LLŶR FLOATING OFFSHORE WIND PROJECT

Llŷr 1 Floating Offshore Wind Farm

Environmental Statement

Volume 3: Chapter 20 – Fish and Shellfish Ecology

August 2024

Prepared by: Llŷr Floating Wind Ltd

FLOVENTIS ENERGY

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Acronyms and abbreviations

Acronym or abbreviation	Definition	Acronym or abbreviation	Definition
CCME	Canadian Council of Ministers of the Environment	MCZ	Marine Conservation Zone
Cefas	Centre for Environment, Fisheries and Aquaculture Science	MMO	Marine Management Organisation
CIEEM	Chartered Institute of Ecology and Environmental Management	MSW	Multi Sea Winter
CMS	Convention on the Conservation of Migratory Species of Wild Animals	NERC	Natural Environment and Rural Communities Act 2006
EIA	Environmental Impact Assessment	NM	Nautical Mile
EMF	Electro Magnetic Fields	NRW	Natural Resources Wales
ERL	Effect range low	OESEA	Offshore Energy Strategic Environmental Assessment
ERM	Effect range medium	OSPAR	OSPAR Commission
ES	Environmental Statement	OWF	Offshore Wind Farm
EU	European Union	SAC	Special Areas of Conservation
EUNIS	European Nature Information System	SBP	Sub-bottom profiler
GIS	Geographical Information System	SPA	Special Protected Areas
HDD	Horizontal Directional Drilling	SSB	Spawning Stock Biomass
HVDC	High-voltage direct current	SSC	Suspended Sediment Concentration
ICES	International Council for Exploration of the Sea	SW	Sea Winter
IEMA	Institute of Environmental Management & Assessment	TraC	Transitional and Coastal Waters
IMO	International Maritime Organisation	UKOOA	UK Offshore Operators Association (Now Oil and Gas UK, founded in 2007)
IUCN	International Convention for the Conservation of Nature	UXO	Unexploded Ordnance
KP	Kilometre Point	WFD	The Water Environment (Water Framework Directive) (England and Wales) Regulations 2019 (European Commission (EC) Directive 2000/60/EC)
LAT	Lowest astronomical tide	WoE	Weight of Evidence

Glossary of project terms

Term	Definition
The Applicant	The developer of the Project, Llŷr Floating Wind Limited.
Array	All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s).
Array Area	The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located.
Electro Magnetic Fields (EMF)	Invisible areas of energy, often referred to as radiation, that are associated with the use of electrical power and various forms of natural and man-made lighting).
Effect range low (ERL)	Concentration below which effects are rarely observed or predicted among sensitive life stages and species of biota for Sediment Effect Concentrations.
Effect range medium (ERM)	Concentration above which effects are frequently or always observed among most species of biota for Sediment Effect Concentrations).
European Nature Information System	Provides access to the publicly available data in the EUNIS database for species, habitat types and protected sites across Europe).
Floventis Energy	A joint venture company between Cierco Ltd and SBM Offshore Ltd of which Llŷr Floating Wind Limited is a wholly owned subsidiary.
Landfall	The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays (TJB).
Lowest astronomical tide (LAT)	The lowest tide level which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.
Llŷr 1	The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases.
Marine Licence	A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team (MLT) on behalf of the Welsh Ministers.
Natural Environment and Rural Communities Act 2006 (NERC)	An act which extended the biodiversity duty set out in the Countryside and Rights of Way (CROW) Act to public bodies and statutory undertakers to ensure due regard to the conservation of biodiversity).
Nautical mile	A unit of measurement used in air, marine, and space navigation, and for the definition of territorial waters. It is based on the circumference of the earth and is equal to one minute of latitude. It is slightly more

	than a statute (land measured) mile (1 nautical mile = 1.1508 statute miles). Nautical miles are used for charting and navigating.
Offshore Development Area	The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application.
Offshore Export Cable	The cable(s) that transmit electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OfECC)	The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall.
Onshore Development Area	The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application.
Onshore Export Cable(s)	The cable(s) that transmit electricity from the landfall to the onshore substation.
Onshore Export Cable Corridor (OnECC)	The area within which the onshore export cable circuit(s) will be located.
Onshore Substation	Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption.
Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Commission)	Forum through which 15 governments and the European Union cooperate to protect the marine environment in the North-East Atlantic Ocean.
The proposed Project	All aspects of the Llŷr 1 development.
Special Areas of Conservation (SAC)	Protect one or more special habitats and/or species – terrestrial or marine – listed in the Habitats Directive.
Special Protected Area (SPA)	Land designated under Directive 2009/147/EC on the Conservation of Wild Birds.
Section 36 consent	Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works.
Transitional and Coastal Waters (TRaC)	Transitional waters where seawater is diluted with river water i.e. a transition zone between the river and sea. Coastal waters - interface between land and ocean and in the context of the Water Framework Directive coastal waters include water, that has not been designated as transitional water, extending one nautical mile from a baseline defined by land points where territorial waters are measured.
WFD	An EU Directive which commits member states to achieve good status of all waterbodies (both surface and groundwater), and requires that no such waterbodies experience deterioration in status.

Table of Contents

List of Figures

List of Tables

20. FISH AND SHELLFISH

20.1 Introduction

1. Llŷr Floating Wind Limited (hereafter the Applicant) is proposing to develop the Llŷr 1 Floating Offshore Wind Farm (hereafter referred to as the proposed Project), located approximately 35 km off the coast of Pembrokeshire in the Celtic Sea.
2. The proposed Project is a test and demonstration wind farm development, comprising up to 10 wind turbine generators (WTGs). The proposed Project will make landfall at Freshwater West before connecting into Pembroke Dock power station and the national grid network.
3. The Applicant is seeking a Section 36 consent and Marine Licence for the proposed Project, and this chapter forms part of the Environmental Statement (ES) which is submitted in support of those consent applications. This chapter describes the potential impacts and effects of the proposed Project on benthic ecology during the construction, operation and maintenance and decommissioning phases, and includes mitigation and good practice measures to reduce the impacts of the proposed Project on fish and shellfish. **Section 20.8** of this ES chapter provides a summary of the impact assessment undertaken and significance of residual effects on fish and shellfish following consideration of any mitigation measures.
4. The assessment presented in this chapter should be read in conjunction with following linked and supporting chapters:
   - **Chapter 04: Description of the Proposed Project** - provides detailed information on construction and installation methods for the Proposed Project;
   - **Chapter 05: EIA Approach and Methodology** - provides further details of the general framework and approach to the EIA;
   - **Chapter 17: Physical Environment** - provides information on the physical habitats in the Study Area, including bathymetry and tidal currents;
   - **Chapter 19: Benthic Ecology** – provides information on benthic habitats in the Study Area, including sediment types;
   - **Chapter 21: Marine Mammals** – provides information on marine mammals in the Study Area; and
   - **Chapter 25: Commercial Fisheries** – provides further information on commercially important fish and shellfish species in the Study Area.
5. Additional information to support the assessment includes:
   - **Appendix 19A: Nearshore 2023 Benthic Survey Report;**
   - **Appendix 19B: Offshore 2023 Benthic Survey Report;**
   - **Appendix 19C: EMF Assessment Report;**
   - **Appendix 19D: Drop down video survey 2024;**
   - **Appendix 21B: Marine Mammal Noise Modelling (including for fish and shellfish); and**
   - **Appendix 32A: Mitigation Register.**
6. The assessment has been undertaken by AECOM. Further details of the Project Team's competency are provided in **Appendix 1A: Statement of Competence**.

20.2 Legislation, Policy and Guidance

7. The following sections identify specific legislation, policy and guidance that is applicable to the assessment of fish and shellfish. Further detail on the wider legislation, policy and guidance relevant to this ES is provided in **Chapter 02: Regulatory and Planning Policy Context**.

20.2.1. Legislation

8. This section outlines legislation, policy and guidance relevant to the appraisal of the potential effects on the fish and shellfish ecology associated with the proposed Projects. The overall regulatory and planning context is described in **Chapter 02: Regulatory and Planning Policy Context** of this ES. The following legislation is considered relevant to the proposed Project in respect of fish and shellfish ecology:

- **European Union Council Directive 92/43/EEC**, on the conservation of natural habitats and of wild fauna and flora adopted in 1992.
- **Conservation of Habitats and Species Regulations (as amended) 2017**, which transposes the Habitats Directive (92/43/EEC) into UK legislation, covering the marine environment to 12 NM offshore;
- **Conservation of Offshore Marine Habitats and Species Regulations 2017**, transposes the Habitats Directive (92/43/EEC) into UK legislation, covering the marine environment beyond 12 NM;
- **The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019,** which amended the Habitats Regulations 2017, that transpose the Habitats and Wild Birds Directives, to make them operable from January 1st 2021, when the UK left the EU;
- **Conservation of European Wildlife and Natural Habitats Convention (Bern convention) 1979,** which was put in place as the first international treaty to provide protection for both species and habitats, and to bring countries together in decision making on nature conservation;
- **Marine and Coastal Access Act 2009**, which provides the legal mechanism to help ensure clean, healthy, safe and productive and biological diverse oceans and seas;
- **The Wildlife and Countryside Act 1981 (as amended)**, which includes provisions relating to nature conservation;
- **The Marine Strategy Regulations 2010**, which transpose the Marine Strategy Framework Directive (2008/56/EC) into UK legislation;
- **The Eels (England and Wales) Regulations 2009**, which implement Council Regulation (EC) No 1100/2007 (EC) No 1100/2007 establishing measures for the recovery of the stock of European eel including providing for the free passage of eels;
- **Environment (Wales) Act (2016)**, Section 7 of the Act includes a list of Species of Principal Importance for the purpose of maintaining and enhancing biodiversity in relation to Wales replacing the duty in Section 42 of the NERC Act 2006;
- **The Environment Act (2021),** which sets clear statutory targets for the recovery of the natural world in four priority areas: air quality, biodiversity, water and waste, and makes biodiversity net gain (BNG) for new developments a mandatory requirement in the UK;
- **The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 ('WFD')**, provides for the establishment of environmental objectives for water bodies, including in relation to fish and the protection of Shellfish Water Protected Areas;

