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Morlais Project
Environmental Statement

Chapter 10: Fish and Shellfish Ecology

Volume I

Applicant: Menter Môn Morlais Limited
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GLOSSARY OF ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
BAP	Biodiversity Action Plan
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
CIA	Cumulative Impact Assessment
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
ES	Environmental Statement
FOCI	Feature of Conservation Importance
GBS	Gravity Base Structure
HDD	Horizontal Directional Drilling
HRA	Habitat Regulations Assessment
HNP	Horizon Nuclear Power
ICES	International Council for Exploration of the Sea
INNS	Invasive Non Native Species
IUCN	International Union for Conservation of Nature
JLDP	Joint Local Development Plan
JNCC	Joint Nature Conservation Committee
LNG	Liquid Natural Gas
MarLIN	Marine Life Information Network
MCZ	Marine Conservation Zone
MDZ	Morlais Demonstration Zone
MMO	Marine Management Organisation
NBN	National Biodiversity Network
NERC	National Environment and Rural Communities
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
RYA	Royal Yachting Association
SAC	Special Area of Conservation
S-P-R	Source-Pathway-Receptor
TAC	Total Allowable Catch
TEC	Tidal Energy Converter
TWAO	Transport and Works Act Order

GLOSSARY OF TERMINOLOGY

Beam trawl	A trawl net whose lateral spread during trawling is maintained by a beam across its mouth.
Benthic	Relating to, or occurring at the sea bottom.
Bony fish	Any of a major taxon (class Osteichthyes or superclass Teleostomi) comprising fishes with a bony rather than a cartilaginous skeleton.
Clupeid	Any of various fishes of the family Clupeidae, which includes the herrings, sprats, sardines and shads.
Crustacean	An arthropod of the large, mainly aquatic group Crustacea, such as a crab, lobster, shrimp, or barnacle.
Demersal	Living on or near the seabed.
Diadromous	Migrating between fresh and salt water.
Elasmobranch	Any cartilaginous fish of the subclass Elasmobranchii which includes the sharks, rays and skates.
Epibenthic	Relative to the flora and fauna living on the surface of the sea bottom.
Gadoid	A bony fish of an order (Gadiformes) that comprises the cods, hakes, and their relatives.
Otter trawl	A trawl net fitted with two ‘otter’ boards which maintain the horizontal opening of the net.
Pelagic	Living in the water column.
Swim bladder	A gas-filled sac present in the body of many bony fish, used to maintain and control buoyancy.

10. FISH AND SHELLFISH ECOLOGY

10.1. INTRODUCTION

1. Menter Môn Morlais Limited (Menter Môn) proposes the development of 240 MW of tidal generating capacity within the Morlais Demonstration Zone (MDZ). The development of the Morlais Project (the Project) will support the development of renewable energy technology objectives of the Anglesey and Gwynedd Joint Local Development Plan (JLDP), providing a consented tidal technology demonstration zone which supports installation, testing and commercial demonstrations of tidal energy devices. The Project will also provide opportunities for the local communities via direct employment and support of the local supply chain.

2. The Project will include communal infrastructure for tidal technology developers which provides a shared route to a local grid connection via nine export cable tails, an onshore landfall substation, and an onshore electrical cable route to a grid connection via a grid connection substation.

3. This chapter of the Environmental Statement (ES) aims to provide an assessment of potential impacts on fish and shellfish ecology within Welsh waters which may arise during the construction, operation and maintenance, repowering, and decommissioning of the Project.

4. This chapter characterises the baseline environment of fish and shellfish, as discerned from local and regional data in the published and 'grey literature'. The chapter then identifies potential impacts on the fish and shellfish receptor species that can arise through the Project phases, presents an impact assessment and associated results, and where applicable proposes mitigation measures. Additional relevant information has been used from other chapters of the ES, specifically:

- **Chapter 7, Metocean Conditions and Coastal Processes**;
- **Chapter 9, Benthic and Intertidal Ecology**; and
- **Chapter 14, Commercial Fisheries**.

5. This chapter has been prepared by MarineSpace Ltd on behalf of Menter Môn.

10.2. POLICY, LEGISLATION AND GUIDANCE

6. A detailed overview of the policy and legislation surrounding this project can be found in **Chapter 2, Policy and Legislation**.

7. The Project is seeking consent for a Transport and Works Act Order from the Welsh Government and a Marine Licence from Natural Resources Wales (NRW). Although this project is not seeking a Development Consent Order (DCO), its size (240 MW) means it is of a scale equivalent to a Nationally Significant Infrastructure Project (NSIP). Therefore, guidance for the DCO procedure constitutes the most appropriate guidance for a project of this scale and as such can be used to inform the approach for this Project. Guidance that is relevant to assessing impacts on fish and shellfish for NSIPs are set out within National Policy Statements (NPSs) which are the principal decision-making documents for NSIPs. Those relevant to fish and shellfish ecology include:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3), July 2011.

8. Details of specific policies within EN-1 and EN-3 used to inform this assessment are provided below.

9. Other relevant legislation has been considered during this assessment (see **Chapter 2, Policy and Legislation**). The following are of particular relevance to the assessment of fish and shellfish ecology:

- EU Habitats Directive (Directive 92/43/EEC);
- Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations) implements species protection requirements of the Habitats Directive in England in inshore waters;
- UK Post-2010 Biodiversity Framework, superseding the UKBAP the UK Governments response to the Convention on Biological Diversity (CBD) 1992;
- Conservation of European Wildlife and Natural Habitats Convention (Bern convention);
- Wildlife and Countryside Act 1981;
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); and
- Environment (Wales) Act 2016 (which incorporates the same list of species of principal importance as originally presented in Sections 41 and 42 of the Natural Environment and Rural Communities Act 2006.

10.2.1. National Policy Statement

10. The Project is seeking consent for a Transport and Works Act Order from the Welsh Government and a Marine Licence from Natural Resources Wales (NRW). Although this project is not seeking a Development Consent Order (DCO), its size (240 MW) means it is representative of a Nationally Significant Infrastructure Project (NSIP), therefore guidance relevant to NSIPs is considered appropriate to use for this Project. Guidance that is relevant to assessing impacts on marine water and sediment quality for NSIPs are set out within National Policy Statements (NPSs) which are the principal decision-making documents for NSIPs. Those relevant to marine water and sediment quality include:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3), July 2011 (DECC, 2011b).

11. Details of specific policies within EN-1 and EN-3 used to inform this assessment are provided in below. The specific assessment requirements for fish and shellfish ecology are detailed, together with an indication of the paragraph numbers of the chapter where each is addressed.

Table 10-1 NPS EN-1 and EN-3 Assessment Requirements Relevant to Fish and Shellfish Ecology

NPS Requirement	NPS Reference	ES Reference
"There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to interact with seabed sediments and therefore have the potential to impact fish communities, migration routes, spawning activities and nursery areas of particular species. In addition, there are potential noise impacts, which could affect fish during construction and decommissioning and to a lesser extent during operation."	EN-3, Paragraph 2.6.73	Potential impact to fish and shellfish ecology arising from construction and decommissioning activities associated with the seabed are discussed in throughout the Impact Assessment in **Section 10.6**.
The applicant should identify fish species that are the most likely receptors of impacts with respect to feeding areas; spawning grounds; nursery grounds; overwintering areas for crustaceans and migration routes;	EN-3, Paragraph 2.6.74	Fish and shellfish species present within the study area have been identified through desk-based assessment of available data and are presented in **Section 10.5**.
Where mitigation measures are applied to offshore export cables to reduce electromagnetic fields (EMF) the effects on sensitive species during operation are unlikely to be a reason for PINS to have to refuse to grant consent. Once installed, operational EMF impacts are unlikely to be of sufficient range or strength to create a barrier to fish movement;	EN-3 Para 2.6.75	EMF impacts to fish and shellfish could arise during the operation of the Project. These are assessed in **Section 10.6.5.6**.
EMF during operation may be mitigated by use of armoured cable for inter-array and export cables which should be buried at a sufficient depth	EN-3 Para 2.6.76	EMF impacts and any proposed mitigation measures are discussed in **Section 10.6.5.6**.
During construction, 24 hour working practices may be employed so that the overall construction programme and the potential for impacts to fish communities are reduced in overall time.	EN-3 Para 2.6.77	24-hour working practices will be employed for offshore construction (see **Chapter 4, Project Description**).

10.2.2. Marine Policy Statement

12. The Marine Policy Statement (MPS) adopted by all UK administrations in March 2011 provides the policy framework for the preparation of marine plans and establishes how decisions affecting the marine area should be made in order to enable sustainable development. The MPS sets out a vision of having 'clean, healthy, safe, productive and biologically diverse oceans and seas' by supporting the development of Marine Plans. It also sets out the framework for environmental, social and economic considerations that need to be considered in marine planning.

10.2.3. Wales National Marine Plan

13. By adopting the MPS, the Welsh Government committed to the requirement to introduce Marine Plans for Wales.

14. The Welsh Government is currently developing the first marine plan for Welsh inshore and offshore waters, the Welsh National Marine Plan (WNMP). The Plan is being developed in accordance with the Marine and Coastal Access Act (MCAA) 2009, the MPS and the Maritime Spatial Planning Directive, a draft version has been issued for consultation (discussed further in Chapter 2, Policy and Legislation).

15. Objective 10 of the WNMP, “to maintain and enhance the resilience of marine ecosystems and the benefits they provide in order to meet the needs of present and future generations”, is of relevance to this chapter as this covers policies and commitments on the wider ecosystem, as set out in the MPS including those to do with the Marine Strategy Framework Directive and the Water Framework Directive, as well as other environmental, social and economic considerations.

16. **Table 10-2** sets out other national and regional policies which are particularly relevant to the Project.

Table 10-2 National and Regional Policy Requirements Relevant to Fish and Shellfish Ecology

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	The effects of underwater noise on migratory and non-migratory fish have been assessed using noise modelling from a similar recent tidal energy project, the PTEC project as well as a technical note prepared for this project (Subacoustech, 2019) This included species considered sensitivity to noise. Noise produced from a variety of activities (both construction and operation) have been included. See **Sections 10.6.4.1** and **10.6.5.1**.
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 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).	Section 3.3.24	Potential impacts on fish and shellfish arising from the Project are assessed in **Sections 10.6.4**, **10.6.5** and **10.6.6**. Displacement of fishing activity is considered in **Chapter 14, Commercial Fisheries**
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	Section 3.3.25	A desk-based review of available data has been used to determine the species present (**Section 10.5.3**) and the potential impacts to

Policy Description	Reference	ES Reference
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.		these species are assessed in **Section 10.6** to be of minor adverse significance.
Draft WNMP		
Proposals should demonstrate how they contribute to the protection, restoration and/or enhancement of marine ecosystems	ENV_01: Resilient marine ecosystems	Potential impacts to fish and shellfish are assessed in **Section 10.6** to be of minor adverse significance.
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 fish and shellfish species is presented in **Section 10.5.** Potential impacts to these species are assessed in **Section 10.6** to be of minor adverse significance.
Proposals should include biosecurity measures to reduce the risk of introducing and spreading invasive non-native species.	ENV_03: Invasive non-native species	The assessment of the impact of invasive non-native species is addressed in **Chapter 9, Benthic and Intertidal Ecology**.
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	The effects of underwater noise on migratory and non-migratory fish have been assessed using noise modelling from a similar recent tidal energy project, the PTEC project as well as a technical note prepared for this project (Subacoustech, 2019) This included species considered sensitivity to noise. Noise produced from a variety of activities (both construction and operation) have been included. See **Sections 10.6.4.1** and **10.6.5.1**.

Policy Description	Reference	ES Reference
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 10.6.7** 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, 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	Policy ADN 3: Other Renewable Energy and Low Carbon Technologies	The impact assessment is included within **Section 10.6** and includes mitigation measures to reduce impact significance.

10.3. CONSULTATION

17. An Environmental Impact Assessment (EIA) scoping process was undertaken for this project. An EIA Scoping Document (Royal HaskoningDHV, 2018) was produced and submitted to the regulators, who consulted with the statutory bodies and key stakeholders upon the contents. The project went through three rounds of scoping, in 2015, 2017 and 2018. All scoping comments from 2018 pertaining to this chapter have been presented in **Table 10-3**. These comments have been addressed fully in this chapter, with the location of the relevant information highlighted in the response column for ease of location.

Table 10-3 Consultation Responses Pertaining to Fish (Including Migratory Fish) and Shellfish from the 2018 Scoping Round

Consultee	Date/Document	Comment	Response
Planning Inspectorate	2018 Scoping Comments	Marine Fish: The documents referred to in footnotes 50 and 51, which have been used to inform the described marine fish baseline, are over 20 years old. Baseline information is expected to be informed by up to date studies, or evidence should be provided to demonstrate that these are still relevant. The Applicant is recommended to make efforts to agree the species to be included within the assessment with NRW; taking into account the comments made in NRW's consultation response (see Appendix 1 of this Scoping Opinion).	More recent references have been used to inform the marine fish baseline, such as Ellis et al. (2012) and Aires et al. (2014). See **Section 10.5.4** to **10.5.6**.
Planning Inspectorate	2018 Scoping Comments	Shellfish: The Fish and Shellfish Ecology chapter does not identify the European Shellfish Water designation that is identified in Section 7.2.1.1 of the Scoping Report. Appropriate cross reference should be made to the Marine Sediment and Water Quality chapter.	The European Shellfish Water designation has now been mentioned in **Section 10.5.7.3** Please also see **Figure 8-1** (**Volume II**) and **Chapter 8, Marine Water and Sediment Quality.**

Consultee	Date/Document	Comment	Response
Planning Inspectorate	2018 Scoping Comments	Potential Impacts: Table 8-7 of the Scoping Report states that the significance of effect for a number of potential impacts would be dependent on construction methods and project design. It is understood that the precise detail of the construction methods will not be known at the time of application. On this basis, the ES should ensure that a worst case scenario attributable to construction is assessed.	The worst-case scenario approach has been adopted throughout this chapter.
Planning Inspectorate	2018 Scoping Comments	Loss of shellfish habitat: The Scoping Report has identified the potential for loss of shellfish habitat through the placement of devices and the swept area of mooring cables. The loss of habitat (including seabed, spawning or nursery grounds) for demersal fish should also be assessed in the ES.	Loss of habitat for demersal fish (and other fish groups) has been considered in the impacts as well as the loss for shellfish. See **Section 10.5.5**.
Planning Inspectorate	2018 Scoping Comments	Impacts on fish and shellfish through a decrease in water quality: The ES should assess the likely significant effects from increased turbidity on larvae of fish and shellfish species.	A short description of the potential effects of turbidity on larvae has been included; see **Section 10.6.4.3**.
Planning Inspectorate	2018 Scoping Comments	EMF: The Scoping Report identifies EMF as a potential barrier to migratory fish. No reference is made of impacts to non migratory fish. This should be considered and if significant effects are likely this should be assessed within the ES.	The effects of EMF on non-migratory fish and shellfish have been included. See **Section 10.6.5.7**.
Planning Inspectorate	2018 Scoping Comments	Underwater noise: The Scoping Report identifies the potential for underwater noise to displace migratory fish. No reference is made of impacts to non-migratory fish (e.g. behavioural impacts, injury or death). Impacts to non-migratory fish which could result in significant effects should be assessed within the ES. The ES should also justify the approach to the assessment based on fish species sensitivity to underwater noise. The assessment of underwater noise during construction should include all construction activities e.g. piling, vessels, seabed preparation and cable installation.	The effects of underwater noise on non-migratory fish have been included in this chapter. The chapter has used species-specific sensitivity levels in the approach. Noise produced from a variety of activities (both construction and operation) have been included. See **Sections 10.6.4.1** and **10.6.5.1**.
Planning Inspectorate	2018 Scoping Comments	Site specific surveys: The need for and design of site specific surveys should be discussed and agreed with NRW.	The rationale for not conducting site specific surveys has been included under **Section 10.4.4**.

