance vessels, and the low level of activity required compared to existing baseline levels, it is considered that there would no additional impacts to marine mammals.	0	0	0	0	0	0	0
Burbo Bank Extension Offshore Wind Farm[11]	Underwater noise and disturbance during operation and maintenance activities	Impacts associated with turbine operating noise are considered to be direct and continuous. It is predicted that marine mammals will quickly habituate to the presence of turbines in the water, and that there will be sufficient distance between turbines to allow movement between foundations. The impact is therefore considered to be of neutral significance.	0	0	0	0	0	0	0

[10] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010027/EN010027-000266-10.1.12%20ES%20Ch%2012%20Marine%20Mammals.pdf
[11] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010026/EN010026-000365-5.1.2.14%20Marine%20Mammals.pdf

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
Codling Wind Park	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Codling Wind Park Extension.	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alexandra Basin Redevelopment Project[12]	Underwater noise and disturbance	The proposed piling and dredging in Dublin Port; dredging works within Dublin bay; and dumping of dredged material the west of the Burford Bank has been assessed to be unlikely to have an effect on marine mammals. It is likely that individual marine mammals entering the works area will be affected by acoustic disturbance resulting from noise and boat activity associated with demolition works, piling, dredging, and dumping. With mitigation measures, it was concluded that there will be no significant impacts of the proposed development on marine mammals.	0	0	0	0	0	0	0
Isle of Man Ferry Terminal[13]	Underwater noise and disturbance	Underwater noise from the construction of the ferry terminal (from piling) could	0	0	0	0	0	0	0

12 http://dublinportabr.ie/wp-content/uploads/2014/03/ABR-Project-March-2014-EIS-Volume-1.pdf

13 https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/fl5r1i6hjphn6nupqhk05qb2l5s7dn77nl89bcpusov36jrpqouns7uq9el2o111je4v kmu1ep7kvpc553h8qv8kmiein9gtjh4i/7f19880e35eb2a9216475d2b17aae95e/Isle+of+Man+Ferry+Terminal+ES+-+Vol+1+-+Main+Text+Part+2+%2528Jan+2019%2529.pdf?

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
		cause behavioural effects in seals, harbour porpoise and dolphin species. It is expected that these noise levels would attenuate quickly from source. Given that only three piles are to be installed, the rapid attenuation of the noise, and therefore the impact is considered to be temporary, local and of minor significance. The only additional vessel movements through the operational phase would be the occasional maintenance dredging vessel. No additional vessel movements are expected at the new ferry terminal above current levels. Based on these considerations, the impact is expected to be temporary, local and of negligible significance.							
Milford Haven, Maintenance Dredge Pembrokeshire	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Afon Dysynni outfall gravel removal and relocation	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
Belfast Harbour D3 terminal cruise ship facility[14]	Underwater noise and disturbance	Only grey and harbour seal were considered within this assessment and this project is within a different MU. Therefore, no potential for cumulative impacts.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disposal of dredge material from the D3 approach channel	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Marine Energy Wales marine testing area	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Argyll Tidal Demonstration[15]	Underwater noise and disturbance	Disturbance during construction would be caused by vessels and drilling (if required) of foundations. Any drilling activities may cause avoidance behaviour if individuals are within a few metres of the drilling activity. Marine mammal numbers in the area are low and the site is predominantly used for transit. The overall impact of disturbance due to construction activity was assessed as being negligible to minor.	0	0	0	0	0	0	0

[14] Available for download from: http://epicpublic.planningni.gov.uk/publicaccess/applicationDetails.do?activeTab=summary&keyVal=O3IS1ISV30000
[15] http://www.nautricity.com/docs/014_036__argylltidal_environmentalappraisal_dec13_lores3_1392661149.pdf

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
		Operational tidal devices can emit low levels of noise. However, considering that marine mammals have the capacity to avoid, adapt to, accommodate and recover from the impact of noise, and the indications of low levels of effect from the monitoring at Strangford Lough tidal turbine, the impact was assessed as negligible.							
Sound of Islay Demonstration Site[16]	Underwater noise and disturbance	Due to the number of vessels already using the area, and the limited duration over which increased levels of construction vessel activity will occur, as well as the existing levels of background noise, the impact is expected to be relatively low. A negligible magnitude is predicted for construction noise, with no measurable response or change anticipated. During operation, the Islands of Islay and Jura will have a shielding effect on noise levels and is not likely to travel out of the Sound.	0	0	0	0	0	0	0