- **The Salmon and Freshwater Fisheries Act (1975)**, to consolidate the Salmon and Freshwater Fisheries Act 1923 and certain other enactments relating to salmon and freshwater fisheries, and to repeal certain obsolete enactments relating to such fisheries;
- **The Electricity Works (EIA) (England and Wales) Regulations 2017**, which sets out requirements for conducting environmental impact assessments for applications for development relating to the provision or generation of electricity;
- **The Marine Works (EIA) Regulations 2007**, which sets out measures relating to the requirement for an assessment of the impact on the environment of marine-associated projects likely to have significant effects; and
- **Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention')**, which was adopted in 1998 and amended in 2007 and consists of fifteen governments, to provide the protection of marine biodiversity and ecosystems from polluting and non-polluting human activities.

20.2.2. National Planning Policy

9. The key national planning policies that are relevant to fish and shellfish ecology include the UK Marine Policy Statement and National Policy Statements (NPS) for Energy (EN-1) and Renewable Energy Infrastructure (EN-3) as set out below.
10. NPS on Energy have been designated by the UK government to guide decision making on Nationally Significant Infrastructure Projects (NSIPs) consented under the Planning Act 2008. Given that the NPSs only applies to offshore wind projects that exceed 350 MW in capacity, they would not directly guide decision making on the proposed Project. However, because they were written to guide decision making on offshore wind projects, they are considered relevant as material considerations.
11. A summary of these planning policies and how they relate to fish and shellfish receptors is set out in **Table 20-1**.
    - **UK Marine Policy Statement**, which aims to achieve sustainable development in the UK marine area;
    - **Overarching NPS for Energy (EN-1) (2024)**, which sets out national policy for energy infrastructure, effecting decisions by the Infrastructure Planning Commissions (IPC) on applications for energy developments falling within the scope of the NPS; and
    - **NPS for Renewable Energy Infrastructure (EN-3) (2024)**, which provides the primary basis for decisions made by the IPC on applications for nationally significant renewable energy infrastructure.

Table 20-1. A summary of national planning policy relevant to fish and shellfish

Summary of policy	How and where it is considered in the chapter
EN-1	
4.5.7 'Applicants are encouraged to approach the marine licensing regulator (MMO in England and Natural Resources Wales (NRW) in Wales) in pre-application, to ensure that they are aware of any needs for additional marine licences alongside their DCO application'.	Consultation with NRW has been carried out during scoping and pre-application and is now concluded. A summary of the consultation is provided in **Section 20.3**.
4.5.9 'Applicants are encouraged to refer to Marine Plans at an early stage, such as in preapplication, to inform project planning, for	Relevant Marine Plans have been considered in **Section 20.2.3**.

Summary of policy	How and where it is considered in the chapter
example to avoid less favourable locations as a result of other uses or environmental constraints'.	
5.4.17 (part) '...Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats'.	Details of designated sites and protected species are discussed in **Section 20.20.5.1**. A full assessment of the impacts of the proposed Project on these species is provided in **Section 20.8**. A Habitat Regulations Assessment (HRA) Screening Report and a HRA Report to Inform Appropriate Assessment (RIAA) have also been conducted to assess the likely significant effects (LSEs) of the proposed Project on European designated sites and Ramsar sites. These are provided in **Appendix 8D: Habitat Regulations Assessment Screening** and **Appendix 8E: HRA RIAA.**
5.4.19 '…The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests'.	Embedded mitigation and best practice measures to conserve and enhance biodiversity are provided in **Section 20.7,** such as the micro-siting of the export cables and only using rock placement where necessary. No additional mitigation measures have been proposed in relation to fish and shellfish ecology.
5.4.23 'Energy projects will need to ensure vessels used by the project follow existing regulations and guidelines to manage ballast water.'	Embedded mitigation and best practice measures for the proposed Project, including those regarding the use of vessels, are provided in **Section 20.7**.
EN-3	
2.8.68 'The applicant should assess the effects of the offshore transmission and any associated infrastructure on the marine… environment.'	All potential effects from impact pathways on the marine environment have been assessed in **Section 20.8**. This includes assessment of offshore transmission infrastructure.
2.8.72 'Assessment of environmental effects of transmission infrastructure and any proposed offshore...substations should assess effects both alone and cumulatively with other existing and proposed infrastructure'.	All likely offshore impacts and cumulative impacts, including assessment of offshore transmission infrastructure, have been assessed in **Section 20.8** and **Section 20.13** respectively.
2.8.73 'Applicants should include details on how avoidance has been achieved, good design principles have been followed and provide proposals for mitigation.'	Embedded mitigation and best practice measures for the proposed Project are outlined in **Section 20.7**. No additional mitigation measures have been proposed in relation to fish and shellfish ecology.
2.8.98 'Applicants should have regard to the specific ecological and biodiversity considerations that relate to proposed offshore renewable energy infrastructure developments, namely: • *fish…'*	All potential impacts to fish resulting from the proposed Project are assessed in **Section 20.8**.

Summary of policy	How and where it is considered in the chapter
2.8.104 'Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non-governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options which should be undertaken'	Consultation with other stakeholders such as the National Federation of Fishermen's Organisation (NFFO) has included consideration of assessment methodologies, baseline data collection and mitigation measures as required. A summary of the consultation is provided **Section 20.3**.
2.8.126 'Applicant assessment of the effects on the subtidal environment should include: • *loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes, e.g. sandwave/boulder/UXO clearance;* • *environmental appraisal of inter-array and other offshore transmission and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour/cable protection and sandwave/boulder/UXO clearance;* • *habitat disturbance from construction and maintenance/repair vessels' extendable legs and anchors;* • *increased suspended sediment loads during construction and from maintenance/repairs;* • *predicted rates at which the subtidal zone might recover from temporary effects;* • *potential impacts from EMF on benthic fauna;* • *potential impacts upon natural ecosystem functioning;* • *protected sites; and* • *potential for invasive/non-native species introduction.'*	All potential impacts to fish and shellfish resulting from the proposed Project are assessed in **Section 20.8**. This includes consideration of each of the effects highlighted.
2.8.147 'Fish in the context of this NPS also includes elasmobranchs (sharks and rays) and shellfish (e.g., crabs).'	Both elasmobranchs and shellfish have been considered in this assessment, see **Section 20.5**.
2.8.150 'The applicant should identify fish species that are the most likely receptors of impacts with respect to: • *spawning grounds;* • *nursery grounds;* • *feeding grounds;* • *over-wintering areas for crustaceans;*	Fish species that are the most likely receptors of impacts, including those highlighted have been identified in **Section 20.5**.

Summary of policy	How and where it is considered in the chapter
• *migration routes; and* • *protected sites.'*	
2.8.151 'Applicant assessments should identify the potential implications of underwater noise from construction and unexploded ordnance including, where possible, implications of predicted construction and soft start noise levels in relation to mortality, permanent threshold shift (PTS), temporary threshold shift (TTS) and disturbance and addressing both sound pressure and particle motion) and EMF on sensitive fish species.'	The impacts resulting from underwater noise and electromagnetic field (EMF) emissions have been assessed in **Section 20.8.2**. Prior to construction there will be a full geophysical survey to determine the presence of UXO and the need for any explosive objects to be cleared. An application for a separate Marine Licence in respect of UXO clearance will be made post submission, when the exact number and type of detonations have been established. However, an initial impact assessment of the effect of UXO detonation is included.
UK Marine Policy Statement	
The UK MPS ensures that marine resources are used in a sustainable way by ensuring biodiversity is protected and conserved by using the precautionary principle and relying on sound evidence.	In line with policy objectives in the MPS, this ES Chapter has taken into consideration measures that can be taken to avoid biodiversity loss. Where possible, consideration has been given to conserving and avoiding harm to fish and shellfish ecology through routeing, mitigation, and consideration of reasonable alternatives. Potential impacts to designated sites and protected features have been avoided where possible. Details of protected sites and species designations are provided in **Section 20.20.5.1**, with an assessment of potential impacts in **Section 20.8**. Relevant additional mitigation measures are detailed in **Section 20.9**.

20.2.3. Welsh Planning Policy

12. The key Welsh planning policies that are relevant to fish and shellfish ecology are set out below. A summary of these planning policies and how they relate to fish and shellfish receptors is set out in **Table 20-2**.