Consultee	Date/Document	Comment	Response
Planning Inspectorate	2018 Scoping Comments	Changes to species composition: Table 9-4 has identified the potential for changes in abundance of commercial fisheries target species. If significant effects are likely, changes to species composition should also be assessed in the Fish and Shellfish chapter of the ES.	**Chapter 14, Commercial Fisheries** has been reviewed. The greatest impact predicted for commercial fisheries was minor adverse, which is not significant. Therefore, there are no significant impacts for commercial fisheries that need to be included in this chapter.
Planning Inspectorate	2018 Scoping Comments	Biosecurity: The ES should assess the potential impacts from the spread of non-native invasive species. Any measures to mitigate the spread of this species should be identified in the ES.	The assessment of the impact of invasive non-native species is addressed in **Chapter 9, Benthic and Intertidal Ecology**. A cross-reference to this chapter has been added to **Section 10.6.1**.
National Resource Wales (NRW) (for PINS)	2018 Scoping Comments	The assessment of fish species to inform the Environmental Statement needs to identify all possible fish species that may be affected by the proposed development and indicate the relevant legislation for each, for example: Common Fisheries Policy zero TAC species, UK Biodiversity Action Plan species, Section 7 Environment Act species, IUCN European Red List species etc. Assessment should consider the impacts of all stages of development (i.e. construction, operation and decommissioning).	All of the listed legislation has been included when assessing the fish species to be included in the assessment. See **Table 10-10, Table 10-12, Table 10-14, Table 10-17**.
NRW (for PINS)	2018 Scoping Comments	In light of the above information we advise that species such as the spurdog or spiny dogfish *Squalus acanthias* will need to be included as a potential impact receptor in the ES; it is known to use the area and is classed as vulnerable in the IUCN Red List. This, and other elasmobranch species may be impacted by, for example, electromagnetic field effects and so should be included in the ES for assessment.	The spiny dogfish and other elasmobranch species have been included in the assessment. See **Section 10.5.4** for the elasmobranch species included, and **Section 10.6.5.7** for EMF effects.
NRW (for PINS)	2018 Scoping Comments	The Pembrokeshire Marine SAC fish species features of sea lamprey, river lamprey and allis shad (note that twaite shad is missing) are included in Table 8-1 but Pembrokeshire Marine SAC has been	The Pembrokeshire Marine SAC (Site code 13116) has been included in this assessment (as shown in

Consultee	Date/Document	Comment	Response
		omitted from Table 8-6 Relevant SACs for migratory fish. NRW welcomes the statement in Table 11-1 that migratory fish will be fully considered in the ES, including the provision of a justification where specific sites and species are scoped out.	**Figure 10-4, Volume II**) as well as the HRA (**Document MOR/RHDHV/DOC/0067, Information to Support HRA**). Migratory fish have been fully considered in this chapter, aligned with the rationale in the HRA.
NRW (for PINS)	2018 Scoping Comments	Section 8.4.2.1 of the EIA scoping report states "that shellfish are the only commercial species landed at Holyhead". This statement is incorrect as fish species are also landed there. The EIA suggests 'that no scallop vessels at Holyhead are licenced for scallop fishing', however, several vessels fish for scallops from Holyhead. Longlining fishing for rays occasionally occurs off western Anglesey with vessels from Holyhead participating.	A brief overview of commercial fisheries information has been included in this chapter, with cross-reference made to **Chapter 14, Commercial Fisheries**
NRW (for PINS)	2018 Scoping Comments	We welcome the acknowledgement of the potential impact pathways identified for Annex II species (fish) features and natural fish and shellfish in Table 8.1 and Table 8.7. We note, however, that the potential impact to migratory and non-migratory fish from 'collision risk with devices' has been identified as 'unlikely to be significant', despite the applicant indicating that migratory pathways are not well understood, and that more information is required to assess potential impacts to non-migratory fish. A full examination and evidenced justification in support of this view will be required within the ES.	A full impact assessment of collision risks with migratory and non-migratory fish has been included in this chapter. See **Section 10.6.5.6.**
NRW (for PINS)	2018 Scoping Comments	We advise that impacts on migratory fish from underwater noise should include consideration of impacts on hearing specialists such as herring which are a prey species of marine mammals. Other impacts which we recommend are assessed within the ES include possible impacts on larvae of fish and shellfish species from increased turbidity.	The impact on migratory fish from underwater noise has been assessed using noise modelling from a similar recent tidal energy project, the PTEC project as well as a technical note prepared for this project (Subacoustech, 2019) This included species considered sensitivity to noise. See **Section 10.6.4.1**. The effect of turbidity on larvae has been included in **Section 10.6.4.3.1**

Consultee	Date/Document	Comment	Response
NRW (for PINS)	2018 Scoping Comments	We welcome the applicant's indication in Table 11.1 that transitional fish species (such as bass, whiting and herring) will be considered as part of the wider fish assessment which will include consideration of seasonal variation in fish spawning and larval activity. We maintain that the ES should differentiate between transitional and migratory fish assemblages where possible.	Transitional fish species and their general seasonality have been included in the assessment. See **Table 10-13** for an example.
NRW	2018 Scoping Comments	No information is provided 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 noise assessment should also include a general review of the latest available scientific evidence of the observed responses of fish to different types of underwater sound for context. Consideration should be given to the sensitivity of fish to particle motion (not just sound pressure level) recent research indicated this to be an equally or potentially more important than sound pressure in some fish	The noise modelling output from a similar project (PTEC, 2014) has been used within this assessment, plus outputs from a recent technical note on subsea noise (Subacoustech, 2019).
NRW	2018 Scoping Comments	Impacts on migratory fish from underwater noise should include consideration of impacts on hearing specialists such as herring which are a prey species of marine mammals. Other impacts which should be assessed within the ES include possible impacts on larvae of fish and shellfish species from increased turbidity.	See above.
NRW	2018 Scoping Comments	We welcome your indication in Table 11.1 that transitional fish species (such as bass, whiting and herring) will be considered as part of the wider fish assessment which will include consideration of seasonal variation in fish spawning and larval activity. The ES should differentiate between transitional and migratory fish assemblages where possible.	See above.

10.4. METHODOLOGY

10.4.1. Impact Assessment Methodology

18. The assessment approach has adopted the following stages:

- Review of existing relevant data and information;
- Formulation of a conceptual understanding of baseline conditions;
- Consultation and agreement with the regulators regarding proposed assessment approaches;
- Determination of the worst-case scenarios;
- Consideration of embedded mitigation measures; and
- Assessment of effects using data analysis, numerical modelling outputs, and expert-based judgements by MarineSpace Ltd.

19. A detailed description of the Impact Assessment Methodology is provided in **Chapter 5, EIA Methodology**. A short summary is provided here for completeness, with additional detail provided for the specific receptor of this chapter.

20. A Project Design Envelope approach, often referred to the 'Rochdale Envelope', has been used in this assessment. This approach "defines a series of realistic maximum extents and magnitudes for the description of a development, so that a realistic 'worst case scenario' is assessed". **Chapter 4, Project Description**, sets out the parameters of the project in order to complete the assessment.

21. Effects are changes in the physical environment that may arise during Project activities. Effects can result in impacts where a receptor is sensitive to them. Impacts can be considered as direct, indirect, inter-relationships, or cumulative (see **Chapter 5, EIA Methodology** for definitions).

22. The assessment of effects on fish and shellfish ecology is predicated on a Source-Pathway-Receptor (S-P-R) conceptual model, whereby the source is the initiator event, the pathway is the link between the source and the receptor impacted by the effect, and the receptor is the receiving entity.

23. An example of the S-P-R conceptual model is provided by cable installation which disturbs sediment on the sea bed (source). This sediment is then transported by tidal currents until it settles back to the sea bed (pathway). The deposited sediment could smother and have an effect on the species on this area of the seabed (receptor).

24. Consideration of the potential effects of the Project is carried out over the following spatial scales:

- Near-field: the area within the immediate vicinity (tens or hundreds of metres) of the project and along the export cable corridor; and
- Far-field: the wider area that might also be affected indirectly by the project (e.g. due to disruption of waves, tidal currents or sediment pathways).

25. The S-P-R approach has been used in order to provide systematic approach to "understanding the potential for effects to arise, the spatial extents of the effect-receptor interactions, impact pathways, and potential impact significance."

26. Three main phases of development are considered over the life-cycle of the Project, in conjunction with the present-day baseline. These are:

- Construction phase;
- Operation and maintenance phase (including repowering); and
- Decommissioning phase.

10.4.1.1. Sensitivity, Value and Magnitude

27. The determination of each aspect of the receptor (sensitivity, value, magnitude) was considered for each species, using available evidence, including published data sources, and expert judgement.

28. The sensitivity of the receptor was considered in terms of its:

- Tolerance to an effect (the extent to which the receptor is adversely affected by an effect);
- Adaptability (the ability of the receptor to avoid adverse impacts that would otherwise arise from an effect); and
- Recoverability (a measure of a receptor's ability to return to a state at, or close to, that which existed before the effect caused a change).

29. In addition, a value component may also be considered when assessing a receptor. This ascribes whether the receptor is rare, protected or threatened; has key life stages in the area; or is of commercial value, which is of particular relevance to fish and shellfish receptors. It is important to note that value does not necessarily imply greater sensitivity to effects.

30. The magnitude of an effect is dependent upon its:

- Scale (i.e. size, extent or intensity);
- Duration;
- Frequency of occurrence; and
- Reversibility (i.e. the capability of the environment to return to a condition equivalent to the baseline after the effect ceases).

31. The sensitivity and value of receptors and the magnitude of effect are assessed using available literature and data, expert judgement, and also published sensitivity assessments on the Marine Life Information Network (MarLIN) (2019). Definitions for each term are provided in **Table 10-4** to **Table 10-6**. These expert judgements of receptor sensitivity, value and magnitude of effect are guided by the conceptual understanding of baseline conditions.

Table 10-4 Definitions of the Sensitivity Levels for Fish and Shellfish Receptors

Sensitivity	Definition
High	Tolerance: Receptor has very limited tolerance of effect Adaptability: Receptor unable to adapt to effect Recoverability: Receptor unable to recover resulting in permanent or long-term (greater than ten years) change
Medium	Tolerance: Receptor has limited tolerance of effect Adaptability: Receptor has limited ability to adapt to effect Recoverability: Receptor able to recover to an acceptable status over the medium term (5-10 years)
Low	Tolerance: Receptor has some tolerance of effect Adaptability: Receptor has some ability to adapt to effect Recoverability: Receptor able to recover to an acceptable status over the short term (1-5 years)
Negligible	Tolerance: Receptor generally tolerant of effect Adaptability: Receptor can completely adapt to effect with no detectable changes Recoverability: Receptor able to recover to an acceptable status near instantaneously (less than one year)

Table 10-5 Definitions of the Value Levels for Fish and Shellfish Receptors

Value	Definition
High	Receptor is designated and/or of national or international importance. Likely to be rare. Has been identified as having a key life stage (spawning or nursery ground) that overlaps the MDZ Is of significant commercial importance (i.e. regularly landed from the area, as revealed by local fishermen or ICES data)
Medium	Receptor is not designated but is of local to regional importance. Has been identified as having a key life stage in the greater region, but not directly overlapping the MDZ The receptor has been landed but not on a regular basis
Low	Receptor is not designated but is of local importance
Negligible	Receptor is not designated and is not deemed of importance

Table 10-6 Definitions of Magnitude of Effect for Fish and Shellfish Receptors

Magnitude	Definition
High	Scale: A change which would extend beyond the natural variations in background conditions Duration: Change persists for more than ten years Frequency: The effect would always occur Reversibility: The effect is irreversible
Medium	Scale: A change which would be noticeable from monitoring but remains within the range of natural variations in background conditions Duration: Change persists for 5-10 years Frequency: The effect would occur regularly but not all the time Reversibility: The effect is very slowly reversible (5-10 years)

Magnitude	Definition
Low	Scale: A change which would barely be noticeable from monitoring and is small compared to natural variations in background conditions Duration: Change persists for 1-5 years Frequency: The effect would occur occasionally but not all the time Reversibility: The effect is slowly reversible (1-5 years)
Negligible	Scale: A change which would not be noticeable from monitoring and is extremely small compared to natural variations in background conditions Duration: Change persists for less than one year Frequency: The effect would occur highly infrequently Reversibility: The effect is quickly reversible (less than one year)

10.4.1.2. Impact Significance

32. Following the identification of receptor sensitivity and value, and magnitude of effect, it is possible to determine the significance of the impact. A matrix is presented in **Table 10-7** as a framework to guide how a judgement of the significance is determined. The matrix approach ensures a consistent approach and limits the subjectivity of the impact assessment arising from expert judgement.

33. Through use of the matrix shown in **Table 10-7** an assessment of the significance of an impact can be made in accordance with the definitions in **Table 10-8**.

Table 10-7 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 10-8 Impact Significance Definitions

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

34. For the purposes of this ES, ‘major’ and ‘moderate’ impacts are deemed to be significant (in EIA terms). In addition, whilst ‘minor’ impacts may not be significant, it is important to distinguish these from other non-significant (negligible) impacts as they may contribute to significant impacts cumulatively.

10.4.1.3. Cumulative Impact Assessment

35. Impact inter-relationships are given consideration in this chapter. These can be defined as the potential for different residual impacts to have a combined impact on key sensitive receptors.

36. Cumulative impacts are assessed through consideration of the extent of influence of changes to fish and shellfish ecology arising from the project alone and those arising from the project cumulatively or in combination with other reasonably foreseeable plans and projects.

10.4.2. Study Area

37. The Project area is delineated by the Offshore Development Area (OfDA) for consent which offshore includes the Morlais Demonstration Zone (MDZ) and the export cable corridor (ECC; **Figure 1-1, Volume II**). The MDZ comprises 35 km^2 and the ECC 4.75 km^2, (including an intertidal area of 0.01 km^2) totalling an area of 39.75 km^2 for the RLB. The RLB extends westward from the west coast of Holy Island, Anglesey, Wales. At the nearest point the MDZ lies approximately 0.5 km from the coast, with the farthest point approximately 7 km from the coast. The ECC lies to the east of the MDZ, between it and the coast.

38. The study area for the purpose of this chapter is defined as the boundary of ICES Statistical Rectangle 35E5, within which the MDZ and ECC are located. The boundaries of ICES Statistical Rectangle are shown in **Plate 10-1**.

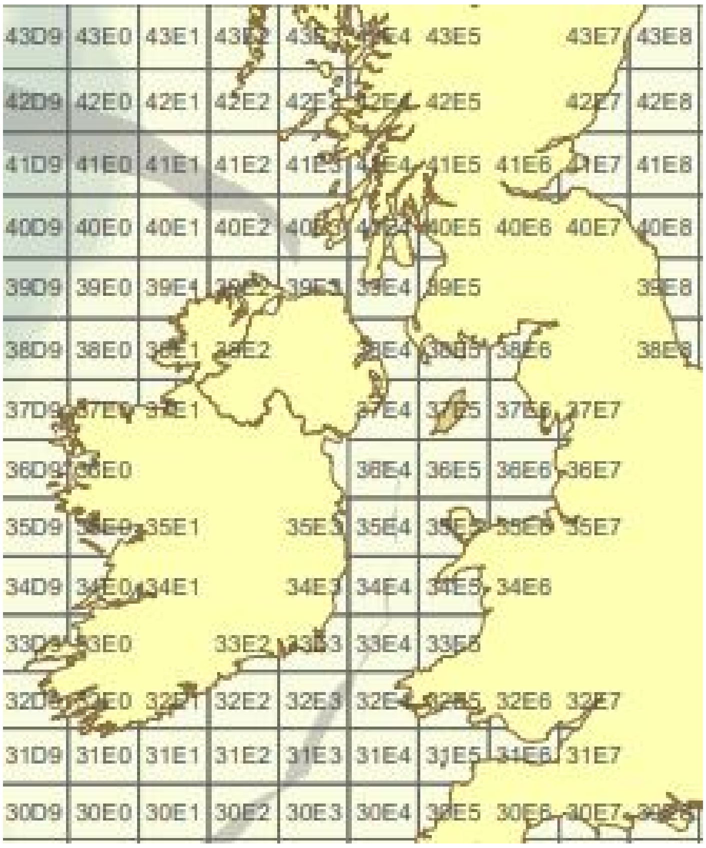

Plate 10-1 The ICES Statistical Rectangles in the Irish Sea

39. This study area lies within the greater Irish Sea West Functional Unit 15, in Division VIIa (Irish Sea), within subarea VII. The area is described in terms of its baseline environment of the fish

and shellfish community, with particular note of species that have key life stages in the area, or those that are of commercial or conservation importance. Where more fine-scale/local information is available, these have been used to supplement the knowledge at the study area scale.

40. The migratory fish community was characterised at a regional scale with their distribution based upon knowledge of their presence in rivers that lead into the Irish Sea (see **Document MOR/RHDHV/DOC/0067, Information to Support HRA,** for more details).

10.4.3. Data Sources – Desk Study

41. The primary resources used to inform this chapter include:

- Marine Life Information Network (MarLIN);
- SeaLifeBase and FishBase;
- SharkTrust;
- National Biodiversity Network (NBN) Atlas;
- ICES landings data;
- IUCN Red list;
- Relevant nature conservation legislative documents;
- Consultation responses; and
- Published and unpublished literature.

10.4.4. Data Sources – Site-Specific Surveys and Reports

42. No site-specific surveys for fish and shellfish were conducted for the Project. Based on the nature of the area and likely (low level of) impacts on fish species it was determined that site-specific surveys were not required. This approach follows the clear precedent set by offshore energy developments in recent years.

43. Although not directly related to fish, one site-specific survey conducted for the Project was used to inform this chapter (detailed results are presented in **Chapter 9, Benthic and Intertidal Ecology**):

- Ocean Ecology, 2018. MDZ Benthic Ecology Characterisation Survey 2018.

10.5. EXISTING ENVIRONMENT

44. The distribution of fish and shellfish is influenced by abiotic and biotic factors. Abiotic factors, those that characterise the physical environment, can include water temperature, salinity, nutrient levels, water depth, bathymetry, hydrographic regime, substrate and physical habitat. Biotic factors, those that characterise the biological environment, can include food availability, predator-prey interactions, competition and human activities.

10.5.1. Physical Environment

45. The study area lies within the eastern Irish Sea. The bathymetry of the Irish Sea is defined by a deep (up to 150 m) channel orientated north-south in the western part (Parker-Humphreys, 2004). This channel forms a boundary at the western edge of the extensive, shallow coastal shelf upon which the Project is located. The channel is thought to play an important role in the ecology of the demersal fish in the area, creating a divide between populations and consequent differences in their life history traits, and also allowing for the occurrence of deep-water fish from the Celtic and Sea and north-west Scotland.

46. The circulation of the Irish Sea is characterised by an overall south-to-north flow, passing to the west of the Isle of Man (Parker-Humphreys, 2004). The eastern Irish Sea, off the coast of North Wales, is dominated by an anti-clockwise gyre, which entrains water from south to north, along the north-west coast of Wales.

47. There are several seasonal fronts within the Irish Sea. In spring, a strong front develops in the western Irish Sea close to Ireland, keeping the mixed waters to the southeast (including the Project) separate from the stratified waters to the northwest. Local seasonal fronts may also develop in the eastern Irish Sea near Liverpool (to the east of the Project), and in Cardigan Bay (to the south of the Project).

48. The site-specific physical characteristics are detailed in **Chapter 7, Metocean Conditions and Coastal Processes**. Within the MDZ, water depth ranges from 2 m at the landfall and up to 72 m in the northwest part. The average depth is approximately 40 m. Most of the seabed comprises large areas of outcropping bedrock with minimal relief above surrounding bed levels. There is a sand ridge north of South Stack that extends northwards for approximately 1 km. The seabed is uneven at a local scale due to the presence of bedforms of a variety of size.

49. Tidal conditions are characterised as having a typical spring tidal range of around 4.5 m and a typical neap tidal range of around 3.0 m. There are very high baseline current speeds (>2 m/s) in the MDZ. Dominant wave conditions in the MDZ are from south-southwest to southwest. Dominant sediment type is gravel or gravelly sand in the MDZ.

10.5.2. Biological Environment

50. Food availability is an important factor in determining the distribution of fish and shellfish. Certain species are mobile and so able to forage large distances for food, whereas others remain in one area and so are reliant upon the environment at that location for food. Important food sources to fish and shellfish can range from plankton, for shellfish and small species including juvenile life stages, through to animals larger than themselves (cetaceans, sharks) for parasitic species such as lamprey.

51. Fish and shellfish are an important food source for many species in the area. Species that may predate on fish include other fish, birds, and cetaceans. As detailed in **Chapter 12, Marine Mammals**, the diet of the most common marine mammal species in the area (harbour porpoise, bottlenose dolphin, grey seal) is comprised mostly of fish, with crustaceans also important. Species such as herring, sprat and sandeel are key prey items of several marine ornithology receptors, as stated in **Chapter 11, Marine Ornithology**.

52. As fish and shellfish can comprise both prey and predators to certain species, there will be competition with identified species occupying the same trophic level. Furthermore, they may be competition for habitats for sessile species.