[16] http://marine.gov.scot/datafiles/lot/So_Islay_Tidal/2014_Application/Environmental%20Report/Volume%201_%202010%20Sound%20of%20Islay%20Environmental%20Statement.pdf

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
		Data from other tidal projects has not shown any significant effect on the activity of marine mammals in the area. With regard to maintenance activities, it is expected that marine mammals in the area will be accustomed to vessel noise. Noise effects from maintenance vessels (if any) are expected to be both short term, limited in scale and transitory. Based on levels of existing noise and the limited scale of potential noise impacts, operational noise is predicted to be limited.							
West of Islay Tidal Energy Park[17]	Underwater noise and disturbance	Not in HP MU, but in GS and HS OSPAR region (CD, RD & MW not assessed). Disturbance from underwater noise was assessed as negligible to minor.	-	-	-	-	-	0	0
Enlli Tidal Energy Scheme, Bardsey Island	Underwater noise and disturbance	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overall Cumulative Impact Assessment (maximum number of individuals potentially disturbed)			Up to 282	Up to 3	Up to 10	Up to 8	Up to 10	Up to 69	Up to 0.2

[17] https://www2.gov.scot/Topics/marine/Licensing/marine/scoping/DPMarineEnergy

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
			HP	BND	RD	CD	MW	GS	HS
Percentage of reference population			0.3%	0.75%	0.1%	0.01%	0.04%	0.2%	0.0006%
Magnitude for any temporary effect			Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Table 12-105 Cumulative impact assessment for collision risk with tidal devices and vessels for harbour porpoise (HP), bottlenose dolphin (BND), Risso's dolphin (RD), common dolphin (CD), minke whale (MW), grey seal (GS) and harbour seal (HS) (N/A = not available)

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals at increased risk)						
			HP	BND	RD	CD	MW	GS	HS
Morlais	Collision risk with tidal devices	Collision risk based on one bottlenose dolphin scenarios (ERM and CRM) – see **Section 12.6.4.4.1**.	23	0.99	1.4	8	3	5	0.01
	Collision risk with vessels	Increased collision risk with vessels (5-10% of individuals in total area; 15.09 km^2) - see **Section 12.6.3.6**.Table 12-88	1.2	0.03	0.05	0.34	0.03	0.24	0.0007
Holyhead Deep Phase I	Collision risk with tidal devices	In the ES for a single device, physical interaction with the DGU was considered low on the basis that the number of passages of animals through the Project area required to bring about population level effects is beyond that which the baseline data suggests is feasible. No values for the collision risk of individuals for each species was provided, just passage rates through swept area for the device.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Collision risk from vessels	The O&M activities associated with the Project will not involve significant numbers of vessels and therefore it is not considered that there would be any additional impacts to marine mammals over and above normal shipping activities and extremely unlikely that vessel collision will occur.	0	0	0	0	0	0	0
Holyhead Deep Tidal Array – 80MW	Collision risk with tidal devices	Scoping report only, therefore no assessments currently available.	N/A 0	N/A 0	N/A 0	N/A 0	N/A 0	N/A 0	N/A 0