- **Welsh National Marine Plan;**
- **Planning Policy Wales;**
- **Future Wales – The National Plan 2040;**
- **The Second State of Natural Resources Report 2020; and**
- **Nature Recovery Action Plan Wales.**

Table 20-2. A summary of Welsh planning policy relevant to fish and shellfish

Summary of policy	How and where it is considered in the chapter
Welsh National Marine Plan *sets out a single framework for sustainable development within Wales marine area, including the requirement to maintain seafloor integrity and safeguard marine ecosystems (Welsh Government, 2019).*	The identification of the fish and shellfish baseline environment is set out in **Section 20.5**. A full impact assessment is provided in **Section 20.8**, with embedded mitigation and best practice measures to safeguard fish and shellfish ecosystems set out in **Section 20.7**.
Planning Policy Wales – Edition 12 *highlights the importance of biodiversity for natural services, sustainability and the Welsh economy. It includes objectives to achieve efficient use and protection of natural resources and enhancing biodiversity.*	A full impact assessment is provided in **Section 20.8**, with embedded mitigation and best practice measures to safeguard fish and shellfish ecosystems set out in **Section 20.7**.
Future Wales – The National Plan 2040 *sets out a development strategy for key national priorities, which includes developing strong ecosystems and climate-resilience in Wales' marine environment*	A full impact assessment is provided in **Section 20.8**, with embedded mitigation and best practice measures to safeguard fish and shellfish ecosystems set out in **Section 20.7**.
The Second State of Natural Resources Report 2020 *aims to achieve sustainable management of natural resources and to protect the environment for future generations in Wales, including in the marine environment.*	A full impact assessment is provided in **Section 20.8**, with embedded mitigation and best practice measures to safeguard fish and shellfish ecosystems set out in **Section 20.7**.
Nature Recovery Action Plan Wales *is a strategy for Wales which aims to address declining biodiversity, including marine habitats, ecosystems and fisheries.*	A full impact assessment is provided in **Section 20.8**, with embedded mitigation and best practice measures to safeguard fish and shellfish ecosystems set out in **Section 20.7**.

20.2.4. Local Planning Policy

13. The key local planning policies that are relevant to fish and shellfish ecology include the Pembrokeshire Coast National Park Development Plan 2 and South West Wales Area Statement as set out below. A summary of these planning policies and how they relate to fish and shellfish receptors is set out in **Table 20-3**:

- **Pembrokeshire Coast National Park Development Plan 2**, which sets out policies for local developments in Pembrokeshire to determine the outcome of planning applications; and
- **South West Wales Area Statement**, which identifies the key risks, opportunities and priorities needed to build the resilience of our ecosystems and support sustainable management of the natural resources.

Table 20-3. A summary of local planning policy relevant to fish and shellfish

Summary of policy	How and where it is considered in the chapter
Pembrokeshire Coast National Park Development Plan	
The Pembrokeshire Coast National Park Development Plan includes several policies to ensure the biodiversity of the National Park is conserved, including Policy 8: *'The special qualities of the Pembrokeshire Coast National Park will be conserved and enhanced.*	As the Pembrokeshire Coast National Park is above MLWS it is not relevant to fish and shellfish ecology. Embedded mitigation and best practice measures are provided in **Section 20.7** to conserve fish and shellfish in the Study Area. Opportunities for enhancement have been

Summary of policy	How and where it is considered in the chapter
The priorities will be to ensure that: …Species and habitats are conserved and enhanced for their amenity, landscape and biodiversity value.'. *The Pembrokeshire Coast National Park is a local plan and relates to the terrestrial planning jurisdiction which will end at mean low water springs.*	explored where required. However, no additional enhancement measures have been proposed at this stage. A full assessment of impacts is provided in **Section 20.8**.
South West Wales Area Statement	
The South West Wales Area Statement has a theme of *'Reversing the decline of, and enhancing, biodiversity',* through enhancing species and habitat connectivity to allow habitats to function effectively.	Embedded mitigation and best practice measures to conserve and enhance fish and shellfish in the Study Area are discussed in **Section 20.7**. A full assessment of impacts is provided in **Section 20.8**.

20.2.5. Guidance

14. In addition to the legislation and policies outlined above, the following key guidance is also applicable for fish and shellfish ecology in UK waters and have been used to help inform a 'Weight of Evidence' (WoE) approach to assess impacts to fish and shellfish from the proposed Project (also see **Table 20-4**). In the absence of Environmental Quality Standards for in situ sediments in the UK, some of these guidance documents refer to toxic contaminant guidelines from other countries. Guidance documents used to inform the assessment include:

- Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018);
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) Guidance Note for Environmental Impact Assessment in respect of Food and Environment Protection Act (FEPA) and Coast Protection Act (CPA) requirement (Cefas, 2004);
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Judd, 2012);
- Cefas Chemical Action Levels (Marine Management Organisation (MMO), 2014) (Reviewed 2020);
- Canadian sediment quality guidelines (CCME, 2001) applied to contaminants where no other regional threshold value is available;
- UK Offshore Operators Association (UKOOA) sediment quality guidelines for the UK North Sea (UKOOA, 2021); and
- OSPAR background concentrations and background assessment concentrations and effect range low (ERL) and effect range median (ERM) concentrations for contaminants (OSPAR, 2009).

Table 20-4. A summary of guidance relevant to fish and shellfish

Summary of Guidance	How and where it is considered in the chapter
Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018).	The CIEEM guidelines for ecological impact assessment have been followed, in addition to methodology outline in **Chapter 05: EIA Approach and Methodology**, in order to assess impacts outlined in **Section 20.8**.
Centre for Environment, Fisheries and Aquaculture Science (Cefas) Guidance Note for Environmental Impact Assessment in respect of Food and Environment Protection Act (FEPA) and Coast Protection Act (CPA) requirement (Cefas, 2004).	The Cefas guidance note on environmental impact assessment has been incorporated into the assessment of impacts in **Section 20.8.**
Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Judd, 2012).	The guidelines produced by Judd (2012) have been followed during gathering of baseline data in **Section 20.5** to inform the assessment of impacts in **Section 20.8**.
Cefas Chemical Action Levels (Marine Management Organisation (MMO), 2014) (Reviewed 2020) are values used in conjunction with a range of other assessment methods to make management decisions regarding the fate of dredged material. The action levels are not 'pass/fail' criteria but triggers for further assessment. In general, contaminant levels below action level 1 are of no concern and are unlikely to influence the licensing decision. Dredged material with contaminant levels between action levels 1 and 2 requires further consideration before a decision can be made and material with contaminant levels above action level 2 is generally considered unsuitable for sea disposal. For non-dredging activities Action Levels are used as a guide in assessment of sediment contamination.	Cefas chemical action levels have been used to determine whether levels of sediment-bound contaminants during the project-specific benthic survey are of concern (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**). Potential effects from the release of sediment-bound contaminants have been assessed in **Section 20.8**.
Canadian sediment quality guidelines (CCME, 2001) applied to contaminants where no other regional threshold value is available. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. The Canadian Sediment quality guidelines were developed by the Canadian Council of Ministers of the Environment as broadly protective tools to support the functioning of healthy aquatic ecosystems.	Cefas chemical action levels have been used to determine whether levels of sediment-bound contaminants during the project-specific benthic survey are of concern (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**). Potential effects from the release of sediment-bound contaminants have been assessed in **Section 20.8**.
UK Offshore Operators Association (UKOOA) sediment quality guidelines for the UK North Sea (UKOOA, 2021).	The UKOOA sediment quality guidelines have been used to determine whether levels of sediment-bound contaminants during the project-specific benthic survey are of concern (**Appendix 19A: Nearshore 2023 Benthic Survey**

Summary of Guidance	How and where it is considered in the chapter
	Report and **Appendix 19B: Offshore 2023 Benthic Survey Report**). Potential effects from the release of sediment-bound contaminants have been assessed in **Section 20.8**.
OSPAR background concentrations and background assessment concentrations and effect range low (ERL) and effect range median (ERM) concentrations for contaminants (OSPAR, 2009).	The OSPAR ERL and ERM concentrations have been used to determine whether levels of sediment-bound contaminants during the project-specific benthic survey are of concern (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**). Potential effects from the release of sediment-bound contaminants have been assessed in **Section 20.8**.

20.3 Stakeholder Engagement and Consultation

15. Consultation with statutory and non-statutory organisations is a key element of the EIA process. Consultation with regards to fish and shellfish has been undertaken to inform the approach to, and scope of, the assessment.
16. Stakeholders for the Projects include statutory consultees, landowners, local communities and other sea users. In addition to the statutory consultation process, there has been ongoing engagement with statutory and non-statutory consultees to steer the development of the Projects and this is detailed in **Table 20-5**.

20.3.6. *Summary of Stakeholder Consultations*

Table 20-5. Summary of the key issues raised by consultees and how each issue was addressed.