53. The biological habitats present in the greater region are outlined in **Chapter 9, Benthic and Intertidal Ecology**. In summary, the intertidal areas around Anglesey are extensive areas of relatively undisturbed habitats comprised of high energy rocky shores, sea cliffs, coastal heathlands and coastal grazing. The west of Anglesey, where the export cable will make landfall, has substantial areas of exposed shores which are largely coastal cliff headlands with beaches comprise of moderate coarse sediments. The benthic communities around the Project are typically common in the Anglesey area and the wider Welsh coastal regions. These communities are typically comprised of common polychaetes, crustaceans, molluscs and echinoderms.

54. Human activities may cause effects in the area that can potentially lead to impacts upon fish and shellfish species. This includes fishing activity, aquaculture, extraction and deposition activities, and development. Furthermore, human-induced climate change may affect the future distribution and production of the fish and shellfish resource.

55. Fisheries are a particularly important extractive activity in the area, as detailed in **Chapter 14, Commercial Fisheries*.*** The most common fishing activity in the MDZ utilises static fishing gear, particularly pots, targeted towards catching crab/lobster and whelks. Otter trawls for scallop species are also common in the deeper waters that surround the MDZ, within the study area.

56. The important biological factors of the receptor species that need to be taken into consideration include the distribution in the study area, with particular reference to the occurrence of key areas such as spawning, nursery or feeding grounds or migratory routes and any overlap with the MDZ.

57. The occurrence of the receptor species in the study area needs to be considered in terms of temporal and spatial patterns. Value of the species, in terms of conservation or commercial importance, is also determined.

58. The Irish Sea is utilised by species of migratory fish that spend part of their life cycle in the marine environment as well as the freshwater environment. Rivers that lead to the Irish Sea and have known populations of such migratory fish species are considered as part of the biological environment that can be influenced by the Project.

10.5.3. Fish and Shellfish Species Present

59. In order to establish the fish and shellfish present in the area a range of resources were used. An overview of the data from commercial fisheries is presented below, though a more in-depth analysis can be found in **Chapter 14, Commercial Fisheries**. Commercial fisheries data is not necessarily representative of the species present in an area, as the species landed are targeted using selective gear types and are predominantly driven by demand. Therefore, information has been sourced from published and grey literature reports, including surveys from nearby developments, to supplement commercial data.

10.5.3.1. Commercial Fisheries

60. Fisheries landing data from ICES Rectangle 35E5 for the period 2013-2017 (MMO, 2018) was used to determine the presence and relative importance of commercial fish and shellfish species. Shellfish species are the highest group by landed weight, of which whelks *Buccinium undutam* are the most landed at 170 tonnes and also the most valuable, worth nearly £5,000,000 from 2013-2017. Other commercially important shellfish species include crabs, lobsters, prawns, scallops, and specifically queen scallops *Aequipecten opercularis*, all of which had more than 50 tonnes landed from 35E5. Bass *Dicentrarchus labrax* are the by far the most landed fin fish at 60 tonnes, with cod *Gadus morhua*, flounder *Platichthys flesus*, mackerel *Scomber scombrus*, mullet species, plaice *Pleuronectes platessa*, pollack *Pollachius pollachius*, and thornback ray *Raja clavata* of minor commercial importance (10-20 tonnes landed).

61. Fishing activity in the MDZ, as indicated by local fishermen, is dominated by static gear, which are used to target shellfish species including crab (velvet and green shore), lobster, whelk and scallop. Prawns also feature highly in the MMO landings data (MMO, 2018), as well as bass. Skate were also highlighted as a key species during consultation. There is generally no pelagic fishing due to no quotas being available to fish species here.

10.5.3.2. Published Literature

62. The Irish Sea has a diverse fish community. Over 170 species of marine fish have been recorded in the area (Ellis et al., 2002). CEFAS beam trawls between 1993-2001 recorded over 100 species (Parker-Humphreys, 2004). Both of these species counts were based upon survey data taken from a spatial scale greater than the survey area. However, these have been used as there is no data at a more fine-scale resolution that contains the MDZ.

63. The fish surveys conducted between 2010-2015 as part of the Horizon Nuclear Power (HNP) development identified 96 unique species through their range of survey methods (HNP, 2018a). These surveys occurred off north Anglesey, wholly within ICES Statistical Rectangle 35E5. The data acquired are considered a good representation of the study area.

64. The Irish Sea contains several distinct assemblages of pelagic and demersal fish. There are three types of demersal fish assemblage, and four types of generic fish assemblage. The study area is characterised as having an inshore demersal assemblage, dominated by plaice, dab and sole, as revealed by otter trawls (Ellis et al., 2002). The MDZ is likely to have traits of the "eastern inshore" fish assemblage, based on depth, although there were no surveyed sites nearby. Little seasonal variation is reported for these assemblages (Ellis et al., 2002). Note that the surveys used for gathering this data are aimed at sampling commercially important species, and so do not sample large pelagic or littoral species, but are still very useful (Ellis et al., 2002).

65. Each of the species identified as overlapping the Project needs to be assessed for its protected status as well as the presence of any spawning, nursery or feeding grounds for the impact assessment. The sources used to identify these parameters are described below.

10.5.3.3. Species and Habitats of Conservation Importance

66. Certain fish and shellfish species found in the area have been given protection measures due to their nature conservation status. The protection measures and the relevant fish and shellfish they protect are listed below:

- Habitats Directive – under this Directive Special Areas of Conservation (SAC) are designated for protected habitats and species. Designated migratory fish species on Annex II of the Directive that are found in the region include sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, allis shad *Alosa alosa*, twaite shad *Alosa fallax*, and Atlantic salmon *Salmo salar*. All five species are interest features of nearby SACs;
- UK Post-2010 Biodiversity Framework (this replaces the earlier UK Biodiversity Action Plan (BAP)) - species which are of principal importance under this designation include those of commercial importance such as plaice, whiting and Dover sole, as well as rare species, such as some elasmobranchs and shellfish;
- Marine Conservation Zones (MCZ) – these focus on threatened, rare or declining habitats and species. One marine site in Wales has been designated as an MCZ, specifically around Skomer Isles in south-west Wales. A further 6 sites have been recommended as MCZs in offshore Welsh waters (beyond 12 nm) (Royal Yachting Association (RYA), 2019), of which the nearest to the site may be approximately 12 nm
- The OSPAR Convention - this Convention provides legislative protection for commercially exploited and ecologically vulnerable species such as cod, sea lamprey and European eel, all of which are found in the region. OSPAR has established a list of threatened and/or declining species and habitats in the north-east Atlantic. The list provides an overview of the biodiversity in need of protection and is being used by the OSPAR Commission to guide priorities for further work on the conservation and protection of marine biodiversity;
- Wildlife and Countryside Act, 1981 – Schedule 5 of this Act lists species that are afford legal protection from intentional harm. Species on the list that are found in the area include shad, basking shark, angel shark, and seahorses;
- Natural Environment and Rural Communities Act 2006 – this Act was designated to help achieve a rich and diverse natural environment as well as improving rural communities. Sections 41 and 42 of this Act lists species of principal importance to achieve this goal. Note that this legislative instrument has been replaced in Wales by the Environment (Wales) Act 2016 though the list remains the same; and
- Common Fisheries Policy (CFP) zero Total Allowable Catch (TAC) species – there are certain species which are not allowed to be landed commercially under the CFP. This includes key species such as European eel and the rarer elasmobranch species.

10.5.3.4. Spawning and Nursery Grounds

67. The presence of spawning and nursery grounds for different fish and shellfish species in the area were identified using the following sources: Pawson and Robson (1996), Coull et al. (1998), Ellis et al. (2012), and Aires et al. (2014). The location of spawning and nursery grounds for different fish species that are in the vicinity of the study area are presented in **Figures 10-1**, **10-2**, and **10-3** (**Volume II**).

68. In summary, the MDZ overlaps important spawning and nursery grounds for many fish species. The MDZ lies within a nursery area for anglerfish (**Figure 10-1, Volume II**). Cod, mackerel, sandeel and sole also have nursery areas that overlap the MDZ, with spawning grounds also nearby (~20 km away) (**Figures 10-1** and **10-2, Volume II**). The MDZ overlaps both spawning and nursery areas for spotted ray and whiting (**Figures 10-2** and **10-3, Volume II**). Tope shark and plaice spawning grounds overlap the MDZ, and plaice also has a nursery area nearby (~20 km) (**Figures 10-1** and **10-3, Volume II**). Thornback ray have spawning areas near (~20 km) the MDZ (**Figure 10-3, Volume II**).

10.5.4. Elasmobranchs

69. The study area is been defined as the ICES Statistical Rectangle 35E5. The presence of elasmobranch species within this study area was determined using several sources: ICES landings from region 35E5 (MMO, 2018), ICES factsheet for region VII (FAO, 2008), National Biodiversity Network (NBN) Atlas (NBN, 2019), and the Horizon Nuclear Power (HNP) report on fish and shellfish (HNP, 2018a).

70. According to the FAO (2008) the elasmobranchs in region VIIa include: thornback ray *Raja clavata,* spotted ray *Raja montagui*, blonde ray *Raja brachyura*. Fish surveys conducted around the north of Anglesey (HNP, 2018a) also confirm bull huss *Scyliorhinus stellaris*, spurdog *Squalus acanthias*, and tope *Galeorhinus galeus*. The NBN Atlas also list additional elasmobranch species with recorded presence (two or more confirmed records) in the study area, including: undulate ray *Raja undulata*, lesser-spotted dogfish *Scyliorhinus canicula*, and basking shark *Cetorhinus maximus*.

71. Common skate *Dipturus batis-c*omplex was historically distributed throughout the continental shelf waters of the north-east Atlantic, however it has declined severely in the Irish Sea, with only very occasional records reported (International Union for Conservation of Nature (IUCN), 2019). There is one record of this species in the area on the NBN Atlas, though this was obtained in 1983 (NBN Atlas, 2019). As a precautionary measure, due to its nature conservation status, this species has been included as part of the baseline community.

72. Similar to common skate, the angel shark *Squatina squatina* originally ranged across the continental shelf waters of northeast Atlantic, however now its presence is almost completely limited to the Canary Islands (IUCN, 2019). There exists one historic record off Anglesey in 1992 on the NBN Atlas. However, recent records of catches have been recorded off Wales (Angel Shark Project, 2019). Due to recent records in the study area, this species has been included as part of the baseline community.

73. Elasmobranch species that have confirmed presence in the study area have been described in terms of their ecology in **Table 10-9**.

74. It should be noted that many of these species would not be expected to be encountered in the MDZ due to absence of suitable habitat. Many elasmobranch species, particularly the skates, rays and angel shark, prefer soft bottoms, which are not found in the MDZ. Only the two *Scyliorhinus* species have habitat preferences that may align with the habitats present in the MDZ. Other more benthopelagic species, with less habitat preference (spurdog, tope, and basking shark), typically inhabit deeper waters with the shallow waters of the MDZ representing the upper limit of their range. .

Table 10-9 Important Elasmobranch Species Present in the Study Area and their Ecology

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
Thornback ray	Overwinters in deeper water, migrating into shallower areas in the late spring and summer (February-September) to spawn.	Inhabits continental shelf and upper slope waters from 10-300 m, though it is most abundant in waters 10-60 m. Frequents a range of sediments, though not typically coarser sediments.	Mostly non-migratory, though fish often moves close inshore during the spring.	Adults feed on large crustaceans and small teleost fish such as sandeels, small gadoids and dragonets, whereas juveniles prefer small crustaceans.	SharkTrust, 2019 MarLIN, 2019
Spotted ray	Limited information on the reproductive biology of this species	Majority of population found in waters 100-500 m deep. Prefers soft, sandy substrates in coastal seas and on continental shelves	Mostly non-migratory, though females migrate to shallow waters from April-July to spawn.	Adults feed on large crustaceans, teleost fish, polychaetes and molluscs, juveniles on small crustaceans.	SharkTrust, 2019 MarLIN, 2019
Blonde Ray	Spawning occurs between February and August.	Varied depth range depending on location, up to 150 m in NE Atlantic, 10-300 m in Mediterranean, and globally up to 900 m. Typically occurs on soft substrate such as sandy and muddy ground.	Shallow, coastal waters are used as nursery areas, leading to an increased presence of juveniles.	Both adults and juveniles feed on crustaceans, with larger adults also taking cephlapods and small teleosts.	SharkTrust, 2019 MarLIN, 2019
Common skate complex	Mating occurs in spring, followed by spawning in summer.	Lives on sandy and muddy bottoms, at depths of 10-600 m.	Juveniles prefer shallow waters.	Actively hunts other elasmobranchs, teleosts, cephlapods and crustaceans.	SharkTrust, 2019 MarLIN, 2019
Undulate ray	Breeding occurs between March and June	The species occurs at a range of depths, from 10-200 m. It prefers sandy substrate	Unknown	Varied diet depending on age. Young feed on crustaceans, molluscs and small fish, whereas adults specialise in crustaceans only	SharkTrust, 2019 MarLIN, 2019
Lesser-spotted dogfish (aka smallspotted catshark)	Egg-laying occurs during spring and early summer	Found from shallow sublittoral waters up to 400 m, mostly on sand and mud, but also on algae, rocky and gravelly bottoms	Females come inshore during the warmer months to lay eggs	It feeds opportunistically on a range of benthic fauna, mostly crustaceans and molluscs. Feeding intensity is highest during the summer	SharkTrust, 2019
Greater spotted dogfish (aka	Spring and summer are when egg-laying occurs	Found at depths of up to 125 m but most common between 20-63 m.	Shallow waters are used for egg-laying. The Llŷn	Take a variety of prey, mostly crustaceans, but also molluscs, small teleosts and *S. canicula*	SharkTrust, 2019 MarLIN, 2019

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
nursehound, bull huss)		Prefers rough, rocky or coralline grounds with algal cover	Peninsula is thought to be important		
Angel shark	Birthing occurs in July in this region	Inhabits coasts and estuaries, in waters of 5-150 m depth. Buries itself in the substrate during the day, active at night	Migratory in this region, moving north during summer, and south during winter	Diet comprises mostly bony fish, especially flatfish, and also skates, crustaceans, and molluscs	SharkTrust, 2019
Spurdog (aka spiny dogfish)	Timing of reproduction varies by location, though it broadly occurs between January-August	Found in inshore waters to continental shelf, most commonly 10-200 m but recorded up to 900 m. Is epibenthic but also occurs in water column, with no preference for habitat	Highly migratory, dependent on age and sex. Young females migrate to shallow waters to give birth	In this region their diet is mostly teleost fish (herring, whiting, Norway pout, cod, and Atlantic mackerel), with crustaceans often taken by smaller individuals	SharkTrust, 2019
Tope	Mating and partuition occurs during the spring	Found inshore through to 550 m depth, mostly near the seabed	Highly migratory in this region, moving north in the summer, and south in the winter. Females give birth in shallow waters	Feeds mostly on a wide variety of teleost fish, in addition to some invertebrates	SharkTrust, 2019
Basking Shark	Very little is known	Occurs mostly offshore but does venture into shallows near shore	Unknown	Passive filter feeder, feeding solely on plankton	SharkTrust, 2019

10.5.4.1. Commercial Importance

75. Commercially important elasmobranch species which are landed from ICES Statistical Rectangle (Rectangle) 35E5 (the study area) include lesser spotted dogfish and thornback ray. Other species of elasmobranch may also be caught, but not routinely identified to species when landed.

10.5.4.2. Spawning and Nursery Grounds

76. Of note is that the Project area overlaps with the spawning areas of tope shark and both the spawning area and nursery area of spotted ray. There are also spawning areas of thornback ray in the study area (nearest distance from the MDZ is 20 km).

10.5.4.3. Conservation Importance

77. The designated status of each of the species on the short list is listed in **Table 10-10**. The majority of elasmobranch species, specifically all but the two *Scyliorhinus* species, present in the study area are listed under nature conservation protection measures. Few of the elasmobranch species are of Least Concern; almost all have a greater threatened status according to the IUCN (2019). There are several species for which commercial landings are prohibited, in that they have a zero Total Allowable Catch (TAC) under the Common Fisheries Policy (CFP) (ICES, 2019).

78. In addition, the undulate ray is also an MCZ Feature of Conservation Importance (FOCI) species (Joint Nature Conservation Committee (JNCC), 2016).

Table 10-10 Nature Conservation Status of Elasmobranch Species Found Within the Study Area

Common Name	Nature Conservation Status							
	IUCN Red List	OSPAR Annex V (list of species threatened and / or in decline)	NERC Act 2006 Section 41 (England)	Environment Act Section 7 (replaced NERC Act Section 42 (Wales))	UK Biodiversity Action Plan (BAP)	UK Wildlife and Countryside Act 1981 Schedule 5	Habitats Directive	Common Fisheries Policy zero TAC species
Thornback ray	Near Threatened	Yes[1]	No	Yes	No	No	No	No
Spotted ray	Least Concern	Yes	No	No	No	No	No	No
Blonde Ray	Near Threatened	No	No	Yes	No	No	No	No
Common skate	Critically Endangered (A2bcd+4bcd)	Yes	Yes	Yes	Yes	No	No	Yes
Undulate ray	Global: Endangered (A2bd+3d+4bd) Europe: Near Threatened	No	Yes	Yes	Yes	No	No	Not assessed
Lesser-spotted dogfish (aka small spotted catshark)	Least Concern	No	No	No	No	No	No	Not assessed
Greater spotted dogfish (aka nurse hound, bull huss)	Near Threatened	No	No	No	No	No	No	Not assessed
Angel shark	Critically Endangered (A2bcd+3d)	Yes	No	Yes	Yes	Yes[2]	No	Yes
Spurdog (aka spiny dogfish)	Global: Vulnerable (A2bd+3bd) Europe: Endangered (A2bd)	Yes	Yes	Yes	Yes	No	No	Yes[3]

Common Name	Nature Conservation Status							
	IUCN Red List	**OSPAR Annex V (list of species threatened and / or in decline)**	**NERC Act 2006 Section 41 (England)**	**Environment Act Section 7 (replaced NERC Act Section 42 (Wales))**	**UK Biodiversity Action Plan (BAP)**	**UK Wildlife and Countryside Act 1981 Schedule 5**	**Habitats Directive**	**Common Fisheries Policy zero TAC species**
Tope	Vulnerable (A2bd+3d+4d)	No	No	Yes	Yes	No	No	No
Basking shark	Vulnerable (A2ad+3d)	Yes	Yes	Yes	Yes	Yes	No	Yes

1: Thornback ray is listed as under threat and / or in decline in OSPAR Region II (the Greater North Sea), which is outside the area.

2: Angel shark is only protected between 0 and 6 nautical miles; this protection does not apply to territorial waters between 6 and 12 nm.