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals at increased risk)						
			HP	BND	RD	CD	MW	GS	HS
		However, if assume same approach as used for Morlais that 1st phase would be used to monitor any collision risk and that development of next phases would be based on adequate mitigation and therefore no increased collision risk.							
	Collision risk with vessels	Scoping report only, therefore no assessments currently available. However, estimate has been based on AfL area of 9.1 km^2, 0.335/ km^2 density estimate for HP, 0.0052/ km^2 for BND, 0.008/ km^2 for CD and 0.0024/ km^2 for MW from the ES and 0.031/ km^2 for RD, 0.155/ km^2 for grey seal and 0.0005/ km^2 based on MDZ and increased collision risk of 5-10% of individuals in total area.	N/A 0.15-0.3	N/A 0.0025-0.05	N/A 0.014-0.03	N/A 0.004-0.008	N/A 0.001-0.002	N/A 0.65-1.3	N/A 0.0025-0.005
Holyhead Port Expansion	Collision risk with vessels	ES not available at time of writing, therefore, no information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Holyhead Waterfront Regeneration	Collision risk with vessels	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wylfa Nuclear Power Plant	Collision risk with vessels	Very precautionary assessment based on the Wylfa Newydd Development Area, the Disposal Site plus 100m buffer and 1 km wide vessel route between the two sites.	5.5	0.75	0	0	0	0.3	0.0015
Wylfa Decommissioning	Collision risk with vessels	No key significant adverse impacts were identified by the ecological assessment, most of work would be done on land.	0	0	0	0	0	0	0
Amlwch LNG	Collision risk with vessels	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rhyl Flats Offshore Windfarm	Collision risk with vessels	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gwynt y Môr Offshore Wind Farm	Collision risk with vessels	Due to the existing high levels of vessel traffic in the area, and the natural avoidance behaviours of marine mammals, the impact of increased collision risk is low. Therefore, it is not considered that there would be any additional impacts to marine mammals over	0	0	0	0	0	0	0

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals at increased risk)						
			HP	BND	RD	CD	MW	GS	HS
		and above normal shipping activities and extremely unlikely that any vessel collision will occur.							
Barrow Offshore Wind Farm Operation & Maintenance Activities	Collision risk with vessels	Collision risk could occur over short-term events, however the risk will be reduced immediately after a vessel has passed by the marine mammal receptor. Marine mammals will, to some extent, be sensitised to vessel movements due to the existing levels in the area. Therefore, it is not considered that there would be any additional impacts to marine mammals over and above normal shipping activities and extremely unlikely that any vessel collision will occur.	0	0	0	0	0	0	0
West of Duddon Sands Offshore Wind Farm Operation & Maintenance Activities	Collision risk with vessels	As above, therefore, it is not considered that there would be any additional impacts to marine mammals over and above normal shipping activities and extremely unlikely that any vessel collision will occur.	0	0	0	0	0	0	0
Ormonde Offshore Wind Farm	Collision risk with vessels	As above, therefore, it is not considered that there would be any additional impacts to marine mammals over and above normal shipping activities and extremely unlikely that any vessel collision will occur.	0	0	0	0	0	0	0
Walney Extension Offshore Wind Farm	Collision risk with vessels	As above, therefore, it is not considered that there would be any additional impacts to marine mammals over and above normal shipping activities and extremely unlikely that any vessel collision will occur.	0	0	0	0	0	0	0
Burbo Bank Extension Offshore Wind Farm	Collision risk with vessels	It is considered unlikely that vessel use during the operational phase of the wind farm for maintenance activities will significantly increase the number of vessels already utilising the Liverpool Bay area. Impacts associated with maintenance vessels are considered to be direct and intermittent. The impact of increased vessel traffic during operation of the offshore wind farm on marine mammals is considered to be probable, of	0	0	0	0	0	0	0