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
Scoping			
NRW	Scoping opinion: 23.05.2022	*Section 21.2 Regulatory and Planning Policy Context*: The Salmon and Freshwater Fisheries Act (1975) **should be included** in the list. Although the site is offshore and outside the 6 NM distance from the coast, the cable corridor and wider Study Area is inside the boundary where the legislation applies.	The Salmon and Freshwater Fisheries Act (1975) has been included in the legislation section and considered within the impact assessment. **Section 20.2** presents legislation and policy.
NRW	Scoping opinion: 23.05.2022	*Section 21.3 Study Area:* NRW (A) agrees that underwater noise from construction activities is likely to be a primary effect on fish, especially for fish where the swim bladder is near or connected to the ear, such as in the clupeids. Recent evidence (Davies *et al* 2020b) has found that Twaite shad from the river Severn undertake long range migration across the Celtic sea, and NRW (A) therefore recommend that to ensure any fish passing through the Study Area are considered, **a regional approach is taken, screening in all sites with noise sensitive fish features**. Furthermore, NRW (A) recommends that **site and project specific noise modelling is undertaken** to inform the detailed assessment.	A regional approach to consider any migratory fish that could interact with the Project has been included in the determination of the Study Area. Underwater noise modelling has been undertaken in order to assess impacts on fish, including high hearing sensitivity fish, such as clupeids and shad. See **Section 20.4.3**. Underwater noise is considered in **Section 20.8 Assessment of Environmental Effects**.
NRW	Scoping opinion: 23.05.2022	*Map of Study Area:* NRW (A) advise that Cardigan Bay and River Teifi SAC, both of which have Annex II diadromous fish features, are borderline on the screening criteria but should be included on the map and **scoped in** for migratory fish.	These sites are now included in **Section 20.5.4** and **Vol 6, Appendix 8C: Habitat Regulations Assessment Screening**

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
NRW	Scoping opinion: 23.05.2022	*Section 21.4.1-21.4.4:* NRW (A) does not disagree with the species described in these sections, and understand that this is not an exhaustive list. However, NRW (A) advise that for EIA purposes receptor fish species should primarily be informed through a combination of species conservation status (e.g. Annex II, OSPAR, Section 7), species of commercial importance and their ecological role, e.g. species which form important prey species for other receptors, such as marine mammals and birds and as such this list should be refined and appropriate processes for species selection identified.	The baseline has been divided into ecological role groups first (e.g. migratory, pelagic, demersal, elasmobranchs etc.) with other factors, such as conservation status and importance considered within those key sections. Reference is made where species have commercial importance. More detail on the commercial importance of fish and the potential impact of the proposed Project is provided within **Chapter 25: Commercial Fisheries**. See **Section 20.20.5.1 Existing Baseline.**
NRW	Scoping opinion: 23.05.2022	*Section 21.4.4 Elasmobranchs:* Angelshark (*Squatina squatina*) is listed as a species on the Wildlife and Countryside Act under Schedule 5; is an OSPAR/Section 7 Species, as well as being listed on the CMS (Convention on the Conservation of Migratory Species of Wild Animals). Angelshark should also **be included in this section** due to historic and current presence in Welsh waters (Barker *et al*. 2021 in-prep) and the potential for this species to make seasonal inshore-offshore movements particularly in relation to potential effects of EMF. This should also **be considered as part of assessment.** Page 12 of 26 www.naturalresourceswales.gov.uk	Consideration has been given to the Angelshark due to its historic and current presence in Welsh waters, specifically the effects of EMF on offshore movements. This species has been covered **in Section 20.5 Existing Baseline** and **Section 20.8 Assessment of Environmental Effects**. The effect of EMF, has been assessed in **Section 20.8.2 Operational Impacts**.
NRW	Scoping opinion: 23.05.2022	Section 21.4.5 Spawning and nursery grounds: The applicant should note and be aware that there are Atlantic herring spawning grounds inside the Pembrokeshire Marine SAC, as well as in the coastal areas (Davies *et al*, 2020a) so these need to be appropriately captured and considered in the ES. While NRW (A) agrees with the use of the fisheries sensitivity maps by Coull *et al*. 2012, and Ellis *et al*., 1998 the limitations of these maps should be noted,	Consideration has been given to the presence of Atlantic herring spawning grounds inside the Pembrokeshire Marine SAC in both the existing baseline (**Section 20.5**) and appraisal of potential impacts (**Section 20.8**).

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
		especially around the lack of survey data for coastal waters and water less than 30 m deep, as well as the age of some of the data. NRW (A) further advise that additional data sources for the Celtic Sea should be consulted, such as the PELTIC surveys conducted by Cefas. The recent report '*Spawning and nursery grounds of forage fish in Welsh and surroundings waters'* (Campanella & van der Kooij 2021) presents a useful summary of data sources for a range of fish species in Welsh waters and we recommend that this is considered.	Additional data sources for the Celtic Sea (including the PELTIC survey reports, Campanella and van der Kooij (2021) and Davies et al. (2020a)) have been consulted and included within the report where applicable. Limitations of data sources have also been discussed in detail with current and relevant literature used where possible. **Section 20.20.5.1** and **Section 20.8 Assessment of Environmental Effects** discuss Atlantic Herring and potential impacts to this species. **Section 20.6.2 Assessment Assumptions and Limitations** discusses the limitations in data sources.
NRW	Scoping opinion: 23.05.2022	NRW (A) welcomes the intention to further assess sandeel and herring spawning in light of the results of the benthic sampling (please note comment above) and would **advise that GIS modelling is carried out** using the methodology described by Reach *et al* (2015), Latto *et al* (2013) and Marine Space Ltd *et al* (2013a, 2013b).	GIS modelling has been included in the baseline determination of suitable herring and sandeel spawning grounds, using MarineSpace *et al.* (2013a and 2013b) guidance. See **Spawning and Nursery Grounds**
NRW	Scoping opinion: 23.05.2022	Furthermore, for oceanic species, such as Bluefin tuna and Basking shark (a Wildlife and Countryside Act and OSPAR protected species) additional data should be consulted to assess the species-specific risk of entanglement. The ES for Project Erebus list several data sources and records which can be used.	and **Elasmobranchs** includes information regarding the presence of bluefin tuna in the Study Area.

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
			The risk of entanglement has been assessed in **Section 20.8 Assessment of Environmental Effects.** The ES for Project Erebus has been referenced and applicable data sources and records have been used where suitable.
NRW	Scoping opinion: 23.05.2022	NRW (A) notes that project specific mammal surveys and Digital Aerial Surveys for birds are proposed. NRW (A) recommend that these also include observations of large oceanic fish to inform the assessment. Furthermore, NRW (A) welcomes the intention to undertake site specific surveys and would recommend that any fish encountered during sampling of benthic habitats, e.g. sandeel from grab sampling, or fish encountered in video surveys, are noted and the information used to inform the assessment in the Fish and Shellfish chapter.	The advice from NRW (A) is noted, however, no fish were observed in samples taken during the benthic characterisation survey by Ocean Ecology. Basking sharks and blue sharks were identified in surveys undertaken by HiDEF and this has been detailed in the relevant sections of the baseline. See **Elasmobranchs**
NRW	Scoping opinion: 23.05.2022	*Section 21.4.7 Designated Sites and Protected Species*. Please see comment above relating to screening distances and inclusion of Cardigan Bay and River Teifi SAC Annex II features. NRW (A) also **advise that Atlantic salmon (Annex II migratory fish), and sea trout are included**, as described in Section 21.4.3, as these are features of the Severn Estuary SAC/Ramsar site migratory fish assemblage. NRW (A) welcomes the intention to screen in the Severn Estuary SAC but would advise that the **rivers Usk and Wye SACs connected to the site, are also included and need to be scoped into the assessment**.	Cardigan Bay and River Teifi SAC have been included in this assessment. Rivers Usk and Wye SAC have also been scoped into the assessment following the advice from NRW (A). In addition, Atlantic salmon and sea trout have been considered and discussed further in **Section 20.20.5.1.** See **Section 20.5.4** and **Section 20.8.**
NRW	Scoping opinion: 23.05.2022	*Section 21.8 Conclusion:* NRW (A) agree with the list of potential impacts identified, and that no specific fish or shellfish surveys are required. However, as described above, should any fish be encountered during the benthic surveys this information should be used to validate the desk top study of spawning/nursery	The advice from NRW (A) is noted, however, no fish were encountered during benthic surveys in relation to species for which the presence of spawning and nursery habitat has