3: Vessels are allowed to land spurdog as bycatch so long as they are part of a bycatch monitoring programme.

10.5.5. Demersal Fish

79. The fish community of the study area comprises mostly demersal fish species.

80. A “long list” of all potential species in the study area was created. The sources that informed this long list were Ellis et al. (2002) and the HNP report (2018a). The long list was then refined to a short list that only included species with preferences for habitat that can be found within the MDZ (based on depth and sediment type). The list was further refined by only including species of nature conservation, key life stages and/or commercial importance. The demersal fish species present on this short list are given in **Table 10-11**.

10.5.5.1. Commercial Importance

81. There are many species of demersal fish that were landed from ICES Rectangle 35E5 between 2013-2017 (MMO, 2018). Such species include bass, brill, cod, conger eel, dab, flounder, gurnards, haddock, john dory, lemon sole, ling, monkfish, mullet species, plaice, pollock, sole, turbot and whiting.

82. The area lies within a Bass Fishing Restricted Area for both recreational and commercial fisheries (MMO, 2019). For the 2019 season, only one individual seabass may be landed per recreational fisherman per day in the period 1st April to 31st October. Dependent on findings of future bass stock assessments, this restriction may be removed or revised in future years.

10.5.5.2. Spawning and Nursery Grounds

83. Of note is that the MDZ partially overlaps with nursery grounds for anglerfish, cod, sandeel, sole, and whiting. It also overlaps spawning grounds for plaice and whiting.

10.5.5.3. Conservation Importance

84. Within the demersal fish species identified as having potential presence in the MDZ (**Table 10-11)** there are many species which are protected under various nature conservation measures (**Table** 10-12). These include whiting, cod, anglerfish, hake, halibut and ling. There are several species with a threatened status according to the IUCN (2019). Only whiting are a zero TAC species under the CFP.

Table 10-11 Important Demersal Species with Likely Presence in the MDZ and their Ecology

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
Whiting	Spawning occurs January-September	Depth range 10-200 m, most commonly 30-100 m, over mud and gravel bottoms mostly, but also on sand and rock	Individuals migrate to open sea after first year	Feed on a range of benthic prey	FishBase (2019) IUCN (2019)
Tub gurnard	Spawns from May to July	Occurs at depth ranges of 20-318 m, on sand and gravel habitats	Unknown, though increase in number over wintering in North Sea	Fish, crustaceans and molluscs are prey	FishBase (2019) Seafish (2010)
Grey gurnard	Spawns April to August	Common on sand, rocky and muddy bottoms between coastal and 140 m depth	Unknown	Feeds on crustaceans and fish	FishBase (2019) Seafish (2010)
Cod	Spawning occurs in winter and beginning of spring	Juveniles prefer shallower waters (10-30 m) with complex habitats than adults (up to 600 m)	Migrate between spawning, feeding and overwintering areas, journeys of <200 km	Omnivorous, feeding on mostly fish and invertebrates	FishBase (2019)
Angler/monkfish	Spawning occurs between January and June	Occur at depths from coast up to 1,000 m, on sandy and muddy bottoms. May also be found on rocky bottoms	Migrate between inshore and offshore spawning grounds	Feeds mostly on fish that it lures	FishBase (2019) IUCN (2019)
European hake	Spawning occurs April-December, with a peak in February-March	Found usually between 30-1075 m, normally 70-400 m	Diurnal; off bottom during day, on bottom at night	Feed mainly on fish, with young feeding on small crustaceans	FishBase (2019) IUCN (2019)
Brill	Spawning occurs in first half of year, varies by location	Live on sandy or mixed bottoms up to 50 m	Adults found more offshore than juveniles	Feed on benthic fish and crustaceans	FishBase (2019) IUCN (2019)
Red gurnard	Spawns in summer	Found over sand, gravel and rock between 15-400 m	Unknown	Feeds mostly on benthic crustaceans and fish	FishBase (2019) Seafish (2010)
Turbot	Spawning season is April-August	Most common on sandy, rocky or mixed bottoms. Depth range 20-70 m	Unknown	Feeds mostly on benthic fish and less on crustaceans and bivalves	FishBase (2019)
Golden grey mullet	Spawn between July-November	Prefers coastal waters including estuaries	Juveniles move inshore in spring and winter	Feed on small benthic organisms	FishBase (2019)

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
Thin-lipped grey mullet	Spawn between September-February	Shallow water species (10-20 m)	Adults spawn at sea but spend most of the time in estuaries	Feed on algae and plankton	FishBase (2019)
Thick-lipped grey mullet	Spawns pelagic eggs in February-April	Prefers inshore waters	Move northward during summer due to temperature rises. Juveniles move between inshore and sea	Feed mostly on benthic plant matter and small invertebrates	FishBase (2019) IUCN (2019)
Bass	Spawning occurs in spring	Inhabit coastal waters up to 100 m on range of bottom types	Migrate from coastal to offshore waters in winter	Feeds mostly on shrimp and molluscs, as well as fish	FishBase (2019)
Conger eel	Spawn in summer	Found on rocky and sandy bottoms between 0-500 m	Moves to deeper waters as it matures	Feeds on fish, crustaceans and cephalopods at night	FishBase (2019)
John Dory	Spawning occurs at the end of winter/early spring	Remains near seabed	Unknown	Feeds mostly on teleosts, also cephalopods and crustaceans	FishBase (2019)
Ling	Spawn in spring	Occurs mostly in deep water (100-400 m) over rocky bottoms	Unknown	Feeds on large fish and invertebrates	FishBase (2019) IUCN (2019)
Pollack	Spawn in the late winter to spring	Found from nearshore to 200 m, over hard bottoms	Larger individuals move to more open sea. May take spawning migrations	Major predator of young cod	FishBase (2019)
Red mullet	Spawning occurs in May-July	Occurs mostly at depths up to 100 m over hard broken grounds	Adults migrate to shallows in spring/summer; juveniles move summer/autumn	Feeds mostly on benthic invertebrates	FishBase (2019) IUCN (2019)
Sand sole	Unknown	Occurs at depths usually 20-50 m. Found on gravel, sand or mud	Unknown	Feeds on a wide range of crustaceans, mostly bivalves	FishBase (2019) IUCN (2019)
Halibut	Spawn December-April	Lives mostly at sea bottom, depth range of 50-200 m. Occurs on sand, gravel or clay bottoms. Spawning over soft sediment	Unknown	Mostly feeds on other fish, also other benthos	FishBase (2019) IUCN (2019)

Table 10-12 Nature Conservation Status of Demersal Fish Species Found Within the Study Area

Common Name	Nature Conservation Status							
	IUCN Red List	**OSPAR Annex V (list of species threatened and / or in decline)**	**NERC Act 2006 Section 41 (England)**	**Environment Act Section 7 (replaced NERC Act Section 42 (Wales))**	**UK Biodiversity Action Plan (BAP)**	**UK Wildlife and Countryside Act 1981 Schedule 5**	**Habitats Directive**	**Common Fisheries Policy zero TAC species**
Whiting	Least Concern	No	Yes	Yes	Yes	No	No	Yes
Tub gurnard	Least Concern	No	No	No	No	No	No	Not assessed
Grey gurnard	Least Concern	No	No	No	No	No	No	Not assessed
Cod	Global: Vulnerable, Europe: Least Concern	Yes	Yes	Yes	Yes	No	No	No
Angler/monkfish	Least Concern	No	Yes	Yes	Yes	No	No	No
Hake	Least Concern	No	No	Yes	Yes	No	No	No
Brill	Least Concern	No	No	No	No	No	No	Not assessed
Red gurnard	Least Concern	No	No	No	No	No	No	No
Turbot	Europe: Vulnerable (A2bd)	No	No	No	No	No	No	Not assessed
Golden grey mullet	Least Concern	No	No	No	No	No	No	Not assessed
Thin-lipped grey mullet	Least Concern	No	No	No	No	No	No	Not assessed
Thick-lipped grey mullet	Least Concern	No	No	No	No	No	No	Not assessed
Bass	Least Concern	No	No	No	No	No	No	No
Conger eel	Least Concern	No	No	No	No	No	No	Not assessed
John Dory	Data Deficient	No	No	No	No	No	No	Not assessed
Ling	Least Concern	No	Yes	Yes	Yes	No	No	No

Common Name	**Nature Conservation Status**							
	IUCN Red List	**OSPAR Annex V (list of species threatened and / or in decline)**	**NERC Act 2006 Section 41 (England)**	**Environment Act Section 7 (replaced NERC Act Section 42 (Wales))**	**UK Biodiversity Action Plan (BAP)**	**UK Wildlife and Countryside Act 1981 Schedule 5**	**Habitats Directive**	**Common Fisheries Policy zero TAC species**
Pollack	Least Concern	No	No	No	No	No	No	No
Red mullet	Global: Least Concern; Europe: Data Deficient	No	No	No	No	No	No	No
Sand sole	Least Concern	No	No	No	No	No	No	Not assessed
Halibut	Global: Endangered (A1d); Europe: Vulnerable (A2ce)	No	Yes	No	Yes	No	No	Not assessed

10.5.6. Pelagic Fish

85. Four species of pelagic fish were identified as part of the ‘eastern inshore assemblage’ of the Irish Sea by Ellis et al. (2002). These were sprat *Sprattus sprattus*, herring *Clupea harengus*, Atlantic mackerel *Scomber scombrus* and horse mackerel *Trachurus trachurus*. Three of these species (not mackerel) were observed during the fish surveys as part of Horizon Nuclear development (HNP, 2018a).

86. Of these four species, herring and horse mackerel have designated status under protection measures. The Atlantic mackerel is the only species of pelagic fish which has been landed from ICES Rectangle 35E5 as sprat is not of conservation or commercial importance it is not considered further.

87. The ecology of the three pelagic species is presented in **Table 10-13**, and their nature conservation status presented in **Table 10-14**.

10.5.6.1. Spawning and Nursery Grounds

88. According to Pawson and Robson (1996), herring in the eastern Irish Sea have spawning grounds to the south of the Isle of Man and nursery grounds along the coastal, extending as far south as the north coast of Wales east of Anglesey. Neither of these are within 50 km of the study area. More recently herring has been assessed to have nursery grounds off the coast of Ireland (Coull et al., 1998; Aires et al., 2014) though again not overlapping the study area.

89. Mackerel is thought to spawn throughout the shelf waters of the UK (Pawson and Robson, 1996). The study area lies within a low intensity spawning ground, and there are low intensity nursery grounds in that adjacent ICES Rectangles to the north, which are approximately 20 km away (Ellis et al., 2012).

90. It is not possible to identify discrete spawning grounds for horse mackerel as juveniles are widespread (Ellis et al., 2012). Aires et al. (2014) indicate a patchy distribution of high probability of 0-group aggregations throughout the Irish Sea, including off north-west Wales.

Table 10-13 Important Pelagic Species Present in the MDZ and their Ecology

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
Atlantic herring	Comes to coastal areas to spawn. Both autumn and winter-spawning stock present	Occupy the water column from surface to 200 m depth	Comes to coastal areas to spawn	Feed mostly on small shrimps and copepods, with occasional filter-feeding	MarLIN (2019)
Horse mackerel	Spawning occurs in early spring for the “West stock”	Found on continental shelves (frequently over sandy bottoms) up to 500 m depth	Following spawning the stock migrates north to southern Norway/northern North Sea	Feeds on crustaceans, cephlapods and dfsh	IUCN Red List (2019) MarLIN (2019)
Mackerel	Spawning occurs during summer	Widely distributed on coastal shelves up to 200 m depth	Migrate in winter and early spring to spawning areas (inshore); spawn in summer; migration to post-spawning feeding grounds and overwinter areas	Filter-feeders on zooplankton, such as small fish and prawns	Angler’s World (2014) MarLIN (2019)

Table 10-14 Nature Conservation Status of Pelagic Fish Species Found Within the Study Area

Common Name	Nature Conservation Status							
	IUCN Red List	OSPAR Annex V (list of species threatened and / or in decline)	NERC Act 2006 Section 41 (England)	Environment Act Section 7 (replaced NERC Act Section 42 (Wales))	UK Biodiversity Action Plan (BAP)	UK Wildlife and Countryside Act 1981 Schedule 5	Habitats Directive	Common Fisheries Policy zero TAC species
Herring	Least Concern	No	Yes	No	Yes	No	No	No
Horse mackerel	Global: Vulnerable (A2bd); Europe: Least Concern	No	Yes	No	Yes	No	No	No
Mackerel	Least Concern	No	Yes	No	Yes	No	No	No

10.5.7. Shellfish

91. The long list of shellfish species found in the area was determined from Pierce et al. (2005), landings data from ICES Rectangle 35E5, consultation with local fishermen, the scoping document (Royal HaskoningDHV, 2018), and the HNP (2018a) report. The long list was then narrowed down to species for which the MDZ presents suitable habitat, followed by those which are of nature conservation, commercial, or key life stage importance. The resultant short list of species and their ecology is presented in **Table 10-15.**

92. Clams, and specifically razor clams, are listed as a species landed from the area (ICES Rectangle 35E5). However, this common name can comprise multiple species therefore it was not possible to determine which species should be included. This is not of issue to the assessment as it is unlikely that clams would be present in the area due to the absence of suitable burying habitat in the MDZ.

10.5.7.1. Commercial Importance

93. Species of shellfish that have been landed from ICES Rectangle 35E5 between 2013-2017 are squid, crab (including specifically velvet swimming crab), European lobster, scallops (including specifically queen scallop), whelks, common prawns, and Norway lobster.

94. In addition, key shellfish species for the local area identified during consultation include crab (velvet and green shore), lobster, whelk, scallop and prawns.

10.5.7.2. Spawning/Nursery Area

95. The majority of shellfish species found in the area do no undertake migrations as they remain in one area throughout their life cycle. Some may undertake seasonal migrations to more inshore waters for spawning and nursery (specifically veined squid and common prawn). As the site is inshore it can be assumed that any shellfish species found in the area will be spawning in the area.

10.5.7.3. Nature Conservation Status

96. Most shellfish species are not designated under any protected measures. Indeed, most species are not even evaluated by the IUCN, and those that are considered of Least Concern (common cuttlefish, curled octopus, European lobster, and Norway lobster).

97. The only designated species found in the study area is the native or flat oyster *Ostrea edulis*. The NBN Atlas details accepted records of this species around the west coast of Anglesey, including off Holy Island (within 10 km). This species is designated under the NERC Act 2006 Section 41 (England), Environment Act Section 7 (replaced NERC Act Section 42 (Wales)), and UK Biodiversity Action Plan (BAP). It is also listed as threatened and / or in decline under OSPAR however only in the North Sea.

98. Although the species in themselves are not designated, both blue mussel beds (including intertidal beds on mixed and sandy sediments) and native oyster beds are designated as MCZ Habitat FOCI (JNCC, 2016). These have been recorded throughout the coast of Holy Island, including landward of the MDZ (NBN Atlas, 2019).

99. These two species have been recorded in the study area and are of conservation importance, therefore they are listed here for precautionary measures. However, it should be noted that these were not found in the MDZ area during the site-specific benthic survey (see **Chapter 9, Benthic and Intertidal Ecology**).

100. There are Shellfish Water Protected Areas in the coastal and brackish waters in Wales which are protected under the Water Framework Directive (NRW, 2018). There are six Shellfish Water Protected Areas around the coast of Anglesey., of which the nearest to the site is approximately 20 km to the south. More information can be found in **Chapter 8, Marine Water and Sediment Quality**.

Table 10-15 Important Shellfish Species with Likely Presence in the MDZ and their Ecology

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
European common squid	Spawning occurs intermittently over several months (season varies; in English Channel peak is late autumn/early winter)	Usually in the water column over sandy and hard bottoms. Occurs down to 200 m	Abundance varies	Squid feed upon fish, as well as crustaceans, polychaetes and other cephalopods	Pierce et al (2005) MarLIN (2019)
Brown crab	Mating takes place in spring and summer. Females are berried for 6-9 months, during which they remain in pits dug into the sediment or under rocks, not feeding. Larvae are released in late spring / early summer juveniles settle in the intertidal zone in late summer / early autumn.	Usually at depths between 6 m-40 m, but can be found offshore at depths of up to 100 m. Found on a range of substrates such as sand, gravel and rocky seabeds	Juveniles may remain in intertidal areas for approximately 3 years before moving to subtidal areas.	Crustaceans including smaller brown crabs as well as bivalve molluscs.	Royal HaskoningDHV (2018) HNP (2018a) Regnault (1994) Bennett (1995) MarLIN (2019)
Spider crab	This species is thought to move offshore during the autumn and inshore during the spring.	Adults occur in sublittoral to depths of 90 m, on rocky bottoms with algae. Juveniles prefer shallows on mixed soft/hard bottoms	Only use slow, small-scale, non-directional movements	Feed upon algae and molluscs during the winter and echinoderms during the summer; general omnivorous diet	Royal HaskoningDHV (2018) Bernardez *et al.* (2000) SealifeBase (2019)
Velvet swimming crab	Mating occurs after the moult. Females bear eggs mostly in spring, eggs hatch in late spring	Shallow and intertidal to 80 m	Females migrate to soft substrates for egg laying	Opportunistic feeder, mostly on molluscs and crustaceans but also detritus and algae	HNP (2018a) SeaLifeBase (2019)

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
European lobster	Mating takes place in the summer and is annual or bi-annual. Eggs carried for 10-11 months.	Rocky and stony substrata, usually not deeper than 50 m	Do not undertake migrations; will only move a few miles along the shore	Preys on crabs, molluscs, sea urchins, polychaete worms and starfish	Royal HaskoningDHV (2018)
Blue mussel	Peaks in spawning in spring and summer	Occurs from the high intertidal to the shallow subtidal. Uses fibrous byssus threads to attach to suitable substrata	N/A	Filter feeders and collect algae, detritus and organic material	Royal HaskoningDHV (2018) Cefas (2014) MarLIN (2019)
Native oyster	Spawning is frequent, most often between June-September	Estuarine and shallow coastal water habitats on mud, rocks, muddy sand, muddy gravel with shells, and hard silt.	N/A. Dispersal of young estimated to be more than 10 km	Filter feeders of phytoplankton	Royal HaskoningDHV (2018) MarLIN (2019)
King scallop	Scallops spawn in spring or summer and probably require dense concentrations to achieve the successful production of larvae.	Coarse gravel with some erect epifauna and shell is known to be suitable for successful settlement and recruitment of larvae to the stock.	N/A	Filter feeder	Royal HaskoningDHV (2018) HNP (2018a)
Queen scallop	Scallops spawn in spring or summer and probably require dense concentrations to achieve the successful production of larvae.	Coarse gravel with some erect epifauna and shell is known to be suitable for successful settlement and recruitment of larvae to the stock.	N/A	Filter feeder	Royal HaskoningDHV (2018) HNP (2018a)
Common whelk	Whelk have a low fecundity and entirely benthic reproductive strategy. Whelk spawn between November and January, laying distinctive egg masses which are then	Muddy sand, gravel and rock.	Common whelk has low growth rates and restricted adult movements.	Carnivorous predator and active scavenger.	Royal HaskoningDHV (2018) HNP (2018a) MarLIN (2019)

Species	Seasonality	Habitat Association	Migration	Predator-Prey relationship	Sources
	attached to suitable substrate.				
Common cockle	Main reproductive season is May-June	Burrows in sand, mud, and gravel substrate in intertidal zone	N/A	Filter feeder	Cefas (2014) MarLIN (2019)
Common prawn	Mating directly after first moult; females carry eggs for 9-11 months	Rocky and muddy bottoms in the shallows (up to 40 m)	Occur in shallows (feeding and nursery habitat) during summer months and in deeper water during winter. Also tidal and diurnal migrations	Omnivorous, feeding on seaweed and small crustaceans	SeaLifeBase (2019)
Common/green shore crab	Berried females found January-May. Eggs hatch in spring/summer	From high water to 60 m depth, though most common in shallows. Found on all types of shore	Generally no migration, though females in estuary move to mouth of estuary to lay eggs	Omnivore, both animal and plant matter from a variety of species	MarLIN (2019)

10.5.8. Migratory Fish

101. There are several species of fish which spend part of their life cycle in the marine environment and the other in the freshwater environment, i.e. diadromous species. Whilst they are in the marine environment they may have the potential to overlap with the Project. It is therefore important to understand their migration patterns to determine whether they require assessment in this chapter. The migratory patterns of diadromous species are outlined in **Table 10-16**.