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals at increased risk)						
			HP	BND	RD	CD	MW	GS	HS
		short duration (i.e. only when vessel is present). Therefore, it is not considered that there would be any additional impacts to marine mammals over and above normal shipping activities and extremely unlikely that any vessel collision will occur.							
Codling Wind Park	Collision risk with vessels	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Codling Bank Extension	Collision risk with vessels	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Isle of Man Ferry Terminal	Collision risk with vessels	The vessels involved in the construction phase would be small and once on site are expected to remain relatively stationary. The risk of a collision with marine mammals is considered to be extremely small. As the only increase in vessels at the site is expected to be from occasional maintenance dredging, the potential for increased collision risk through the operation of the Ferry terminal is not expected to be any greater than current shipping activities and it is extremely unlikely that any vessel collision will occur.	0	0	0	0	0	0	0
Milford Haven, Maintenance Dredge Pembrokeshire	Collision risk with vessels	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Afon Dysynni outfall gravel removal and relocation	Collision risk with vessels	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Belfast Harbour D3 terminal cruise ship facility	Collision risk with vessels	The probability of a collision occurring is considered to be low as, while collision incidents have been recorded in the UK and Ireland, they are generally considered to be a rare occurrence. In addition, construction activities are only short term and temporary. The conclusion is that there would be a negligible impact on marine mammal species.	0	0	0	0	0	0	0
Marine Energy Wales marine testing area	Collision risk with tidal devices	Scoping. No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals at increased risk)						
			HP	BND	RD	CD	MW	GS	HS
	Collision risk with vessels		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Argyll Tidal Demonstration	Collision risk with tidal devices	Based on a modelling of other tidal arrays which assessed the impact of collision risk to be negligible for cetaceans, the impact of collision on marine mammal populations can also be assessed as negligible for this project. No values for the collision risk of individuals for each species was provided.	-	-	N/A	N/A	N/A	N/A	N/A
	Collision risk with vessels	Construction vessels are likely to be moving slowly, indicating a lower collision risk than from other vessels already in the area. The risk of collision is considered to be low as numbers of individuals in the area are low, and construction activities would be expected to require only a short period of activity. No values for the collision risk of individuals for each species was provided.	-	-	N/A	N/A	N/A	N/A	N/A
Sound of Islay Demonstration Site	Collision risk with tidal devices	The noise generated by the devices during operation could be detected up to a distance of between 20 and 400m and is expected to alert mammals to the presence of the devices when they are operating at full power and enable avoidance measures to be taken. This, along with the environmental awareness and manoeuvrability of marine mammals, the relatively slow movement of the rotors on each device, are all a factor in the impact assessment. No values for the collision risk of individuals for each species was provided.	-	-	N/A	N/A	N/A	N/A	N/A
	Collision risk with vessels	Based on existing levels of vessel activity in the area, the limited scale and timeframe for installation, as well as the lack of any evidence of collision risk from other tidal turbine installation works, impact is therefore predicted to be minor.	-	-	N/A	N/A	N/A	N/A	N/A

Project	Potential Cumulative Impact	Notes	Assessment of Cumulative Impact (maximum number of individuals at increased risk)						
			HP	BND	RD	CD	MW	GS	HS
		No values for the collision risk of individuals for each species was provided.							
West of Islay Tidal Energy Park	Collision risk with tidal devices	Assessment of possible collision risk used a 3-dimensional model for estimating encounter rates between marine mammals and tidal turbines. Estimated number of collisions for 30 rotors per year, based on 97% avoidance.	-	-	N/A	N/A	N/A	17	14.14
	Collision risk with vessels	Collision risk with vessels was assessed as negligible	-	-	0	0	0	0	0
Enlli Tidal Energy Scheme, Bardsey Island	Collision risk with tidal devices	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Collision risk with vessels	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overall Cumulative Impact Assessment (maximum number of individuals at possible risk)			Up to 30	Up to 2	Up to 2	Up to 9	Up to 3	Up to 24	Up to 15
Percentage of reference population			0.03%	0.5%	0.02%	0.02%	0.01%	0.06%	0.05%
Magnitude for any permanent effect			Medium	Medium	Medium	Medium	Medium	Medium	Medium

Table 12-106 Cumulative impact assessment for potential displacement of harbour porpoise (HP), bottlenose dolphin (BND), Risso's dolphin (RD), common dolphin (CD), minke whale (MW), grey seal (GS) and harbour seal (HS) as a result of changes in prey availability from habitat loss (N/A = not available)

Project	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
		HP	BND	RD	CD	MW	GS	HS
Morlais	The worst-case scenario for permanent habitat loss would be up to 2.18 km^2 (see **Section 12.6.4.12.2**).	1.7	0.04	0.07	0.48	0.04	0.34	0.001
Holyhead Deep Tidal Array – 80MW	Scoping report only, therefore no assessments currently available. However, the Holyhead Deep tidal development area is 9.1 km^2, therefore this area has been used as a worst-case scenario with the density estimates for the MDZ.	7	0.2	0.3	2	0.2	1.4	0.005