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
		habitat and please note advice above relating to additional data sources and modelling for some receptor species.	been assessed. The advice above relating to additional data sources is also noted.
NRW	Scoping opinion: 23.05.2022	*Section 28 Designated sites: Table 28-1. Terrestrial sites:* Please see comments above on additional sites which should be scoped in for Annex II migratory fish features.	The above sites for migratory fish features have been added to the designated sites assessment. See **Section 20.5.4** and **Section 20.8.**
NRW	Scoping opinion: 23.05.2022	*Section 30 Combined and Cumulative Effect of the project*: NRW (A) agrees with the listed project and plans from a fish perspective and advise that particular attention is paid to temporal and spatial cumulative effects on spawning and nursery habitats for fish receptors, as well as underwater noise.	Consideration has been given to the temporal and spatial cumulative effects on spawning and nursery habitats for fish receptors, as well as underwater noise in **Section 20.13 Cumulative Effects of the Project.**
NRW	Consultation meeting: 28.03.2023	A consultation meeting was held between the NRW advisory team, Floventis and AECOM, specifically relating to fish and shellfish. During the meeting, it was confirmed that: - The Rochdale Envelope approach will be adopted by the Project; - Popper et al. (2014) thresholds will be used during the assessment of underwater sound production on fish; - Shad will be included as a feature of Pembrokeshire Marine SAC and considered as highly sensitive; - It is expected that migratory routes will be defined as the impact assessment progresses; - There was potential for restrictions to be required for the Project to cross watercourses as mitigation for potential effects on migratory fish that may use such watercourses; and - EMF will be scoped into the assessment for relevant fish species.	These issues have been addressed as follows: - The Rochdale Envelope approach has been adopted by the Project. For the overall assessment methodology for fish and shellfish, CIEEM guidance has been followed as it is more suitable for application to ecological receptors; - Thresholds defined by Popper et al. (2014) have been used in the assessment of underwater noise and vibration effects on fish in **Section 20.20.8.1** (assessment starts from paragraph 258); - Allis and Twaite shad have been included in the baseline as a diadromous feature of the Pembrokeshire Marine SAC and assessed as part of the diadromous fish

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
			group in the impact assessment (see **Section 20.20.5.1** and **Section 20.8**); - Migratory routes for fish species have been identified and included as part of a regional approach to define the Study Area, using guidance from ABPmer (2014). Key migratory rivers designated for the protection of migratory fish located in the Study Area have also been included in **Section 20.20.5.1** - Designated Sites; - The Project is not expected to directly cross and / or create a barrier to watercourses which provide a key migratory route for fish. This has been considered further in **Section 20.8**; and - Effects of EMF on fish and shellfish species has been assessed in **Section 20.8.2**).
NRW	Survey Report Advice (PDF via email): 19.07.2023	NRW provided advice on the geophysical survey report**, Appendix 19A: nearshore 2023 benthic survey report** and **Appendix 19B: Offshore 2023 benthic survey report.** This included highlighting gaps in data collection required for protection measures on Annex I sandbank Turbot Bank, and insufficient information to understand potential impacts on designated features of the surrounding designated sites.	These reports have been used to inform the baseline and impact assessment in this chapter where applicable. Further discussion regarding the benthic surveys has been undertaken, with additional data collection carried out where gaps were present.
NFFO	Scoping opinion: 24.05.2022	Questioned the credibility of the ecological baseline used to assess impacts on fish and shellfish stocks (dating from 2012 or earlier).	Information from more recent data sources have now been added to inform the baseline. This includes data from the PELTIC surveys and Davies *et al*. (2020a).

Consultee	Consultation type and date	Comment raised	How issue has been addressed and location of response in chapter
			Relevant sections can be found in **Section 20.5 Baseline**.
NFFO	Scoping opinion: 24.05.2022	Recommended the potential impact of EMF on commercial fish and shellfish stocks or cetacean populations is scoped into the ES, citing research from Harsanyi *et al*., 2012.	This has been scoped in and is included in **Section 20.8.2 Operational Impacts.**
Natural England	Consultation meeting: 06.06.2023	A consultation meeting was held between Natural England, Floventis and AECOM, specifically relating to fish and shellfish. Points raised in relation to **Chapter 20: Fish and Shellfish** were: Decommissioning impacts will be considered within the EIA. Additional text will be included where impacts are anticipated to differ from construction and maintenance, otherwise cross references will be made to the relevant impact assessments.	Consideration has been given to decommissioning impacts in **Section 20.8.3.**

20.4 Approach to Assessment

20.4.1. Assessment Methodology

17. **Chapter 05: EIA Approach and Methodologies** provides a summary of the general impact assessment methodology applied in this ES. The following sections provide further detail on the specific methodology used to assess the potential impacts on fish and shellfish.
18. The chapter has been prepared in accordance with the CIEEM Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal, and Marine (CIEEM, 2018), which recommends following a non-matrix approach for ecology. This reflects a lack of quantitative thresholds for ecological disciplines and the need to apply professional judgement to the assessment of effects. The CIEEM assessment approach first considers the importance of the ecological features which will be affected by the proposed Project using research, surveys and publicly available information (see **Section 20.4.4**) before assessing the impacts which could affect the important features, and characterising the impacts based on extent, magnitude, duration, reversibility, timing (for example if the impact is to occur during important seasonal timeframes such as spawning) and frequency.
19. As detailed by CIEEM (2018), to determine important ecological features at risk of impact from a development, statutory sites designated under both international conventions and national legislation and their qualifying features, national biodiversity lists, biodiversity action plans and red listed species should all be considered. However, ecological features which are not included in these lists but are locally important, or are rare/uncommon, irreplaceable, in decline or play a role in habitat connectivity should also be considered. Geographical context should also be defined.
20. Therefore, the significance of potential effects has been evaluated using a systematic approach together with the expert judgement of the specialist consultant, in conjunction with the methodology outlined by CIEEM (2018) using the magnitude and sensitivity criteria outlined in **Chapter 05: EIA Approach and Methodology**. This systematic approach is based upon the identification of the importance/value of receptors and their sensitivity together with the predicted magnitude of the potential impact. However, the extent, duration, frequency, timing and reversibility have also been taken into consideration (CIEEM, 2018).
21. The approach to the assessment of cumulative impacts, transboundary impacts and interrelated effects is provided in **Section 20.13**.
22. The terms used to define receptor sensitivity and magnitude of impact are based on the CIEEM Methodology (CIEEM, 2018).
23. A non-statutory scoping report, submitted to and consulted on by NRW in May 2022, identified aspects of the proposed Project that have the potential to impact the fish and shellfish ecology during construction, operation and maintenance, and decommissioning phases.

20.4.2. Significance Criteria

Magnitude of Impact

24. The scale or magnitude of potential impacts (both beneficial and adverse) is determined by a combination of three criteria: scale of change, spatial extent of change and duration of change, as outlined in **Chapter 05: EIA Approach and Methodology**, **Section 5.4.9**. Intensity and volume of change is also considered, with magnitude quantified where possible, i.e. the amount of habitat loss or percentage of change to a habitat area (CIEEM, 2018).

25. The criteria for defining magnitude of impact for the purpose of the assessment on fish and shellfish are provided in **Table 20-6**.

Table 20-6. A summary of the magnitude criteria that are associated to specific impacts

Magnitude Criteria	Definition
Large	The impact occurs over a large spatial extent resulting in widespread, long-term, or permanent changes in baseline conditions or affects a large proportion of a receptor population. The impact is very likely to occur and/or will occur at a high frequency or intensity. **Adverse:** Loss of resource and / or quality and integrity of resource; severe damage to key characteristics, features or elements. **Beneficial:** Large scale or major improvement of resource and / or quality; extensive restoration; major improvement of attribute quality.
Medium	The impact occurs over a medium spatial extent resulting in medium-term, or partial changes in baseline conditions or partially affects a proportion of a receptor population. The impact is likely to occur and/or will occur at a medium frequency or intensity. **Adverse:** Loss of resource, but not adversely affecting the integrity; partial loss of / damage to key characteristics, features or elements. **Beneficial:** benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Small	The impact occurs over a small spatial extent resulting in short-term, or small changes in baseline conditions, or partially affects a small proportion of a receptor population. The impact has a low likelihood of occurring and/or will occur at a low frequency or intensity. **Adverse:** Some measurable change in attributes, quality, minor loss of, or alteration to, one or more key characteristics, features or elements. **Beneficial:** Minor benefit to, or in addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk or negative impact occurring.
Negligible	The impact occurs over a minor spatial extent resulting in very short-term, or minor changes in baseline conditions or partial affects to a very small proportion of a receptor population. The impact has a very low likelihood of occurring and/or will occur at a very low frequency or intensity. **Adverse:** Very minor loss of detrimental alteration to one or more characteristics, features or elements. **Beneficial:** Very minor benefit to or positive addition of one or more characteristics, features or elements.

Sensitivity of Receptor

26. Receptor sensitivity is defined as the degree to which a receptor would be affected by an impact. The sensitivity of the receptor is characterised by three factors: vulnerability, recoverability and importance, as outlined in **Chapter 05: EIA Approach and Methodology**, **Section 5.4.10**.

27. The criteria for defining receptor sensitivity for the purpose of the assessment on fish and shellfish are provided in **Table 20-7**.

Table 20-7. A summary of the criteria determining a receptor's sensitivity

Receptor Sensitivity Criteria	Definitions
Very High	Very high importance and/or rarity, internationally important receptor. For example, Annex II species listed under the Habitats Directive as a designating feature of an SAC or other designated site. Little or no ability to absorb change without fundamentally altering its character. Limited potential for substitution.
High	High importance and/or rarity, nationally important. For example, species designated under MCZs or SSSIs or listed under Section 7 of the Environment (Wales) Act 2016. Limited ability to absorb change and limited potential for substitution.
Medium	Medium or high importance and/or rarity. Such as commercially important species. Substitution, with a medium ability to absorb change.
Low	Low or medium importance and/or rarity, with some ability to absorb change. For example, species commonly identified are subject to high levels of natural disturbance.
Negligible	Very low importance and/or rarity, with good ability to absorb change.