Table 10-16 Migratory Periods of Key Diadromous Species

Species	Time spent in freshwater before downstream migration	Timing of downstream migration	Time spent at sea before first return	Timing of upstream migration
Atlantic salmon	2-3 years	April- May (Smolt)	1, 2 or 3 years	All year round with peak in late summer early autumn (Adults)
Sea trout	2-3 years	Spring/early summer	2 or more in coastal areas	April- June
European eel	Males 7-20 years Females 9-50 years	Late spring (as silver eels)	Many do not return to fresh water	January to June (as juvenile glass eels)
Sea lamprey	3-4 years	July to September to open sea	18-24 months	April-May spawning in May/June
River lamprey	5 years or more. Remain in burrows in river silt beds until adults	July to September to feed in estuaries	2 years spent in estuaries.	Winter and spring when temps are <10oC. Migrate at night
Allis and Twaite Shad	Short period few months (Juveniles)	April/May (Juveniles)	3-4 years Estuarine areas	April to May spawning in freshwater

102. As a precautionary measure all species considered to have a migratory pathway overlapping the site in the HRA are scoped in for assessment here. This includes Atlantic salmon, both species of lamprey and both species of shad. Though it should be noted that there are no natal rivers for any of these species on the coastline adjacent to the MDZ.

103. The European eel undertakes extensive migration from rivers around the UK to their spawning grounds in the Sargasso Sea, North America. Eels travelling through the Irish Sea therefore migrate in a southerly direction, exiting through the southwest approaches. There are known stocks of European eel to the north of the site (Bark et al., 2007), therefore it can be considered that the species may overlap with the site and as such should be assessed.

104. Sea trout are present in the rivers of Anglesey, although it should be noted that no such rivers have mouths adjacent to the MDZ. When they move into the marine environment sea trout remain in coastal waters, as they have very limited migrations in terms of distance, although there is limited information on the range. Due to the lack of knowledge on at-sea migration and the presence of sea trout rivers nearby, this species has been screened in as a precautionary measure.

10.5.8.1. Commercial Importance

105. Most of the species listed in Table 10-16 are not commercially landed whilst at-sea, hence their absence from TACs and catch data from ICES Rectangle 35E5. The exception is European eel, for which ICES state that all anthropogenic impact (including recreational and commercial fishing) should be "reduced to – or kept as close to – zero as possible."

106. Across England and Wales in 2015 catches of eel (across all life stages) weighed a total of 25,000 kg (Environment Agency, 2017), indicating species value despite the near-zero TAC. By contrast lampreys caught in England and Wales in 2015 weighed 285 kg (Environment Agency, 2017), indicating limited commercial importance.

107. Atlantic salmon and sea trout are of importance to the recreational fishing industry in Wales. These species are typically caught by rod (of which, most are released) and by net. In Wales approximately 3,000 salmon and 15,000 sea trout were caught in 2015 (Environment Agency, 2017).

108. Shad are considered rare and as such are not meant to be fished in Wales.

10.5.8.2. Spawning/Nursery grounds

109. There is no predicted overlap between the study area and any spawning grounds of diadromous species. Almost all of the diadromous species return to freshwater to spawn; the exception is the European eel, though these spawn in the Sargasso Sea, North America.

110. Nursery grounds for the freshwater spawning fish can typically include coastal areas at the base of the rivers they have spawned in. There are no estuaries adjacent to the project, therefore it is not considered that it will overlap with any nursery areas.

10.5.8.3. Nature Conservation Status

111. The nature conservation status of migratory fish species is detailed in **Table 10-17**.

112. Of the migratory fish species listed in **Table 10-16** there are five that are listed under Annex II of the Habitats Directive. These species, listed in **Section 10.5.3.3**, are the sea lamprey, river lamprey, allis shad, twaite shad, and Atlantic salmon. These are all the species listed on Annex II that are known to enter the marine environment.

113. There are 20 SACs in the vicinity of the study area that are designated for Annex II migratory fish species. The location of these SACs are shown in **Figure 10-4** (**Volume II**). The nearest SAC, Afon Gwyrfai a Llyn Cwellyn, is approximately 30 km distance from the study area.

114. It is possible that individuals from populations designated under these sites may occur in the study area, due to their migratory behaviour. All five Annex II migratory fish species have populations in these nearby SACs.

115. The European eel is also an MCZ (highly mobile) species FOCI (JNCC, 2016), though no MCZs are designated for this species in the vicinity of the study area.

Table 10-17 Nature Conservation Status of Migratory Fish Species Found Within the Study Area

Common Name	Nature Conservation Status							
	IUCN Red List	OSPAR Annex V (list of species threatened and / or in decline)	NERC Act 2006 Section 41 (England)	Environment Act Section 7 (replaced NERC Act Section 42 (Wales))	UK Biodiversity Action Plan (BAP)	UK Wildlife and Countryside Act 1981 Schedule 5	Habitats Directive	Common Fisheries Policy zero TAC species
Atlantic salmon	Global: Least Concern; Europe: Vulnerable (A2ace)	Yes	Yes	Yes	No	No	Yes	Not assessed
Sea trout	Least Concern	No	Yes	Yes	No	No	No	Not assessed
European eel	Critically Endangered (A2bd+4bd)	Yes	Yes	Yes	No	No	No	Yes
Sea lamprey	Least Concern	Yes	No	Yes	No	No	Yes	Not assessed
River lamprey	Least Concern	No	No	Yes	No	No	Yes	Not assessed
Allis shad	Least Concern	Yes	Yes	Yes	No	Yes	Yes	Not assessed
Twaite shad	Least Concern	No	Yes	Yes	No	Yes	Yes	Not assessed

10.6. IMPACT ASSESSMENT

10.6.1. Overview of Potential Impacts

116. **Table 10-18** provides a brief list of the potential impacts on fish and shellfish that may arise during activities undertaken during each phase of the Project.

Table 10-18 Potential Impacts of the Project Phases on Fish and Shellfish

Phase	Potential Impact
Construction	Impact 1: Underwater Noise Impact 2: Physical disturbance of habitats and temporary habitat loss Impact 3: Increased suspended sediment concentration and sediment deposition
Operation and Maintenance	Impact 1: Underwater Noise (and via repowering) Impact 2: Long-term habitat loss via placement of project infrastructure (project footprint) (and via repowering) Impact 3: Physical disturbance of habitats and temporary habitat loss (repowering only) Impact 4: Increased suspended sediment concentration and sediment deposition (repowering only) Impact 5: Barrier Effects Impact 6: Collision Risk Impact 7: Electromagnetic Fields
Decommissioning	Impact 1: Underwater Noise Impact 2: Physical disturbance of habitats and temporary habitat loss Impact 3: Increased suspended sediment concentration and sediment deposition

117. It should be noted that the impact of Invasive Non-Native Species (INNS) is addressed in **Chapter 9, Benthic and Intertidal Ecology**.

10.6.2. Embedded Mitigation

118. The following assessment provides a summary of all impacts identified during scoping study and those which have been noted as the EIA has progressed. These impacts are not 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 and decommissioning). Further, these impacts are comprised of both direct and indirect impacts.

119. 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 (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.

10.6.3. Worst Case Parameters

10.6.3.1. Temporary Habitat Disturbance

120. During all project phases, temporary habitat disturbance will occur to seabed habitats via device, hub and cable installation and also anchor deployments for installation barges. Based on information provided in **Chapter 4, Project Description** the following values listed in **Table 10-19** have been calculated to define the worst-case parameters for temporary habitat disturbance. These are defined in terms of project phase, as different amounts of temporary seabed disturbance are predicted to arise in each phase.

121. For the purpose of defining impact assessment parameters for the repowering phase, an assumption has been made that 50 % of the tenants will undertake repowering, i.e. for 50 % of the tenants, their infrastructure will be removed and replaced (potentially with different infrastructure by a different tenant). For the other 50 % of tenants, their infrastructure will remain over the lifetime of the project.

122. In terms of impact assessment parameters, the repowering process has, therefore, been defined as per below:

- Initial temporary seabed disturbance via deployment of barge anchors to remove foundations, TEC's, hubs, inter-array cables and monitoring equipment for 50 % of the Tenants (berths); and
- Further temporary seabed disturbance via re-installation (repowering) of foundations, TEC's, hubs, inter-array cables and monitoring equipment for the same 50 % of Tenants (berths).

123. The operational phase values also include the temporary seabed disturbance that would arise from up to ten cable repair events.

Table 10-19 Summary of Worse-Case Scenario Temporary Habitat Loss during Construction, Operation (repowering) and Decommissioning Phases

Project Component	Worse Case (240 MW)	Unit	Notes
Construction Phase:			
Post-lay burial of cable	27,259	m^2	Area of sandwave field where post-lay burial via Mass-Flow Excavator (MFE) may be required
Deployment of anchor blocks by barges during cable installation	100,240	m^2	Up to 8 x 25 m^2 (5x5) m anchor blocks for a single barge = a total footprint per anchor deployment of 200 m^2 (8 x 25 m^2) Assumed that these types of anchor barges generally deploy a spread every 500 m. So, for every 500 m of cable installation a footprint of 200 m^2 of temporary seabed disturbance occurs (via the anchor blocks) Combining all potential export, array and cable tails the total length of cables (full 240 MW) is 250.6 km

Project Component	Worse Case (240 MW)	Unit	Notes
			Assumes the footprint of 200 m^2 every 500 m (0.5 km), or 400 m^2 every 1 km, and assumes all cables are installed using anchor barges Temporary disturbance impact of (400 m^2 x 250.6) = 100,240 m^2 (0.10 km^2) "
Deployment of anchor blocks by barges during TEC device installation	248,000	m^2	Max. no of devices set at 620 x small (0.3 kW devices) Assumed that deployment of each device requires 2 x anchor deployments from barge (2 x 200 m^2 = 400 m^2) Therefore, total temporary seabed disturbance = 620 x 400 m^2 = 248,000 m^2
Deployment of anchor blocks by barges during hub installation	48,000	m^2	Max. no of seabed mounted hubs set at n = 120 Assumed that deployment of each hub requires 2 x anchor deployments from barge (2 x 200 m^2 = 400 m^2) Therefore, total temp. seabed disturbance = 120 x 400 m^2 = 48,000 m^2
Construction Phase TOTAL		**423,499 m^2 (0.42 km^2)**	
Operational Phase:			
(Repowering) 50 % of tenants infrastructure (Foundations; TEC's; hubs' array cables; monitoring equipment) removed and replaced with new (different) tenant infrastructure	377,400	m^2	Initial removal of tenant infrastructure from 50 % of berths • 50 % of anchor block value (above) for inter-array cables only (203.5/2 * 0.4) = 40,700 m^2 • 50 % of anchor block value of tidal device installation = 124,000 m^2 • 50 % of anchor block value for hub installation = 24,000 m^2 Sub-Total = 188,700 m^2 Subsequent re-installation (re-powering) of tenant infrastructure from 50 % of berths • 50 % of anchor block value (above) for inter-array cables only (203.5/2 * 0.4) = 40,700 m^2 • 50 % of anchor block value of tidal device installation = 124,000 m^2 • 50 % of anchor block value for hub installation = 24,000 m^2 Sub-Total = 188,700 m^2
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 750 m 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
Operational Phase TOTAL		**380,400 m^2 (0.38 km^2)**	

Project Component	Worse Case (240 MW)	Unit	Notes
Decommissioning Phase:			
Decommissioning Phase		**TOTAL 423,499 m² (0.42 km²) –** same worst-case as per construction phase due to same activities needed to remove infrastructure	

10.6.3.2. Permanent Habitat Loss via Project Infrastructure

124. The installation of project infrastructure, including anchor systems for TEC devices, seabed mounted devices, hubs and cables/cable protection, will all result in permanent habitat loss. Based on information provided in **Chapter 4, Project Description** the following values listed in **Table 10-20** have been calculated to define the worst-case parameters for permanent habitat loss via project infrastructure. The majority of these effects will only occur in the operational phase. The exception is the value of 7,400 m^2 related to the trench for up to 9 cables at landfall. Trenching of cables will only be undertaken if horizontal directional drilling (HDD) works (preferred method) are not possible/viable. Without detailed geotechnical analysis it is not currently possible to state if trenching, and subsequent backfill of the trench(es) would be possible. If it was, this would represent a temporary disturbance on intertidal habitats. However, to ensure a precautionary approach is built into the assessment, it has been concluded that trenching/surface-laying of the landfall cables would lead to permanent habitat loss, thus this value is included below.

125. As detailed above, the permanent habitat loss values also account for additional permanent habitat loss due to placement of re-installed (repowered) foundations/TECs in different areas to where originally installed.

Table 10-20 Summary of Worse-Case Scenario: Permanent Habitat Loss via Project Infrastructure (including repowering)

Project Component	Worse Case (240 MW)	Unit	Notes
Main operational phase			
Gravity Base Structures (GBS)	74,790	m^2	Max value across entire project. Based on anchor mooring systems for floating devices. Includes hubs.
Swept Area of Catenary Cables	2,055,000	m^2	Based on: 30 devices having swept area of 9,500 m^2 (large floating devices (Orbital, Magallanes) 140 devices having swept area of 7,500 m^2 floating devices (Tocardo UFS, Aquantis) & hubs 240 devices having swept area of 3,000 m^2 small floating devices (Instream, SME PLATO)
Export Cable Footprint (cables; protection systems; rock bags)	11,745	m^2	Up to 40.5 km of export cables (with split-pipe protection/shells and rock bags)

Project Component	**Worse Case (240 MW)**	**Unit**	**Notes**
Array Cable Footprint (cables; protection system; rock bagss)	30,040	m^2	Up to 204.5 km of array cables (with split-pipe protection/shells and rock bags)
Cable tails	120	m^2	Based on 9 x tails of 620 m length
Trench for 9 x landfall cables	7,400	m^2	740 m long trench x 10 m width in intertidal region
Footprint of Navigation Marker Buoys	540	m^2	3 m diameter square gravity anchor (9 m^2) per anchor x 60 anchors/buoys
Footprint of ADCP moorings	280	m^2	7 m^2 per ADCP mooring x 40 units
Footprint of seabed mounted environmental monitoring units	112	m^2	14 m^2 per env monitoring unit x 8 units
Footprint of mooring for floating environmental monitoring units	45	m^2	9 m^2 per mooring x 5 units
Permanent habitat loss (initial operational phase: 2,180,072 m^2 (2.18 km^2)			
Repowering Phase			
New tenant infrastructure in 50 % of berths	52,504	m^2	See **Chapter 4, Project Description** for more details
Permanent habitat loss (repowering of 50 % of berths): 52,504 m^2			
Permanent Habitat Loss: Total of 2,232,576 m^2 (2.23 km^2)			

10.6.3.3. Underwater Noise

126. The installation of project infrastructure, including drilling for pin piles and cable installation, will result in the production of underwater noise. Therefore, as per **Chapter 12, Marine Mammals**, the assessment has been based on underwater noise modelling that has been conducted for the nearby Wylfa Newydd Development Area, the Perpetuus Tidal Energy Centre (PTEC) off the coast of the Isle of Wight and MeyGen in the Inner Sound of the Pentland Firth.

127. For each of the three projects modelling was undertaken in order to make an assessment of the source levels of underwater noise from several potential noise sources expected to occur during construction. All three projects made an assessment of the levels of underwater noise emitted from drilling and vessels. The results of the modelling studies have been provided in **Table 10-21**.

Table 10-21 Summary of Worse-Case Scenario: Subsea Noise Effects

Project Component	Worse Case (240 MW)	Notes
Noise from drilling of pin piles	Predicted source level was 179.8 dB re 1 µPa@1 m (RMS)	From PTEC (2014). Note that these results reflect the worst case scenario of drilling (4 m pin piles, 333 kW drill).
	Predicted unweighted source level of 185.3 dB re 1 µPa (RMS) @ 1 m	From Wylfa Newydd Development Area (HNP, 2018b).
	Drilling noise measurements of up to 178 dB re 1 µPa @ 1 m	From MeyGen (Kongsberg, 2012).
Vessel noise	172 dB re 1 µPa @ 1 m	From MeyGen (Kongsberg, 2012). Note that this value comes from assessment of noise from a tugboat, the noisiest type of vessel likely to be used during operations at MeyGen.
	170 – 180 dB re 1 µPa @ 1 m	From PTEC (2014).
	168 dB re 1µPa (RMS) @ 1 m for large vessels; 161 dB re 1µPa (RMS) @ 1 m for medium vessels	From Wylfa Newydd Development Area (HNP, 2018b).

128. PTEC (2014) give a high-level summary of the expected species-specific impact ranges from these other sources of underwater noise; these are provided in the following section.