Project	Notes	Assessment of Cumulative Impact (maximum number of individuals potentially displaced)						
		HP	BND	RD	CD	MW	GS	HS
Holyhead Port Expansion	ES not available at time of writing, therefore, no information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Holyhead Waterfront Regeneration	No information available to inform cumulative assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wylfa Nuclear Power Plant	Based on a precautionary approach, the marine area of the Wylfa Newydd Development Area (approximately 0.35 km^2) and Disposal Site including a 100m buffer (approximately 0.65 km^2), could experience a potential change or loss of habitat (1 km^2). For RD, CD and MW density estimates for the MDZ used.	2.09	0.34	0.03	0.2	0.02	0.16	0.0008
Milford Haven, Maintenance Dredge Pembrokeshire	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Afon Dysynni outfall gravel removal and relocation	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Enlli Tidal Energy Scheme, Bardsey Island	No information available to inform assessment.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overall Cumulative Impact Assessment (maximum number of individuals potentially displaced)		Up to 11	Up to 0.6	Up to 0.4	Up to 3	Up to 0.3	Up to 2	Up to 0.007
Percentage of reference population (*grey and harbour seal South and West England and the Wales MU)		0.01%	0.15%	0.005%	0.005%	0.001%	0.03%*	0.01%*
Magnitude for any long-term effect		Negligible	Low	Negligible	Negligible	Negligible	Low	Negligible

12.6.6.3.1. Impact Significance for Cumulative Impacts

758. Taking into account the low sensitivity to any disturbance (i.e. has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact) and the potential magnitude of the effect, the impact significance for disturbance from cumulative underwater noise has been assessed as **negligible** for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour (**Table 12-107**).

759. The impact significance for any cumulative collision risk with tidal devices and vessels has been assessed as **minor (not significant)** for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal, without any mitigation, taking into account the receptor sensitivity and magnitude of effect (**Table 12-107**).

760. As outlined in **Section 12.6.4.5.5**, the potential population level effects of collision risk with operational tidal turbines on marine mammals have been assessed in **Appendix 12.2** (**Volume III**). The result of the PVA indicate that population trajectories of the baseline and collision risk scenarios of 1, 2 and 3 animals are very similar, with only a potential for a decline when more than three adults per year are removed from the population of 397 bottlenose dolphins in the Irish Sea MU.

761. The impact significance for any cumulative displacement due to changes in prey availability as a result of habitat loss has been assessed as **negligible to minor (not significant)** for harbour porpoise, **negligible** for common dolphin and harbour seal and **minor (not significant)** for bottlenose dolphin and grey seal, taking into account the receptor sensitivity and magnitude of effect (**Table 12-107**).

Table 12-107 Assessment of impact significance for potential cumulative impacts

Potential Cumulative Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Underwater noise and disturbance	Harbour porpoise	Low	Negligible	Negligible	No further mitigation proposed	Negligible
	Bottlenose dolphin		Negligible	Negligible		Negligible
	Risso's dolphin		Negligible	Negligible		Negligible
	Common dolphin		Negligible	Negligible		Negligible
	Minke whale		Negligible	Negligible		Negligible
	Grey seal		Negligible	Negligible		Negligible
	Harbour seal		Negligible	Negligible		Negligible
Collision risk with tidal devices and vessels	Harbour porpoise	Low	Medium	Minor	Phased deployment, monitoring and mitigation	Minor (not significant)
	Bottlenose dolphin		Medium	Minor		Minor (not significant)
	Risso's dolphin		Medium	Minor		Minor (not significant)
	Common dolphin		Medium	Minor		Minor (not significant)
	Minke whale		Medium	Minor		Minor (not significant)
	Grey seal		Medium	Minor		Minor (not significant)
	Harbour seal		Medium	Minor		Minor (not significant)

Potential Cumulative Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Displacement due to changes in prey availability as a result of habitat loss	Harbour porpoise	Low to medium	Negligible	Negligible to Minor	No mitigation required or proposed	Negligible to Minor (not significant)
	Bottlenose dolphin	Low	Low	Minor		Minor (not significant)
	Risso's dolphin	Medium	Negligible	Minor		Minor (not significant)
	Common dolphin	Low	Negligible	Negligible		Negligible
	Minke whale	Medium	Negligible	Minor		Minor (not significant)
	Grey seal	Low	Low	Minor		Minor (not significant)
	Harbour seal	Low	Negligible	Negligible		Negligible

12.6.6.3.2. Mitigation

762. No further mitigation measures are proposed, other than those already outlined for the Morlais project, including MMMPs and the phased deployment, monitoring and mitigation.