28. Receptor sensitivity is considered to vary depending on the magnitude of the impact, and therefore the sensitivity of each receptor to an impact has been assessed in **Section 20.8** based on professional judgement.

Frequency and Timing

29. The frequency and timing of an activity can influence the resulting impact which occurs. If an activity only occurs once, the likely effect is considered to be very limited. However, if an activity (i.e. piling) continuously occurs over a considerable amount of time (for example the duration of the construction period) which results in frequent disturbance to ecological features and their behaviours, this could result in adverse effects. In addition, if this disturbance occurs during a time period which coincides with critical life stages and behaviours, for example during specific spawning seasons, further adverse effects could also occur.

Reversibility

30. Effects resulting from project activities can be reversible or irreversible. Irreversible effects are those for which recovery is not considered to occur within a reasonable timescale, or at all. For effects which are reversible, recovery may occur due to natural processes which may or may not be facilitated by mitigation. Both irreversible and reversible effects on different ecological receptors could occur from the same activity depending on receptor sensitivity, magnitude, frequency and timing.

Significance of Effect

31. The significance of effect is determined using the magnitude and sensitivity criteria as provided in **Chapter 05: EIA Approach and Methodology** (to still allow for consistency between chapters) but adopts a non-matrix approach, in accordance with CIEEM guidelines, to allow for the application of expert judgement in the final significance rating. In the absence of quantitative thresholds for ecology, assessments are undertaken based on available evidence, professional judgment, and knowledge from previous projects, rather than adopting a matrix-based approach (CIEEM, 2018).
32. In addition, a precautionary approach has been taken with the reasonable worst-case scenario assessed for each impact, in order to account for uncertainty or lack of baseline survey data in the assessment. Consideration has been given to whether the proposed Project and associated activities could undermine the conservation objectives for a designated site or whether it could have positive or negative effects on qualifying features, in line with CIEEM guidance (2018). For ecosystems, it has also been determined whether the proposed Project could result in a change of the ecosystem structure. The marine environment is highly dynamic with high levels of physical and ecological connectivity which can influence the nature, extent and scale of environmental change.
33. Following the CIEEM approach, levels of effect significance ranging from major to negligible are assigned. Assignment of significance is carried out with consideration of embedded mitigation measures. Embedded mitigation, management plans and best practice measures are presented within **Section 20.7**. For the purposes of this assessment, moderate and major levels of significance are defined as significant, and will require additional mitigation measures, whilst negligible or minor impacts are defined as not significant.

Table 20-8. A summary of the definitions of each significance of effect criteria

Significance Category	Definitions	Significant / Not Significant Effect
Major	A large and detrimental change to a valuable / sensitive receptor; likely or apparent exceeding of accepted (often legal) threshold. Or… A large and beneficial change, resulting in improvements to the baseline result in previously poor conditions being replaced by new legal compliance or a major contribution being made to national targets. These effects may represent key factors in the decision-making process. Potentially associated with sites and features of national importance or likely to be important considerations at a regional or district scale. Major effects may relate to resources or features which are unique and which, if lost, cannot be replaced or relocated.	Significant
Moderate	A medium scale change which, although not beyond an acceptable threshold, is still considered to be generally unacceptable, unless balanced out by other significant positive benefits of a project. Likely to be in breach of planning policy rather than a legal statute.	Significant (unless otherwise specified)

Significance Category	Definitions	Significant / Not Significant Effect
	Or… A positive moderate effect is a medium scale change that is significant in that the baseline conditions are improved to the extent that guideline targets (e.g. UK BAP targets) are contributed to. These effects, if adverse, are likely to be important at a local scale and on their own could have a material influence on decision making.	
Minor	A small change that, whilst adverse, does not exceed legal or guideline standards. Unlikely to breach planning policy. Or… A small positive change, but not one that is likely to be a key factor in the overall balance of issues. These effects may be raised as local issues and may be of relevance in the detailed design of a project but are unlikely to be critical in the decision-making process.	Not Significant
Negligible	A very small change that is so small and unimportant that it is considered acceptable to disregard. Effects which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error. These effects are unlikely to influence decision making irrespective of other effects.	Not Significant

20.4.3. *Study Area*

34. The proposed Project is located in the north Celtic Sea in proximity to the Bristol Channel. It lies on the fringe of St George's Channel, the area of water between the Celtic and Irish Sea, which forms a boundary with the Bristol Channel and is thought to play an important role in the ecology of local demersal fish assemblages (Parker-Humphreys, 2004). This area also falls within the ICES division VII.g: Celtic North Sea and approximately 12.5 km east of the boundary with ICES division VII.f: Bristol Channel. The ICES Celtic Ecoregion encompasses all of these ICES divisions, covering the northwestern European continental shelf and seas, from western Brittany in the south to north of Shetland.

35. The study area for the assessment of fish and shellfish (here after referred to as the "Study Area") is determined by the distance which encompasses all Zones of Influence (ZoI) for this receptor group (for all ZoI distance see **Table 20-27**). The maximum predicted ZoI for the Project is 30.7 km[1], based on potential low-level behavioural response to underwater noise effects (**Figure 20-1**). This distance was calculated as part of the Project specific underwater sound modelling for impact piling (**Appendix 21B: Marine Mammals Noise Modelling**).

36. In addition to the above, to determine if there are any potential interactions between the proposed Project and the migratory routes of certain fish species which are a qualifying feature of a site outside the main Study Area (i.e. the maximum ZoI) a regional site screening approach has also been adopted. This approach takes into consideration underwater noise effects (i.e. the maximum ZoI) which overlap with the migratory routes of far-ranging species. For example, Twaite shad are known to undertake long range migration across the Celtic Sea to reach the River Severn (Davies *et al.* 2020b).

37. For the purposes of this report, disturbance is considered to occur where an impact falls in front of a migratory route into a river (i.e. based on the noise contours for behavioural disturbance provided by the underwater noise modelling, **Appendix 21B: Marine Mammals Noise Modelling**). Therefore, any designated sites that are located onshore of the proposed Project have also been included to consider the potential for an interaction between the offshore components of the proposed Project and potential migratory routes of migratory fish. This regional approach takes into consideration work undertaken by ABPmer (2014), which provided guidance on using this approach to screen for designated sites as part of the HRA process and included seven broad coastal regions in the UK to consider for important fish migration routes (**Figure 20-2**). This guidance was produced to inform the Crown Estates wave and tidal leasing process but is applicable to a range of sectors.

[1] The behavioural threshold used for this calculation is highly precautionary (150 dB re 1 mPa rms) and has been used in the absence of any alternative values available. Despite this, based on work undertaken by Popper *et al.* (2014), potential behavioural disturbance from impact piling is much more likely to occur over intermediate distances (i.e. within hundreds of metres or <1 km).