10.6.3.4. Construction Programme

129. The construction of offshore works (for installation of tidal devices and associated cabling and infrastructure) would be phased over a period of several years, taking up to 15 days per device or hub and up to 1.5 days for each inter-array cable, up to 20 days for each offshore cable, and up to 12 days for each phase of cable protection. Up to eight separate cable laying and protection campaigns are possible. The HDD at the landfall would be completed over a four to six month period with two months for offshore cable tail installation.

10.6.4. Potential Impacts during Construction

10.6.4.1. Construction Impact 1: Underwater Noise Effects

130. Underwater noise may arise from the installation of project infrastructure, including TEC devices, cables and electrical hubs. Of the proposed foundation systems, the worst-case scenario for the production of underwater noise is predicted to be from pin pile foundations. These may need to be installed using drilling due to the hard substrate in the study area. The maximum amount of drilling that could arise would be 1,280 drill holes, which at three days each, would result in a total of 3,840 days of drilling on site to install the full 240 MW capacity.

131. In order to assess the potential impacts from underwater noise emitted during drilling the results from the three similar underwater noise modelling studies of percussive drilling have been utilised here (see **Table 10-21**).

132. The sensitivity of fish species to noise is poorly understood though it is thought to vary between species, depending on several factors including the auditory 'threshold', presence of and physical coupling of any swim bladder to ear structures, resonance frequency of the otolith system, and behavioural traits (Kongsberg, 2012; PTEC, 2014). Examples of predicted hearing sensitivity of different fish species are given in **Table 10-22**. It should be noted that shellfish are considered insensitive to noise due to the absence of a swim bladder (PTEC, 2014) and so have not been included in this assessment.

Table 10-22 Hearing Specialisation of Various Species of Fish Present in the Region (adapted from Kongsberg, 2012; PTEC, 2014)

Species	Family	Swimbladder connection	Sensitivity
Atlantic salmon/sea trout	Salmonidae	None	Medium
European eel	Anguillidae	None	Medium
Cod	Gadidae	None	Medium
Plaice	Pleuronectidae	No swim bladder	Low
Elasmobranchii		No swim bladder	Low
Mackerel	Scombridae	No swim bladder	Medium
Herring	Clupeidae	None	Medium

133. Underwater noise can cause a range of effects in fish, depending on the noise level produced. The sound levels at which different effects may be seen are as follows (from Parvin et al., 2007):

- Physical injury to mortality – 220-240 dB re 1uPa
- Strong behavioural reaction - 90 dB re 1uPa
- Mild behavioural reaction – 75 dB re 1uPa

134. All three modelling studies demonstrated that the noise produced by percussive drilling did not exceed the sound levels for physical injury to mortality. However, levels associated with behavioural changes can be emitted. Behavioural changes in fish can result in changes to migration, feeding, spawning etc. therefore they are important to assess.

135. The level of behavioural impact will depend on the apparent loudness of the noise source perceived by the target species. This can be calculated using the dB_{ht} technique, where the frequency spectrum of the source noise is compared with the hearing threshold of the target species. The dB_{ht} (species) metric and associated effect of exposure have been calculated by Nedwell et al. (2007) and are provided in **Table 10-23**. This metric was used in the modelling for PTEC (2014) and MeyGen (Kongsberg, 2012).

Table 10-23 Assessment Criteria used for the Potential Impact on Marine Species (after Nedwell et al., 2007)

Sound level dB_{ht} (Species)	Effect of exposure
Above 130	Possibility of traumatic hearing damage from a single event
90	Strong behavioural reaction

Sound level dB_{ht} (Species)	Effect of exposure
75	Some avoidance reaction by the majority of individuals, but habituation or context may limit effect

136. PTEC (2014) assessed that no physical or injury effects were predicted from noise levels emitted during drilling as determined in the noise modelling study. Behavioural reactions were predicted to different extents and at different ranges for the modelled species, as outlined in **Table 10-24**. Cod were demonstrated to be the most sensitive species to sound, showing a behavioural reaction at distances up to 50 m and a "startle" reaction at distances up to 8 m from the source (PTEC, 2014). The results for this species are considered the worst-case scenario and any other species are not considered likely to have a greater impact from noise.

Table 10-24 Summary of the Modelled Ranges for 90 and 75 dB_{ht} (Species) Levels for Worst-Case Scenario Percussive Drilling (taken from PTEC, 2014)

Species	90 dB_{ht} (Species)			75 dB_{ht} (Species)		
	Max Range (m)	Min Range (m)	Mean Range (m)	Max Range (m)	Min Range (m)	Mean Range (m)
Bass	<1	<1	<1	4	3	4
Cod	8	7	8	50	49	50
Dab	3	2	3	16	15	16
Salmon	<1	<1	<1	5	4	5
Elasmobranch	<1	<1	<1	<1	<1	<1

137. Kongsberg (2012) also assessed the distance from drilling activities at which the two metrics for behavioural reactions would occur (90 dB_{ht} and 75 dB_{ht}). They determined that both metrics (i.e. types of behavioural impact) would only occur within 1 m of the sound source, for both hearing specialists and generalists, under the most precautionary conditions. As a result, it was concluded that behavioural reactions are unlikely to be observed in fish species.

138. The underwater noise modelling undertaken for Wylfa Newydd were calculated based on Popper *et al.* (2014), and specifically assessed the distance at which the sound level would cause a recoverable injury (after 48 hours of exposure to continuous percussive drilling noise, using 170 dB re 1 µPa (SPL_{RMS})), and the distance at which the sound level would cause a temporary threshold shift (TTS) (after 12 hours of exposure, using 158 dB re 1 µPa (SPL_{RMS})), for fish with swim bladders involved in hearing i.e. hearing specialists. The maximum distance at which a recoverable injury would be caused was 7 m. The maximum distance at which TTS would occur was 67 m.

139. The impact ranges of vessel noise were assessed for the three projects, based on the source level metrics provided in **Table 10-24**. The modelling studies for MeyGen (Kongsberg, 2012) and PTEC (2014) utilised the dB_{ht} metric to assess the impact ranges from vessel noise on fish. Kongsberg (2012) predicted that the lowest level of noise that could cause a behavioural impact would occur up to 1 m from the vessel, under the most precautionary conditions, and for hearing specialists as well as generalists. PTEC (2014) indicate that the most sensitive species (cod) would receive sufficient sound levels to exhibit a behavioural impact at a maximum distance of 8 m from a large vessel (i.e. the worst-case scenario).

140. For the Wylfa Newydd project, HNP (2018b) assessed the vessel noise as a continuous noise, using the same metrics that were used for modelling drilling sound. The maximum distance at which a recoverable injury would be caused was <1 m for both large and medium vessels. The maximum distance at which TTS would occur was 4 m for large vessels, and <1 m for medium-sized vessels.

141. PTEC (2014) also assessed the behavioural impact ranges from other construction activities, specifically trenching and cable protection. For the most sensitive species (cod), the impact range for trenching was 1 m (using the 90 dB_{ht} metric) and 16 m (using the 75 dB_{ht} metric). For cable protection, the impact range was 2 m (using the 90 dB_{ht} metric) and 25 m (using the 75 dB_{ht} metric).

142. From the evidence presented it can be determined that the highest noise levels during installation will be emitted by drilling. The maximum impact range for fish during this activity is predicted to be 67 m. This contour is considered to be low; as a result, the maximum concluded sensitivity for fish receptor species is medium.

143. As part of the construction phase of operations it is anticipated that the installation of each hub may take up to 15 days. Under full site deployment circumstances, this could result in a total of 1,800 days (just under 5 years) of installation. It should be noted that these days are likely to occur concurrently for different devices, although the extent to which construction will overlap is not known. Due to the short-term scale of construction operations and taking into consideration the small extent of the site in the context of available habitat in the surrounding area, it is considered that the magnitude for effect is low.

144. As a result of the low magnitude of the effect in coupled with the medium sensitivity of the receptor there is a **minor adverse** impact on the receptors during construction.

10.6.4.1.1. Mitigation

145. No mitigation measures are considered to be required.

10.6.4.1.2. Residual Impact

146. The residual impact is **minor adverse**.

10.6.4.2. Construction Impact 2: Temporary Habitat Disturbance

147. Temporary seabed habitat disturbance will occur during the construction phase of the project via a range of effects including deployment of anchor blocks for installation barges and cable installation works.

148. The total area of seabed predicted to be subject to temporary disturbance over the duration of the construction phase is detailed in **Table 10-19.** This value of 423,499 m^2 (0.42 km^2) will not arise at one time as construction will be phased over several years. However, for the purpose of this assessment, this total amount of temporary habitat disturbance has been assessed.

149. Based on the values presented in **Table 10-19**, the total amount of temporary disturbance of habitat due to the deployment of anchor blocks during the construction phase will be 396,240 m^2 (0.39 km^2). It should be noted that this is highly precautionary as it is unlikely that a moored barge will be used to install all cables (a Dynamically Positioned (DP) vessel will likely be used for some cables which produces no seabed disturbance). This amount of temporary seabed disturbance equates to disturbance of less than 1% of the wider habitat within the MDZ. This disturbance will also be short-term, and as such is also classified as having a **low** magnitude.

150. The fish and shellfish species found in the study area are typical of this region and are widely distributed throughout the surrounding area. The study area does not represent unique habitat for any given species. The study area does lie within an area of low intensity spawning ground for cod, whiting, sandeel, mackerel, plaice and (dover) sole; a low intensity nursery ground for whiting, sandeel and plaice; and high intensity nursery ground for sole (Coull et al., 1998; Ellis et al., 2012; Pawson and Robson, 1996). Coull et al. (1998) also determined that the area was a spawning ground for sprat, in agreement with Aires et al. (2014) who indicated a high number of 0-year sprat in the area. The low intensity grounds listed for the species are typically widespread (Coull et al., 1998; Ellis et al., 2012; Pawson and Robson, 1996) and so not restricted to the study area. Similarly, the high intensity nursery ground for sole extends into the eastern Irish Sea, and it should also be noted that it is a “nominal” nursery ground due to the presence of juveniles only (Ellis et al., 2012). Indeed, the data in Coull et al. (1998) and Ellis et al. (2012) are high-level and broad scale and therefore is intended only to be used indicatively.

151. The worst-case scenario, therefore, is that the area is used as a low intensity spawning ground and a high intensity nursery ground for certain common, commercially important species. Due to the presence of this key life stage the sensitivity of fish receptors is considered medium, taking into account the fact that the study area represents a very small proportion of the total spawning and nursery grounds available to the species in the wider region.

152. Shellfish species typically occupy the seabed and as such are considered sensitive to habitat loss. Three representative species have been chosen for an assessment of sensitivity: blue/common mussel *Mytilus edulis* as a representative sessile species; and European spiny lobster[1] *Palinurus elephas* (as a proxy for mobile species). Blue mussel and European spiny lobster have undergone sensitivity assessments that are presented on MarLIN (2019).

153. Blue mussel is considered as having a moderate sensitivity to substratum loss and a low sensitivity to abrasion and physical disturbance. European spiny lobster is assessed as having a medium sensitivity to the abrasion/disturbance of the surface of the substratum or seabed. As a result, it is assessed that the worst-case scenario for sensitivity of shellfish receptor species is medium.

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[1] European spiny lobster, though not found in the study area, is a similar species to the European lobster found in the study area, therefore it has been used as a proxy for effects on this species as it has undergone a sensitivity assessment on MarLIN.

154. The study area is subject to high tidal energy therefore the site is mainly exposed bedrock and boulders, though in the north there are sand and gravel habitats, in addition to the sandbank. The habitats suitable for spawning and nursery are therefore present across large portions of the study area, greater than the potential lost habitat. They are also present across the wider region, as revealed by the biotope mapping in **Chapter 9, Benthic and Intertidal Ecology**.

155. As a result of the low magnitude of the effect in coupled with the medium sensitivity of the receptor there is a **minor adverse** impact on the receptors during construction.

10.6.4.2.1. Mitigation

156. No mitigation measures are considered to be required.

10.6.4.2.2. Residual Impact

157. The residual impact is **minor adverse**.

10.6.4.3. Construction Impact 3: Increased Suspended Sediment Concentrations and Sediment Deposition

158. Increased suspended sediment concentrations and sediment deposition can arise during the construction phase due to installation of infrastructure on the seabed (foundations, hubs and cables). As the study area is highly tidal, with high nearbed transport, there is minimal fine sediment present.

159. Furthermore, any sediment that may be deposited as a result of construction activities will be immediately minnowed and un-detectable beyond a small spatial (100 m) and temporal (few tidal cycles i.e. days) scale. Though no specific modelling has been conducted, it is expected that there may be localised increased in sediment levels above 10 mg/l but these will rapidly disperse.

160. Specifically, during drilling of foundations it is expected that suspended sediment will not be detectable above background levels beyond 100 m. There are no sediment plumes to be expected to arise during construction that will significantly increase the suspended sediment concentration (SSC) or result in smothering from deposition. Deposition is considered to be effectively immeasurable at the benthic level.

161. For cable installation works, there is also potential for some sediments to be disturbed, creating a plume, particularly in the nearshore part of the cable (within ‘Abraham’s Bosom’). Any plume created will be short-term and will be dispersed by tidal current action until coarser sediments settle once again on the sea bed.

162. The principal causes of sediment disturbance during offshore cable installation would be:

- Free-laying of up to 35 km of offshore cable on the sea bed;
- Placement of cable protection (rock bags of concrete mattresses) at specific locations along the cable length; and

- Post-installation jetting to bury offshore cable across the sand ridge feature in the northern half of the cable corridor.

163. 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. In the nearshore, the bedrock is overlain by sand which has the potential to be disturbed by the free-laying of cables and the placement of cable protection. However, any plume arising from these activities would only arise from the force of the cable or protection measures on the sea bed. At the landfall, the worst case scenario would be open trenching rather than the preferred option of HDD. Under open trenching, up to 7,440 m^3 of sand would be excavated and the majority replaced to backfill the trench, with only a small net loss to the inshore system. Due to these factors, the likely increase in suspended sediment concentration in areas with sand cover nearer to shore (including at the landfall) will remain within the bounds of natural behaviour that are governed by storm waves and surge effects. Furthermore, these effects will be one-off and temporary in duration and are unlikely to be measurable.

164. The principal effect would arise from the post-installation jetting to bury the offshore cable across the sand ridge feature in the northern half of the cable corridor. Under this activity, it is likely that the maximum envisaged effect associated with sediment plumes arising from the jetting will cause only modest (but measurable) increases in suspended sediment concentration locally (typically a few tens of mg/l above background levels). This increase 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).

165. 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.

166. With respect to sediment deposition, from experience of similar schemes, it is envisaged that in the immediate vicinity (up to 10 m from point of jetting) of the post-lay jetting through the sand wave area, deposition depths of no more than 0.1 m will be observed. These are highly likely to become quickly re-entrained by currents during the peak velocities of the following tide and transported further away in small concentrations.

167. Further away from the immediate vicinity of the post-lay jetting, the deposition of sediments would extend over a similar zone of influence to that of the sediment plume (i.e. within a few hundred metres of each release point, following the axis of the tidal current flow). Within a short distance from the release points the thickness of deposits will be extremely small, typically millimetres. In this highly dynamic tidal area, this is effectively an immeasurable change.

168. Overall, the magnitude of effect of increased suspended sediment and deposition is judged to be negligible for all areas apart from the sandwave area, where a low magnitude effect may arise (near-field).

169. The species considered most sensitive to increased sediment and deposition are the shellfish species. The blue (or common) mussel and European spiny lobster, have been used for assessing sensitivity to sediment changes, through the information presented on MarLIN (2019).

170. European spiny lobster is assessed as having a medium sensitivity to changes in suspended solids (water clarity) and is not sensitive to 'light' smothering and siltation rate changes. Blue/common mussel have a low sensitivity to smothering and are considered not sensitive to an increase in suspended sediments. Therefore, the worst-case scenario is a medium sensitivity of the receptor (also taking into account the receptor value).

171. As a result of the low/negligible magnitude of the effect in coupled with the medium sensitivity of the receptor there is a **minor adverse** impact on the receptors during construction.

172. It should also be noted that turbidity can positively impact the larvae of fish and shellfish species. Increased turbidity can create a "shading effect" which can lead to a reduction in predation rate on fish larvae, thereby increasing survival (Fiksen et al., 2002). The extent of this effect will likely vary depending on the trophic level of the larvae. Due to this species-specific variation this impact has not been directly considered as part of the impact assessment. However, it can be thought that the magnitude of adverse effect may be somewhat offset by this potentially positive effect.

10.6.4.3.1. Mitigation

173. No mitigation measures are considered to be required.

10.6.4.3.2. Residual Impact

174. The residual impact is **minor adverse**.

10.6.5. Potential Impacts during Operational Phase

10.6.5.1. Operational Impact 1: Underwater Noise Effects via (a) device operational noise and (b) repowering works

175. There is very little information on the operational noise produced by tidal devices. However, the information available has informed a number of preceding EIA studies, including the recently consented PTEC project. The results from the noise modelling conducted for the PTEC project (2014) and MeyGen (Kongsberg, 2012) have been applied to this project. Information from the Technical Note produced by Subacoustech (2019) for this project are also used.

176. Subacoustech (2019) reviewed the noise outputs of a suite of tidal devices. It was reported that predicted source noise levels ranged from 145 to 175 dB re 1 uPa @ 1 m. The corresponding frequency range was rarely reported. One turbine design with the most information available, OpenHydro, has a predicted source noise level of 152 dB SPL_{RMS}, with the majority of the energy centred on the 125 Hz 1/3 octave frequency band. This low frequency noise is within the typical frequency range of the predominant component of ambient noise (Subacoustech, 2019) as well as fish hearing ability (e.g. salmon; Harding *et al.,* 2016). The noise emitted from OpenHydro was reported to reach background noise levels within 1-1.5 km from the source.

177. For the PTEC project (2014), modelling was conducted of operational noise that would arise using 24 m rotor (worst-case scenario for this project). Note that this is smaller than the maximum rotor size potentially proposed for the Project, 27 m, however, the scale of potential effect on fish species associated with the noise of tidal turbines from PTEC and MeyGen shows

range to be limited to the low 10s of metres at greatest, and this is expected for other tidal turbines of a similar scale.

178. The worst-case scenario modelling for the 24 m rotor at threshold levels (90 dB_{ht} and 75 dB_{ht} (Species) (Nedwell et al., 2007)) for impact on fish species are listed in **Table 10-25**. The largest range at which a behavioural reaction can be expected (i.e. levels of 75 dB_{ht} are reached) is 36 m, specifically for cod species. The largest range at which a startle response can be expected (i.e. levels of 90 dB_{ht} are reached) is 3 m, also for cod.