12.6.6.3.3. Residual Impact

763. The residual impact for disturbance from cumulative underwater noise would remain **negligible** for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.

764. The residual impact for any cumulative displacement due to changes in prey availability as a result of habitat loss would remain **negligible to minor (not significant)** for harbour porpoise, **negligible** for common dolphin and harbour seal and **minor (not significant)** for bottlenose dolphin and grey seal.

765. With the propose phased deployment, monitoring and mitigation at Morlais, the residual impact would be **minor (not significant)** for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.

12.7. SUMMARY

766. **Table 12-108** summarises the impact assessments undertaken for marine mammals. Throughout the construction, operation and maintenance, repowering, and decommissioning phases, taking into account the proposed mitigation, the impact on marine mammals is considered to be of negligible or minor adverse significance. The only exception is the potential collision risk of bottlenose dolphin with operational turbines, which has been precautionarily assessed as potentially minor to moderate adverse. This reflects the small number of individuals in the area, however, the potential risk is likely to be lower as bottlenose dolphins have not been recorded in the MDZ and are more likely to move along the coast than through the MDZ array area.

Table 12-108: Summary of potential impacts on marine mammals

Phase	Potential Impact	Receptor	Value / sensitivity combined	Magnitude	Significance	Mitigation	Residual Impact
Construction	Underwater noise	All species	Medium	Negligible / very low	Minor adverse	MMMPs	Minor adverse (not significant)
	Barrier effects from underwater noise	All species	Low	Negligible / very low	Negligible	None proposed, other than MMMPs	Negligible
	Disturbance haul-out sites	Grey seal	Low	Negligible / very low	Negligible	None required or proposed	Negligible
	Increased collision risk with vessels	All species	Low	Negligible to low	Negligible to Minor adverse	Not required or proposed	Negligible to Minor adverse (not significant)
	Changes in water quality	All species	Negligible	Low	Negligible	EMP and MPCP	Negligible
	Changes in prey availability	All species	Low to Medium	Negligible / very low	Negligible to Minor adverse	None required or proposed	Negligible to Minor adverse (not significant)
Operation, Maintenance and Repowering	Underwater noise	All species	Low	Low to Medium	Minor adverse	None required or proposed	Minor adverse (not significant)
	Collision risk with operational turbines	Bottlenose dolphin	High	Medium to High	Major adverse	Phased deployment, monitoring and mitigation	Minor to Moderate adverse
		All other species	Low	Low to Medium	Minor adverse		Minor adverse (not significant)
	Increased collision risk with vessels	All species	Low	Negligible to low	Negligible to Minor adverse	None required or proposed	Negligible to Minor adverse (not significant)
	Entanglement with mooring lines	Minke whale	Low	Low to High	Minor to Moderate adverse	Phased deployment, monitoring and mitigation	Minor adverse (not significant)
		All other species	Low	Low to Moderate	Minor adverse		Minor adverse (not significant)
	EMF effects	All species	Negligible	Negligible	Negligible	None required or proposed	Negligible
	Barrier effects	All species	Low	Low	Minor adverse	None required or proposed	Minor adverse (not significant)
	Changes in water quality	All species	Negligible	Negligible to Low	Negligible	EMP and MPCP	Negligible
	Changes in prey availability	All species	Low to Medium	Low	Minor adverse	None required or proposed	Minor adverse (not significant)
Decommissioning	Same or less than construction phase						
Cumulative Impacts	Underwater noise and disturbance	All species	Low	Negligible	Negligible	No further mitigation proposed	Negligible

Phase	Potential Impact	Receptor	Value / sensitivity combined	Magnitude	Significance	Mitigation	Residual Impact
	Collision risk with tidal devices and vessels	All species	Low	Medium	Minor	Phased deployment, monitoring and mitigation	Minor adverse (not significant)
	Displacement due to changes in prey availability / habitat loss	All species	Low to Medium	Negligible to Low	Negligible to Minor adverse	None required or proposed	Negligible to Minor adverse (not significant)

12.8. REFERENCES

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