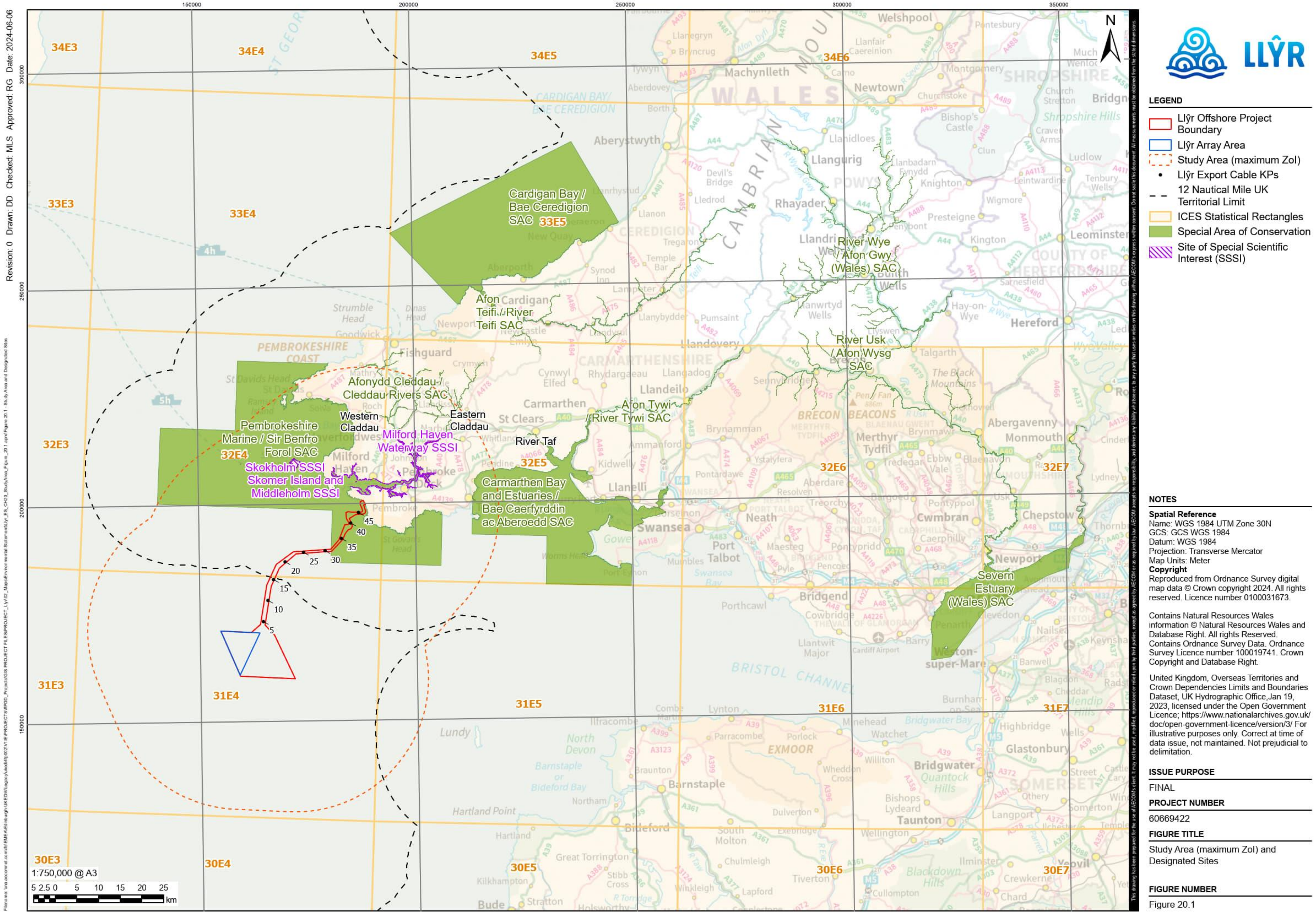

Figure 20-1. Fish and shellfish Study Area (maximum ZoI) and designated sites

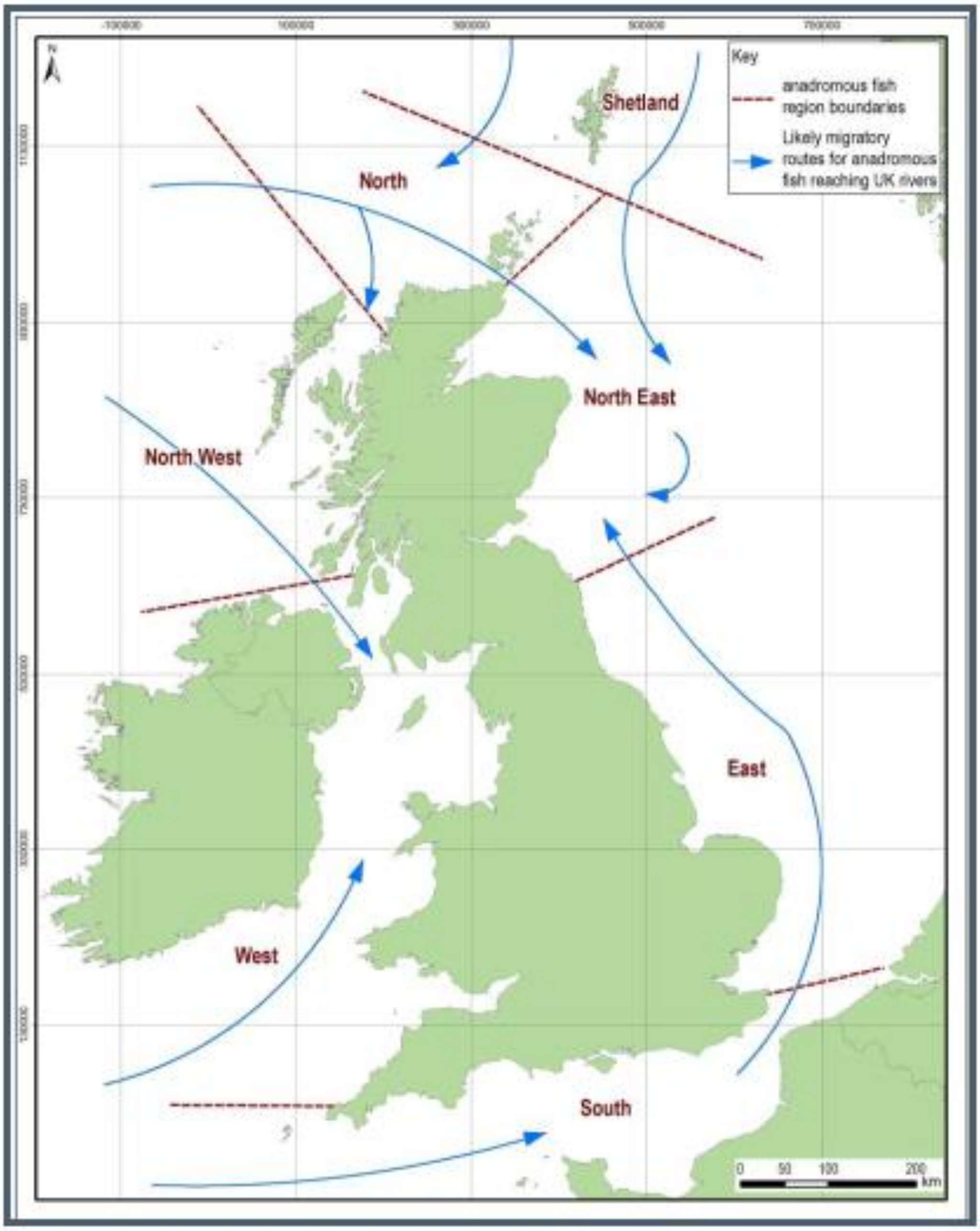

Figure 20-2. Location and extent of coastal regions to be used for screening fish qualifying interests. (ABPMer, 2014)

20.4.4. *Data Sources*

Site Specific Surveys

38. Benthic characterisation surveys were conducted in the nearshore and offshore portions of the Study Area (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**) to assist in identifying suitable spawning habitat for key fish species including herring and sandeel.
39. In early 2024 a drop down video (DDV) survey was undertaken in the nearshore area of Freshwater West (this survey undertook a significant number of DDV transects, specifically targeting areas of sediment and potential Annex I reef in order to revise the OfECC (**Appendix 19D: Drop down video survey 2024**). Thus, since the completion of the surveys in 2023, the OfECC has been revised and some of the data collected is now outside the OfECC red line boundary but does provide baseline data within the Study Area.
40. As agreed with NRW at the scoping stage, no site-specific surveys were undertaken for the purpose of understanding the baseline environment in relation to fish and shellfish.

Desk Study

41. A comprehensive desk-based review was undertaken to inform the baseline for fish and shellfish ecology. These data sources were used to inform the understanding of the relative importance and functionality of the Study Area in the regional context of fish and shellfish populations in the Celtic Sea. Key data sources used to inform the assessment are set out in **Table 20-9**.

Table 20-9. Summary of key desktop sources

Title	Source	Year	Brief description	Author
FishBase	www.fishbase.org	2023	General fish ecology, distribution and biological information (UK data sources used where available)	FishBase
EMODnet biological data portal	http://www.emodnet.eu/biology	2023	Provides records of rarer fish and shellfish species	EMODnet
Fisheries Sensitivity Maps in British Waters	Coull *et al*. (1998)	1998	Provide spatial data highlighting spawning and nursery grounds of selected fish species in British waters	Coull *et al*. (1998)
Spawning and Nursery Grounds of Selected Fish Species in UK Waters	Ellis *et al*. (2012)	2012	Provide spatial data regarding the location of spawning and nursery grounds of selected fish species in UK waters	Ellis *et al*. (2012)
Transitional and coastal waters (TraC) fish counts	Environment Agency	2021	TraC fish counts for all species for all estuaries data from	Environment Agency

Title	Source	Year	Brief description	Author
			fish surveys between 2000-2019 in the Bristol Channel	
Spawning data	Davies *et al.* (2020a and 2020b);	2020	Provide details of fish spawning within Milford Haven and surrounding waters	Davies *et al.* (2020a and 2020b);
MMO landings statistics 2016 - 2022	Marine Management Organisation (MMO)	2023	Data regarding total landed weight (tonnes) for fish and shellfish, separated into ICES statistical rectangles	MMO (2023)
Cefas distribution and relative abundance of demersal fishes from beam trawl surveys in the Irish Sea (ICES division VIIa) (as well as surveys in the Celtic Sea and Bristol Channel)	Parker-Humphreys (2004)	2004	A review of demersal fish distribution and abundance in the Irish Sea between 1993 - 2001	Parker-Humphreys (2004)
Cefas small pelagic fish sampling programme (PELTIC Surveys)	Rodriguez-Climent *et al.*, 2019; Cefas 2020a	2019 2020	Data from the main small pelagic fisheries in the Southwest coast of England (Western Channel) and the Celtic Sea	Rodriguez-Climent *et al.* (2019); Cefas 2020a
ICES EHVOE (French South Atlantic Bottom Trawl Survey) dataset	ICES (2023)	2023	Catch per unit effort (per hour) of species in the Celtic Sea collected during the ICES EVHOE survey	ICES (2023)
ICES Herring Assessment Working Group	International Council for the Exploration of the Sea (ICES)	2018 2022	Scientific advice on the herring, sprat and sandeel stocks in the North Sea and the adjacent areas spanning from the Celtic Sea to the Western Baltic	ICES (2018; 2022)
The IUCN Red List of Threatened Species	International Convention for the Conservation of Nature (IUCN) https://www.iucnredlist.org/	2023	A global assessment of the population levels of both marine, terrestrial and aquatic species	IUCN

Title	Source	Year	Brief description	Author
Publicly available and relevant academic journal papers and reports	Various and included in reference lists as appropriate	Various	Various	Various

20.5 Baseline

42. This section covers the fish and shellfish ecology baseline for the proposed Project, with regards to the general fish and shellfish communities, spawning and nursery grounds, commercial fish species (from an ecology perspective only), the relevant designated sites and species-specific information.