Table 10-25 Summary of the Modelled Ranges for the 90 and 75 dB_{ht} (Species) Levels for an Operational Device with a Rotor Diameter of 24 m (taken from PTEC, 2014)

Species	90 dB_{ht} (Species)			75 dB_{ht} (Species)		
	Max Range (m)	Min Range (m)	Mean Range (m)	Max Range (m)	Min Range (m)	Mean Range (m)
Bass	<1	<1	<1	4	3	4
Cod	3	2	3	36	35	36
Dab	<1	<1	<1	<1	<1	<1
Salmon	<1	<1	<1	<1	<1	<1
Elasmobranch	<1	<1	<1	<1	<1	<1

179. For the MeyGen project, the behavioural impact ranges of fish were modelled for the operational noise predicted to be emitted from a 1 MW and 2.4 MW turbine. Operational noise was predicted to be up to 177 dB SPL_{RMS} for a 2.4 MW turbine, with peak energy content below 100 Hz but also significant peaks in the 1,500 Hz and 5,000 Hz bands (Subacoustech, 2019).

180. The operational noise from a single turbine of either size was predicted to cause a behavioural impact within 1 m of the source only (for both 90 dB_{ht} and 75 dB_{ht} metrics). The PTEC (2014) report modelled that for their fully deployed site (30 MW) the noise level "will generally be 130-150 dB re 1 uPa".

181. The exact cumulative noise produced by a fully deployed tidal demonstration zone (240 MW) is currently unknown. Although the modelling undertaken at PTEC is indicative of the scale of deployment anticipated by the Project for each single array deployment within the overall 240MW, the overall cumulative noise is expected to be greater.

182. The level of potential impact of operational noise is assessed in the context of background noise and natural variation. The level of noise predicted to be produced by the fully deployed PTEC site (130-150 dB re 1 uPa) was within the natural variation in background levels of the site (average of 120 dB re 1 μPa, and regularly exceed 130 dB re 1 μPa; PTEC, 2014). The background levels were measured from the PTEC site situated off southern Isle of Wight in the English Channel, an area exposed to heavy shipping traffic. As a result, they concluded a low magnitude for effect.

183. Four underwater noise monitoring stations were installed in the MDZ by SEACAMS (University of Bangor) to record background noise and assess variation on a daily and tidal cycle basis (Subacoustech, 2019). Underwater noise measurements were taken over periods of 15-30 days in 2016, 2017 and 2018.

184. Analysis of the records revealed that noise levels were highly consistent between sites and years; all were between 89 dB to 107 dB SPL_{RMS} re 1 μPa. As expected there was variation in the noise levels with the position of the tide, and when marine traffic was present.

185. Ambient noise levels have also been determined for the nearby Wylfa Newydd Development Area. 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 (see **Chapter 12, Marine Mammals**). The analyses reported that existing natural background noise levels for the area were between 111.4 dB re 1 μPa (SPL_{RMS}) and 120.9 dB re 1 μPa (SPL_{RMS}) (based on all transects measured).

186. It is considered that the main component to ambient noise in the MDZ is "shore noise", though there was also influence of shipping noise to the north of the site (QinetiQ, 2005). In addition, due to the highly tidal nature of the site and the anticipated low levels of anthropogenic noise, tidal flow noise may also be a major component of the background noise levels in the MDZ (Merchant et al., 2016).

187. Due to the combination of potentially greater operational noise produced and lower background noise levels it can be expected that the magnitude of effect will be higher than that concluded in the PTEC report. Following the generic guidelines presented for the determination of magnitude of effect in **Chapter 5**, **EIA Methodology**, the magnitude of effect of underwater noise falls into the category of medium. The noise levels would constitute a minor alteration to the environment, occur on the long-term scale (i.e. duration of project, 37 years) though be reversible (once operations had stopped).

188. Whilst making consideration of the definitions for magnitude of effect, it is important to note that the zone of influence of noise generated during operation will have a limited spatial extent in the context of the wider habitat available to receptor species within the Irish Sea. As a result, based on expert judgement, it is concluded that the magnitude of effect of operational noise is low. This follows the rationale based in the PTEC assessment, which concluded low magnitude based on the very limited spatial range of the effect.

189. The most sensitive species to noise is the hearing specialists such as those in the herring family, which are considered as having a medium sensitivity to noise.

190. As a result of the low magnitude of the effect in coupled with the medium sensitivity of the receptor there is a **minor adverse** impact on fish and shellfish receptors during the operational phase via device noise.

191. With respect to repowering, the worst case scenario for underwater noise production as determined for the construction phase can also be applied to any repowering phase as similar sub-activities (installation, vessel presence) can be assumed.

192. As only 50 % of the berths will be subject to repowering, the magnitude of effect will be lower than for the main construction phase, due to a shorter time period of noise effects.

193. Therefore, in accordance with the assessment for construction and the short(er) term temporal scale of effect from repowering works, the magnitude of the effect is classified as low, the receptor sensitivity is considered medium, resulting in an impact significance that is **minor adverse**.

10.6.5.1.1. Mitigation

194. No mitigation measures are considered to be required.

10.6.5.1.2. Residual Impact

195. The residual impact is **minor adverse**.

10.6.5.2. Operational Impact 2: Permanent Habitat Loss via Project Infrastructure (including repowering)

196. The worst-case scenario for permanent habitat loss via initial installation of project infrastructure is 2,180,072 m^2; (2.18 km^2), plus an additional 52,504 m^2 via repowering of up to 50 % of the berths (see **Table 10-20**).

197. The worst-case scenario footprint accounts for 5 % of the 39.76 km^2 area covered within the study area. This is based on the assumption that all areas where infrastructure is placed would be “lost” as habitat during the operational phase (in practice, project infrastructure deployed over the lifetime of the project, such as anchor blocks and/or surface-laid cables will itself represent new habitat. However, for fish and shellfish, loss of existing habitat which currently provides foraging/spawning/nursery habitat is the focus of this assessment).

198. The exact layout of project infrastructure is currently unknown; therefore, it is not possible to make any specific conclusions on the specific habitat lost due to the location of infrastructure. The predominant seabed habitat type within the MDZ (as outlined in **Chapter 7, Metocean Conditions and Coastal Processes**) includes gravelly sand and sandy gravels, with large areas of exposed bedrock, and areas of sand and outcropping bedrock. There are also small areas of mobile sands with features of possible biogenic interest, areas of boulders and surface mobile sands.

199. The biotopes present within the export cable corridor include very tide-swept faunal communities, mixed faunal turf communities, circalittoral coarse sediment, and sublittoral sands and muddy sands (Ocean Ecology, 2018). As stated in **Chapter 9, Benthic and Intertidal Ecology** the habitats and associated benthic communities found in the study area are typical of those found in Anglesey and wider Welsh coastal regions.

200. As discussed previously, any loss of habitat for spawning and nursery grounds will be not be of significance as they are typically widespread throughout the surrounding regional waters.

201. Following the generic guidelines presented for the determination of magnitude of effect in **Chapter 5, EIA Methodology**, the magnitude of effect of habitat loss falls into the category of medium. Habitat loss would constitute a minor loss of the environment (5 % of available habitat in the MDZ), occurring on the long-term scale (i.e. duration of project, 37 years) though be reversible (once infrastructure removed).

202. Whilst making consideration of the definitions for magnitude of effect, it is important to note that the amount of habitat lost during operation will have a very limited spatial extent in the context of the wider habitat available to receptor species within the Irish Sea. Furthermore, there is evidence that habitat will not be completely lost as the infrastructure may be colonised by shellfish species (Langhamer and Wilhelmsson (2009), as cited in PTEC (2014)). As a result, based on expert judgement, it is concluded that the magnitude of effect of habitat loss during operations is low.

203. The same species used for the sensitivity assessment for habitat loss during the construction phase have been used for habitat loss for the operational and maintenance phase, specifically the blue/common mussel and European spiny lobster.

204. The blue/common mussel has a moderate sensitivity substratum loss and such changes are considered not relevant to the European spiny lobster. As a precautionary measure the maximum sensitivity to habitat loss for the receptor is concluded as medium.

205. As a result of the low magnitude of the effect in coupled with the medium sensitivity of the receptor there is a **minor adverse** impact on the receptors during operation via permanent habitat loss. This conclusion remains valid even with the additional permanent habitat loss that would be caused by repowering works.

10.6.5.2.1. Mitigation

206. No mitigation measures are considered to be required.

10.6.5.2.2. Residual Impact

207. The residual impact is **minor adverse**.

10.6.5.3. Operational Impact 3: Physical disturbance of habitats and temporary habitat loss (cable repair and repowering)

208. As with other marine energy infrastructures, there will be a requirement for planned and unplanned maintenance activities throughout the operation phase of the Project. These activities may vary in nature, however the maintenance activities considered likely to cause disturbance impacts are cable repairs and repowering works. Repowering is defined as being ‘the removal of a tenant’s infrastructure at the end of a demonstration period and replacement with the infrastructure of a new tenant, including the removal of devices (including foundations, TECs, support/super structure, inter-array cables, hubs and monitoring equipment) and reinstallation via the original construction methods.

209. Cable repairs will result in localised and temporary disturbance of the seabed up ten times throughout the project life, each requiring around 5 days of repair work. This equates to a total of a possible 3,000 m^2 of temporary disturbance occurring due to project maintenance works throughout the project life, equal to around 0.007 % of the MDZ total area.

210. As a worst-case scenario, repowering works of 50 % of the berths is predicted, which will involve removal of existing tenant infrastructure and the re-installation of new infrastructure.

211. Based on the values in **Table 10-19**, a total area of 377,400 m^2 is predicted to be subject to additional temporary seabed disturbance via repowering. Therefore, a total of 380,400 m^2 (0.38 km^2) of seabed will be temporarily disturbed for cable repairs and repowering during the operational phase of the project. All this activity will only take place within the main MDZ array site (35 km^2), meaning that 1.1 % of the MDZ array area will be affected.

212. This amount of temporary seabed disturbance via cable repair and repowering works is slightly less than that predicted from the main installation phase which concluded an impact of minor significance. Therefore, a similar impact is predicted for these operational phase impacts.

10.6.5.3.1. Mitigation

213. No mitigation measures are considered to be required.

10.6.5.3.2. Residual Impact

214. The residual impact is **minor adverse**.

10.6.5.4. Operational Impact 4: Increased Suspended Sediment Concentrations and Sediment Deposition Loss (via repowering)

215. The repowering phase may cause increased suspended sediment concentrations and sediment deposition during both the removal and construction of infrastructure. As outlined previously, it is not anticipated that a significant amount of sediment will be added to the water column due to the high tidal energy of the site. This results in a conclusion of very low/negligible magnitude of effect.

216. The very low/negligible magnitude of effect, in combination with the previously assessed medium sensitivity of representative worst-case receptor species, results in an impact significance that is **minor adverse**.

10.6.5.5. Operational Impact 5: Barrier Effects via Project Infrastructure

217. 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) for the swept area of TEC's is predicted to be 84,500 m^2 based on seabed-mounted multiple rotor platform device types with rotors up to 27 m in diameter.

218. The perceived barrier effect however will depend on a variety of factors including the type, width, number of tidal devices, and spacing between devices and the seabed. The potential distribution of infrastructure within the project area is currently unknown, however, it is unlikely to present a complete barrier to the passage of migratory fish due to the separation distance (70 m distance in the shortest dimension).

219. Of particular concern to barrier effects are the potential impacts on migratory fish who move from the freshwater to marine environment, thereby utilising the coastal environment as a migratory route. It should be noted that limited information is present on the fine-scale migration of migratory fish species. However, the study area does not form a barrier at the mouth of any

natal rivers. Indeed, the nearest protected area for migratory fish species is in excess of 50 km away.

220. Barrier effects that may arise during the operation of the project can be considered long-term and reversible in nature, as well as causing a minor alteration in the environment. As a result, the magnitude of the effect can be classified as medium.

221. The sensitivity of migratory fish species to barrier effects is considered low. This is based upon the site's potential 'barrier effect' not being at the mouth of any natal river for migratory fish species, and the small spatial extent of the site which results in individual receptors being able to avoid it.

222. As a result of the medium magnitude of the effect in coupled with the low sensitivity of the receptor there is a **minor adverse** impact on the receptors during operation.

10.6.5.5.1. Mitigation

223. No mitigation measures are considered to be required.

10.6.5.5.2. Residual Impact

224. The residual impact is **minor adverse**.

10.6.5.6. Operational Impact 6: Collision Risk

225. Collision risks can arise from fish and shellfish coming into contact with the devices. The area within which collision risk can occur is equivalent to the maximum swept area (84,500 m^2). However, it is not possible to determine the distance from the device at which entrainment may occur and result in collision risk, due to the lack of information and varied factors that can affect this parameter (e.g. species-specific avoidance as a function of swim speed, visual and auditory acuity amongst other factors, rotor structure, speed and visibility, etc.)

226. There is limited information available on the interaction of this risk and fish species. This assessment uses information from ABPmer (2010) report entitled "Collision Risk of Fish with Wave and Tidal Devices".

227. There are four factors which affect the likelihood of collision risk: exposure, long-range avoidance, close-range evasion, and collision damage (ABPmer, 2010). Exposure is based on likelihood of overlap between the fish and device based on the ecology of the fish. Long-range avoidance is based on the potential of the fish to detect the operational noise of the device. Close-range evasion is based on the potential of the fish to visually detect the device. Collision damage is based on the likely consequence of collision on the fish.

228. It is very difficult to assess the maximum sensitivity of the fish species to the effect. The worst-case scenario would assume that a fish species would overlap the device, would not be able to audibly detect the device (e.g. due to low hearing sensitivity), and are unable to conduct close-range evasion (due to insufficient burst swimming speeds). Fish behaviour when presented with a tidal turbine is unknown; however, the predicted maximum (average) rotor tip speed (22 m/s for small rotors) is above the threshold for which there is a significant risk of

physiological damage (10-12 m/s; ABPmer, 2010), therefore it can be assumed that the worst-case result of a collision will be mortality.

229. According to ABPmer (2010), the worst-case scenario for ability to avoid collision risk based on the different levels of avoidance are as follows:

- Long-range avoidance – ability to undertake this may (in a worst-case scenario) be very low i.e. long-range avoidance shown at distances of 10 m where close-range evasion begins. Predicted for all species that have low sensitivity to noise. Only assessed for horizontal axis turbine;
- Close-range evasion – ability to undertake this may (in a worst-case scenario) be medium i.e. most fish should be able to exhibit an evasion response although some strikes are possible. This is predicted for all species groups and tidal turbine combination; and
- Physiological damage – risk of physiological damage may (in a worst-case scenario) be medium-high i.e. moderate-high risk of physiological damage and/or mortality to some individuals. This is predicted for all species taking into account collision with the blade tip (i.e. the fastest segment).

230. Based on the findings of ABPmer (2010) that the worst-case scenario is a medium avoidance ability, i.e. it has some tolerance to avoid the impact, it is considered that the sensitivity of the receptor is low. The confidence in this assessment is low, reflecting the low confidence in the findings of ABPmer (2010).

231. It is very hard to assess the magnitude of the effect due to the absence of information. However, 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, is considered to be within the natural levels of mortality due to other factors, therefore the magnitude of the effect at a population is considered to be very low/negligible.

232. According to the impact matrix 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 has been augmented to **minor adverse** as a precautionary measure.

10.6.5.6.1. Mitigation

233. No mitigation measures are considered to be required.

10.6.5.6.2. Residual Impact

234. The residual impact is **minor adverse**.

10.6.5.7. Operational Impact 7: Electromagnetic Fields

235. Electromagnetic fields (EMF) can arise in the immediate vicinity of electrical cables. The Project will include a maximum of 248 km of cable around which EMF can arise, with an overall footprint of 43,337 m^2 (see **Table 10-20**). Most turbines will export grid compliant power at 11 kV, though some may be 24 kV or 33 kV longer term. Note that the seabed cables will be covered with protection systems which will decrease the likelihood of overlap of EMF with fish and shellfish species occurrence.

236. The strength of EMF produced depends on a variety of environmental factors including strength of the magnetic (B) field, distance from cable, speed and direction of water flow, and to a lesser extent the chemical composition of the surrounding water (PTEC, 2014). Most of the cables in the Project will export at 11 kV, however the worst-case scenario is 33 kV.

237. This is within the lower range of voltage typically used for offshore windfarms (33-66 kV), for which it is currently industry practice to not conclude significant effects from EMF. Based on the predicted low voltage, the small spatial coverage of the cables, and the use of cable protection, it is predicted that the magnitude of EMF will be low.

238. There is limited information on the effect of EMF on fish and shellfish receptors. Certain groups of fish such as elasmobranchs, salmonids and eel use electromagnetic fields for key functions such as navigation and prey detection (PTEC, 2014), therefore it is possible that an alteration in the natural levels of EMF may affect these functions. Both avoidance and attraction responses have been reported to different extents for different species, making it difficult to generalise the response and infer the significance.

239. The majority of fish and shellfish species that utilise the study area are flexible in their habitat use. The worst-case scenario of complete exclusion from the area due to anthropogenic EMF and subsequent relocation to areas nearby of similar habitat function would not have a likely impact at the population level of most species.

240. However, of concern would be the potential impacts on migratory fish, as a change to their migration routes could lead to effects on the local population. Atlantic salmon and sea trout are unlikely to encounter areas of elevated EMF as they swim in the upper water column, away from the seabed cables.

241. In the unlikely event of encountering areas of increased EMF, it is considered unlikely to affect their navigation to natal rivers as this relies principally on their sense of smell. European eel have been shown to continue on their migratory paths over subsea export cables for offshore wind farms carrying a significantly higher voltage than can be expected for this Project (Westerberg and Lagenflet, 2008). It is therefore considered that effects of EMF on migratory fish will be negligible at a population level, taking into account the position of the site away from the mouth of any natal rivers.

242. Also of concern is the potential effects on the nearshore migration of shellfish species, particularly those that are of commercial importance or come to the nearshore to breed. OSPAR (2009) reported observations that marine species such as crab showed no impact on their migratory routes from the presence of subsea cables in the Baltic Sea.

243. There are a limited number of preliminary laboratory tests that also show minimal behavioural changes resulting from EMF on crab species (PTEC, 2014). As a result, it can be concluded that there will be little impact on shellfish populations from anthropogenic EMF arising through the Project.

244. The sensitivity assessment of fish and shellfish to EMF during operation of the Project is concluded as low. This assessment, coupled with the low magnitude of effect, results in the potential for a **minor adverse** impact upon receptor species. This is considered sufficiently precautionary given the lack of knowledge on potential impacts on receptor species.

10.6.5.7.1. Mitigation

245. The emplacement of cable protection constitutes embedded mitigation measures in the project design. No further mitigation measures are considered to be required.

10.6.5.7.2. Residual Impact

246. The residual impact is **minor adverse**.

10.6.6. Potential Impacts During Decommissioning

247. It is likely that decommissioning of individual structures will be the responsibility of the individual structures, as overseen by Mentor Môn. Decommissioning of the site comprises the complete removal of all infrastructure associated with the tidal energy project. Offshore decommissioning methodologies would vary considerably between devices but would be expected to be similar to the construction phase in reverse. For the purpose of this chapter, it is assumed that cables are required to be removed as this represents the worst-case scenario in terms of impacts. Therefore, it can be assumed that all impacts identified as having the potential to arise during the construction phase (**Section 10.6.4**) may also occur during the decommissioning phase.

248. As the methodologies for decommissioning are expected to be similar to construction it can be assumed that the same impacts arise, specifically underwater noise, physical disturbance and temporary loss of seabed habitat, and sediment changes. The conclusion of all three of these impacts were that they would cause a **minor adverse** impact significance, therefore this can be applied to the decommissioning phase. It should be noted that this is a highly precautionary assessment as it is likely that the impacts from decommissioning will be less than those from construction (PTEC, 2014).

10.6.6.1.1. Mitigation

249. No mitigation measures are considered to be required.

10.6.6.1.2. Residual Impact

250. The residual impact is **minor adverse**.

10.6.7. Cumulative Impacts

251. A draft list of projects and plans that, together with the Project, have the potential to result in cumulative or in-combination impacts is given in **Chapter 26, Cumulative Impact and In-Combination Effects**.

252. For this Cumulative Impact Assessment (CIA) the consideration of which projects may result in cumulative or in-combination impacts on fish and shellfish receptors has been based upon the Project-specific impact assessment and expert judgement.

253. As described in this chapter, the majority of impacts on fish and shellfish associated with the Project have a spatial extent that is limited to the site and the immediate surroundings. As such it is only projects that will affect the immediate local environment that shall be screened in for consideration. A nominal buffer of ~20 km has been chosen as a worst-case maximum extent over which impacts may overlap i.e. accumulate. Any projects beyond 20 km are screened out of this CIA on the basis that they are beyond the spatial extent of impacts from the Project. In addition, any projects that do not involve any construction in the marine environment have also been screened out. The projects taken forward for this CIA are outlined in **Table 10-26**.

254. Migratory fish have the potential to be impacted at distances greater than non-migratory fish. However, as the cumulative impacts on Annex II migratory fish are assessed as part of the HRA they are not included here, but a summary is provided for context. Of the European sites screened in for assessment for migratory fish, only two (Severn Estuary/ Môr Hafren SAC and Pembrokeshire Marine/ Sir Benfro Forol SAC) had the potential to directly spatially overlap with reasonably foreseeable plans or projects being screened in for combination effects, of which the projects were:

- Greenlink Interconnector;
- Marine aggregate dredging area 531 – Tarmac and Hanson Aggregates;
- M4 Corridor around Newport (M4CaN); and
- Newport Relocation Proposals.

255. The conclusion of the HRA for migratory fish was that no significant effects are expected at a designated population level on any of the sites due to the lack of spatial (or temporal) overlap with all reasonably foreseeable plans and projects.

Table 10-26 Projects Taken Forward into the Cumulative Impact Assessment

Project name	Project Developer	Overview	Distance from the Project	Project Status (as of July 2019)
Wylfa Decommissioning	Magnox Limited	Decommissioning of the Existing Power Station. The project is currently in a defueling phase, which will be followed by site care and maintenance, then decommissioning and final site clearance. Decommissioning understood as likely to be between 2015 and 2025. It is understood that the only marine works will be the explosive demolition of the cooling water jetty and offshore structures	17.5 km	Operational
Wylfa Nuclear Power Plant	Horizon Nuclear Power	Construction of a new nuclear power station. As part of the components there will be the disposal of dredged material at the “Holyhead North” dredge disposal site. Note that work on the project has been suspended since January 2019 for commercial reasons	17.5 km	Pre-consent
Amlwch LNG	Amlwch LNG (previously Cantaxx)	Project involves importing liquid gas to a mooring 3 km from the Amlwch coast and then transference of the gas by an undersea pipeline. Consent for this project was renewed in 2013, though the timescales of future plans are unclear	20.5 km	Consented
Holyhead Deep – 10 MW project	Minesto	10 MW Tidal kite installation plus associated onshore elements. A Marine Licence to build the first 0.5 MW installation was granted in April 2017. There is currently one device in the water. ES and HRA available: http://minesto.com/projects/holyhead-deep.	<2 km	Consented
Holyhead Deep – 80 MW project	Minesto	The Project includes construction, installation, commissioning, operation and maintenance, and decommissioning activities for an array of up to 160 DGUs (80 MW). The DGUs will be installed in clusters of between six and seven DGUs, with each DGU linked to a Deep Green Connection Hub (DGCH) via a subsea umbilical. Energy generated by the DGUs will be transmitted to the DGCH, before being ‘stepped-up’ on its way to the transmission infrastructure, a process whereby the voltage of the electricity is modified to reduce transmission losses. Each of the DGUs will require its own subsea foundation, utilising one of three options: a concrete gravity base structure, a monopile, or a mud mat foundation. Onshore aspects not discussed, intention to develop transmission infrastructure with Morlais Project.	<2 km	Pre-application

256. The main potential cumulative and in-combination impacts from the combination of projects are:

- Underwater noise;
- Physical disturbance of habitats and habitat loss; and
- Increased suspended sediment concentration and sediment deposition.

257. Each of these impacts can arise during multiple phases of the Project. Therefore, the worst-case scenario for each impact, across phases, was taken into consideration for a single assessment per impact pathway.

258. Collision risk was screened out from cumulative and in-combination effects as these can only occur within the footprint of the Project, for which there are no overlaps.

259. Barrier effects (from the emplacement of infrastructure in the water column) were screened out from cumulative and in-combination effects as there is no adjacent project which has infrastructure in the water column that may affect fish and shellfish receptors (see below for rationale behind screening out Holyhead Deep).

260. Similarly, EMF has been screened out from cumulative and in-combination effects as the two Wylfa projects and the Almwch LNG do not involve emplacement of electric cables in the marine environment, and Holyhead Deep has no pathway for impacting fish and shellfish receptors (see below).

261. It should be noted that, although Holyhead Deep project co-occurs with the current Project, any impacts on fish species was ruled out from the Holyhead Deep 10 MW project as the "*nature of device deemed of very low impact to fish ecology*". There is no further detail on the Holyhead Deep 80MW project at the time of writing. However, as there are no primary impacts on fish and shellfish expected to arise from this project, there is no pathway for cumulative or in-combination effects to arise with the current Project.

262. At the time of writing it was not possible to find out any more information on the proposed Almwch LNG project. A period of more than five years has elapsed since the consent for this project was renewed yet there has been no recent information released and available online. It is therefore not possible to assess the potential cumulative and in-combination impacts between this project and the current Project at this time.

10.6.7.1. Cumulative Impact 1: Underwater Noise

263. The production of underwater noise from the Wylfa decommissioning project will only arise during the potential explosive decommissioning of the cooling water jetty and associated infrastructure. The underwater noise produced by explosive detonations is typically of high intensity and short duration (<1 second). The noise from underwater explosions in itself can cause mortality in the immediate area and effects at a range of up to 350 m. There is little information on the sub-lethal impacts in fish from explosions. Due to the short temporal scale (single explosion per piece of infrastructure) of the underwater noise produced during the Wylfa decommissioning it is considered unlikely to cause any added impact above the level of impact that may arise during the Project.

264. Marine works associated with the construction of Wylfa Nuclear Power Plant will include both permanent and temporary works. The Project Description states that "*the majority of works will be undertaken within the first two years of the Project's construction phase, though certain works may take up to five years to complete*". As the project is in suspension it is uncertain when or if these works will occur. The Project Description has identified the activities that may generate underwater noise as including drilling, piling (vibratory piling hammer), dredging, rock breaking, vessel noise. Of these, it can be expected that piling using the hydraulic drop hammer would produce the greatest amount of underwater noise. It has not been possible to ascertain any ranges of underwater noise impacts from the construction activities from Wylfa Nuclear Power Plant. If it can be assumed that the piling will produce underwater noise of a similar level to that produced by the current Project, then there is no pathway for overlap of the zone of influence of underwater noise. Indeed, even if the noise levels were higher, it is deemed highly unlikely that the zone of influence would exceed the 17.5 km distance between the two projects.

265. Furthermore, the deposition of dredge material at the Holyhead North dredge site as part of the Wylfa Newydd project will also produce underwater noise. Little is known about the underwater noise generated from deposition at sea therefore as a worst-case scenario the sound levels from cutter suction dredging were used in the Horizon Nuclear Disposal site characterisation report. For the sound levels produced by cutter suction dredging, the maximum range for injury to fish was modelled to be 2 m, and the maximum range of TTS was 13 m. Based on these distances there is no spatial overlap of the acoustic zones of influence produced by the two projects.

266. It is not known when the activities creating underwater noise from the other Projects will occur. Therefore, for the purpose of this assessment, the worst-case scenario of complete temporal overlap between the noise-producing activities of the identified projects and each phase of the Project has been assumed.

267. Following the measurements given above, and taking into account the maximum impact range of worst-case noise produced during the Project activities (50 m, during construction; see **Table 10-24**), it can be concluded that there will be no overlap between the acoustic footprints of the Project with other projects and plans in the area. Furthermore, the footprint over which there will be elevated noise levels is small and represents only a small portion of the greater area available to fish and shellfish species. Therefore, the cumulative impacts from the underwater noise pathway are considered not significant.

10.6.7.2. Cumulative Impact 2: Physical Disturbance and Habitat Loss

268. Another potential cumulative and in-combination impact between the Project and other projects and plans is the physical disturbance and habitat loss. The current Project represents 2,184,932 m^2 (2.18 km^2) of permanent habitat loss during the lifetime of the Project in addition to temporary habitat loss which is anticipated to have a maximum total of 423,499 m^2 (0.42 km^2) during each of the construction and decommissioning phase, and 127,000 m^2 (0.12 km^2) during the operational phase.

269. The seabed footprint of marine infrastructure associated with the existing Power Station at Wylfa is very small as it comprises a single jetty not more than 150 m long. The marine works as part of the construction of the Wylfa Newydd project are in a similar location, adjacent to the coast

at Wylfa on the north Anglesey coast, and are also considered small (extending a maximum of 3 km into the marine zone). Due to the small area and distance from the site it is considered that the cumulative impact of habitat disturbance and loss from these project activities on north Anglesey will have a negligible effect.

270. In addition to construction the Wylfa Newydd project involves dredge disposal at a large site nearer to the MDZ. As part of the plume dispersion modelling, a worst-case scenario of maximum extent of deposition on the seabed (at a thickness of 1 cm) was a total area of 1.8 km^2. This value can also be utilised to represent the maximum habitat loss in the area.

271. In comparison to the amount of comparable habitat identified in the survey area, the overall area of habitat that will be impacted by the additional seabed activities will be small and it is predicted that no significant cumulative impacts should occur.

10.6.7.3. Cumulative Impact 3: Increased Suspended Sediment Concentrations and Sediment Deposition loss

272. The decommissioning work of the existing Wylfa Power Station that are in the marine environment, i.e. the explosive demolition of the jetty, has been identified as having the potential to result in "*substantially elevated levels of suspended sediment in the water column, possibly resulting in smothering of sensitive habitats and species*". NRW that sediment transport modelling be conducted to predict effects, although it is uncertain if this was undertaken and no evidence of this has been found online.

273. As part of the Environmental Statement produced for the application for the Wylfa Newydd Project a detailed assessment of the sediment regime in the area was undertaken. The results can be used to inform the potential extent of impacts from the decommissioning activity of the existing Wylfa Power Station as they are in the same location.

274. The Environmental Statement details that, despite the high amount of wave energy, "*sediment movement is essentially limited to individual bays as rock platforms and headlands provide barriers (natural groynes)*" this prevents the movement of sediment. On this basis it is possible to infer that any increased sediment suspension as a result of marine activities in the Wylfa area will not extend as far as the Morlais zone, which is situated 17.5 km away.

275. Dredge disposal at the Holyhead North/Deep site as part of the Wylfa Newydd project also has the potential to cause localised increase in sediment concentrations and deposition. Modelling of the environmental change and effects on fish and shellfish lead to a conclusion of negligible magnitude, a worst-case medium sensitivity of the receptor (due to commercial fish), and therefore an overall negligible impact due to increased suspended sediment concentration. Similarly, the report concluded a negligible effect on fish and shellfish receptors from smothering due to the negligible magnitude of effect (due to mortality or displacement) and the medium value/sensitivity of the receptor. It was expected that all resuspended sediment would remain wholly contained within the disposal site.

276. Due to the minor adverse impact of increased sediment resulting from the Project, coupled with the negligible effect of the sediment pathways on fish and shellfish concluded from the only nearby project, and the lack of spatial overlap of effects, it can be concluded that the cumulative impacts from increased sediment will not be significant.

10.6.7.4. Cumulative Impact Summary

277. In summary, significant cumulative impacts are not expected from the Project in combination with any other reasonably foreseeable plans or projects in the study area. This is applicable throughout the lifecycle of the Project, as the key impact pathways may arise during all phases (construction through to decommissioning).

10.6.8. Inter-Relationships

278. **Table 10-27** lists out the inter-relationships between this chapter and other chapters within the ES.

Table 10-27 Inter-Topic Relationships

Topic and description	Related Chapter	Where addressed in this Chapter	Rationale
Marine Sediment and Water Quality	Chapter 8	Section 10.5.7.3	Both chapters consider the potential effects of the project on the European Shellfish Water designation.
Benthic and Intertidal Ecology	Chapter 9	Section 10.6.1 and 10.6.5	Both chapters consider the potential effects of the project in an assessment of the impact of invasive non-native species.
Marine Mammals	Chapter 12	Section 10.5.2	Noted that cetaceans may predate on species listed in this chapter; both chapters consider the effects of the project on the prey species directly or as a proxy
Marine Ornithology	Chapter 11	Section 10.5.2	Noted that birds may predate on species listed in this chapter; both chapters consider the effects of the project on the prey species directly or as a proxy
Commercial Fisheries	Chapter 14	Section 10.5.2 and 10.5.3	Noted that commercial fisheries utilise some of the species of fish listed in this chapter; both chapters consider the effects of the project on the fish species directly or as a proxy

10.6.9. Interactions

279. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts as a result of that interaction. The worst case impacts assessed within the chapter take these interactions into account and for the impact assessments are considered conservative and robust. For clarity the areas of interaction between impacts are presented in **Table 10-28**, along with an indication as to whether the interaction may give rise to synergistic impacts.

Table 10-28 Potential Interaction Between Impacts

Potential interaction between impacts						
Construction/ Repowering/ Decommissioning	1: Underwater noise		2: Physical disturbance of habitats and temporary habitat loss		3: Increased suspended sediment concentration and sediment deposition	
1: Underwater noise	-		Yes		No	
2: Physical disturbance of habitats and temporary habitat loss	Yes		-		Yes	
3: Increased suspended sediment concentration and sediment deposition	No		Yes		-	
Operation	Impact 1: Underwater Noise	Impact 2: Long-term habitat loss	Impact 3: Barrier effects	Impact 4: Increased suspended sediment concentration and sediment deposition	Impact 5: Collision risk	Impact 6: Electromagnetic fields
Impact 1: Underwater Noise	-	Yes	Yes	No	No	No
Impact 2: Long-term habitat loss via placement of project infrastructure (project footprint)	Yes	-	Yes	Yes	Yes	Yes
Impact 3: Barrier effects	Yes	Yes	-	Yes	Yes	Yes
Impact 4: Increased suspended sediment concentration and sediment deposition	No	Yes	Yes	-	Yes	Yes
Impact 5: Collision risk	No	Yes	Yes	Yes	-	No
Impact 6: Electromagnetic fields	No	Yes	Yes	Yes	No	-

10.7. SUMMARY

280. **Table 10-29** presents a summary of the impact assessments undertaken for fish and shellfish receptors in this chapter. Throughout the construction, operation and maintenance, repowering, and decommissioning phases, the impact on fish and shellfish is considered to be of **minor adverse** significance.

Table 10-29 Potential Impacts on Fish and Shellfish Receptors

Phase	Potential Impact	Receptor	Value / sensitivity combined	Magnitude	Significance	Additional Mitigation Measures	Residual Impact
Construction	Impact 1: Underwater noise	All fish species	Medium	Low	Minor adverse	None proposed	Minor adverse
	Impact 2: Physical disturbance of habitats and temporary habitat loss	All fish and shellfish species	Low	Low	Minor adverse	None proposed	Minor adverse
	Impact 3: Increased suspended sediment concentration and sediment deposition	All fish and shellfish species	Medium	Very low	Minor adverse	None proposed	Minor adverse
Operation and Maintenance	Impact 1: Underwater Noise Effects via (a) device operational noise and (b) repowering works	All fish species	Medium	Low	Minor adverse	None proposed	Minor adverse
	Impact 2: Long-term habitat loss via placement of project infrastructure (project footprint) (and via repowering)	All fish and shellfish species	Medium	Low	Minor adverse	None proposed	Minor adverse
	Impact 3: Physical disturbance of habitats and temporary habitat loss (repowering only)	All fish and shellfish species	Medium	Low	Minor adverse	None proposed	Minor adverse
	Impact 4: Increased suspended sediment concentration and sediment deposition (repowering only)	All fish and shellfish species	Medium	Very low	Minor adverse	None proposed	Minor adverse
	Impact 5: Barrier effects	All fish and shellfish species	Low	Medium	Minor adverse	None proposed	Minor adverse

Phase	Potential Impact	Receptor	Value / sensitivity combined	Magnitude	Significance	Additional Mitigation Measures	Residual Impact
	Impact 6: Collision risk	All fish and shellfish species	Low	Negligible	Minor adverse	None proposed	Minor adverse
	Impact 7: Electromagnetic fields	All fish and shellfish species	Low	Low	Minor adverse	None proposed	Minor adverse
Decommissioning	Impact 1: Underwater noise	All fish species	Medium	Low	Minor adverse	None proposed	Minor adverse
	Impact 2: Physical disturbance of habitats and temporary habitat loss	All fish and shellfish species	Low	Low	Minor adverse	None proposed	Minor adverse
	Impact 3: Increased suspended sediment concentration and sediment deposition	All fish and shellfish species	Medium	Very low	Minor adverse	None proposed	Minor adverse

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