20.5.1. Existing Baseline

43. This baseline is divided into key functional fish groupings based on species class, habitat preferences and life history, factors that can determine a species' particular sensitivity to different anthropogenic pressures and their importance as protected species, features of designated sites, and their importance to commercial fisheries (further information provided below). There can be overlap between the functional fish groupings, for example elasmobranchs can be defined as pelagic or demersal. The key groups are:

- Pelagic;
- Demersal;
- Diadromous (Migratory Fish);
- Elasmobranchs;
- Shellfish; and
- Spawning and nursery grounds.

44. The most commonly caught fish species in the Celtic Sea over the past 10 years (based on catch per unit effort (CPUE) - per hour), determined from data collected during the French Southern Atlantic Bottom Trawl Survey, include horse mackerel, Norway pout and Atlantic mackerel (**Table 20-10**; ICES, 2023).

Table 20-10. Top 10 most caught fish species in the Celtic Sea based on bottom-trawl surveys 2014 - 2023

Species Name	Latin Name	10-year average (CPUE per hour, 2014 - 2023)
Horse mackerel	*Trachurus trachurus*	8,938
Norway pout	*Trisopterus esmarkii*	4,468
Atlantic mackerel	*Scomber scombrus*	3,920
Atlantic herring	*Clupea harengus*	3,891
Haddock	*Melanogrammus aeglefinus*	2,236
Sprat	*Sprattus sprattus*	2,132
Grey gurnard	*Eutrigla gurnardus*	2,061
European anchovy	*Engraulis encrasicolus*	1,071
Whiting	*Merlangius merlangus*	1,063
Blue whiting	*Micromesistius poutassou*	1,013

Source: ICES (2023)

45. Although these species are considered to be some of the most common in the Celtic Sea, for the purpose of this assessment, focus has been given to those species which have a higher level of protection (either listed as protected species or protected as part of a designated site) or are considered to be of commercial importance.

20.5.2. Protected Species

46. There are several fish species known to be present in the Study Area which are protected (Table 20-11), listed in Section 20.2.1.

Table 20-11. Summary of relevant fish and shellfish species protected by national and international legislation or policy

Common names	Latin names	Wildlife and Countryside Act Schedule 5	Habitats Directive Annex II and IV species	OSPAR list of threatened and/or declining species	NERC 2006 Species of Principal Importance / Section 7 of the Environment Act (Wales) 2016	Features of Conservation Interest (FOCI)
Allis shad	*Alosa alosa*	✓	✓	✓	✓	
Atlantic salmon	*Salmo salar*		✓	✓	✓	
Angelshark	*Squatina squatina*	✓		✓	✓	
Basking shark	*Cetorhinus maximus*	✓		✓	✓	
Bluefin tuna	*Thunnus thynnus*			✓		
Dover sole	*Solea solea*				✓	
European eel	*Anguilla anguilla*			✓	✓	✓
Herring	*Clupea harengus*				✓	
Mackerel	*Scomber scombrus*				✓	
Plaice	*Pleuronectes platessa*				✓	
Sandeel	*Ammodytidae*					
River lamprey	*Lampetra fluviatilis*		✓		✓	
Sea lamprey	*Petromyzon marinus*		✓	✓	✓	
Sprat	*Sprattus sprattus*					

Twaite shad	*Alosa fallax*	✓	✓		✓	
Whiting	*Merlangius merlangus*				✓	
Native oyster	*Ostrea edulis*			✓	✓	✓

20.5.3. *Commercial Importance*

47. The proposed Project footprint occurs within ICES statistical rectangles 32E4 and 31E4. A number of commercially important species are also found within the Study Area, including shellfish, demersal and pelagic fisheries. The combined 10-year average landed weights for shellfish within these rectangles was 27.60 tonnes from 2013 to 2022, compared to 20.75 tonnes of fish species over the same period (MMO, 2023).
48. The top ten commercially exploited species in the Study Area (ICES rectangles 32E4 and 31E4) based on a 10-year average of total landed weight (tonnes) between 2013 and 2022 (MMO, 2023) are shown in **Table 20-12**. Commercial fisheries existing environment are discussed in detail in **Chapter 25: Commercial Fisheries**.

Table 20-12. Top ten commercially exploited species (based on total landed weight in 2022) found within the Study Area (ICES rectangles 32E4 and 31E4), as shown by MMO landings data (2023)

Species Name	Latin Name	10-year average landed weight (tonnes)
Horse Mackerel	*Trachurus trachurus*	15.73
Whelks	*Buccinum undatum*	14.36
Brown crab	*Cancer pagurus*	4.56
Scallops	*Pectinidae spp.*	1.76
Spider Crabs	*Stenorhynchus rostratus*	1.32
Haddock	*Melanogrammus aeglefinus*	1.05
European lobster	*Homarus gammarus*	0.97
Common periwinkle	*Littorina littorea*	0.91
Norway lobster	*Nephrops norvegicus*	0.88
Blonde ray	*Raja brachyura*	0.75

20.5.4. *Designated Sites*

49. The Study Area overlaps with a number of designated sites, which form part of the UK's national site network of Special Areas of Conservation (SAC), Special Protected Areas (SPA), and Marine Conservation Zones (MCZ). Several sites occur within the Study Area which are designated for the protection of fish and shellfish. These are described in **Table 20-13** and presented in **Figure 20-1**.

Table 20-13: Designated sites within the Study Area and their protected species

Designated Site	Distance to OfECC	Distance to Array Area	Protected Species
Sir Benfro Forol/Pembrokeshire Marine SAC	0.0 km	23.04 km	Allis shad, River lamprey, Sea lamprey, Twaite shad
Bae Caerfyrddin ac Aberoedd/Carmarthen Bay and Estuaries SAC	24.63 km	53.94 km	Allis shad, River lamprey, Sea lamprey, Twaite shad

Afonydd Cleddau/Cleddau River SAC	16.52 km	55.03 km	River lamprey, Sea lamprey
Bae Ceredigion/Cardigan Bay SAC	50.18 km	88.42 km	River lamprey, Sea lamprey
Afon Teifi/River Teifi SAC	51.22 km	89.87 km	Atlantic salmon, River lamprey, Sea lamprey
Afon Tywi/River Tywi SAC	55.07 km	90.19 km	Allis shad, River lamprey, Sea lamprey, Twaite shad
River Usk/ Afon Wysg SAC	98.15 km	131.13 km	Sea lamprey, River lamprey, Twaite shad, Atlantic salmon
River Wye/ Afon Gwy SAC	141.17 km	174.8 km	Sea lamprey, River lamprey, Twaite shad, Atlantic salmon
Mor Hafren/Severn Estuary SAC	132.98 km	154.78 km	River lamprey, Sea lamprey, Twaite shad

50. Several Sites of Special Scientific Interest (SSSIs) are also present in the Study Area which provide protection to shellfish including oyster and mussels (**Table 20-14**).

Table 20-14. SSSIs in the Study Area protecting shellfish species

Designated Site	Distance to Offshore ECC	Distance to Array Area	Protected Species
Milford Haven Waterway SSSI	1.32 km	39.66 km	Native oyster
Skomer Island and Middleholm SSSI	10.3 km	38.94 km	Blue mussel
Skokholm SSSI	8.15 km	35.27 km	Blue mussel

20.5.5. *Pelagic Species*

51. The pelagic assemblage of the Celtic Seas ecoregion is characterised by sprat (*Sprattus sprattus*), herring (*Clupea harengus)* inshore and along the continental shelf, with boarfish (*Capros aper)*, blue whiting (*Micromesistius poutassou*), herring, mackerel (*Scomber scombrus)*, and horse mackerel (*Trachurus trachurus)* abundant along the shelf edge (ICES, 2021a). Recent surveys in the Study Area were conducted as part of the pelagic ecosystem survey in the Western Channel and Celtic Sea (PELTIC; CEFAS, 2020a). Acoustic fishery surveys and trawling were completed within the Bristol Channel to characterise the small pelagic fish assemblage in the southwest UK waters. Trawls within the channel observed sprat, sardine *(Sardina pilchardus)*, anchovy *(Engraulis encrasicolus)*, horse mackerel, and herring, with sprat found to be the dominant species (CEFAS 2020a). The highest densities of sprat are observed inshore but, a lack of significant biomass has been reported inshore of the 10-20 m isobath (Rodriguez-Climent *et al*., 2019). Despite the large number of sprat observed in the study, around 70% reside in Lyme Bay on the southwest coast of England rather than within the Study Area (Rodriguez-Climent *et al*., 2019).
52. The only pelagic species with mean landings greater than one tonne within the Study Area from 2016-2020 were mackerel (3 tonnes) and horse mackerel (4 tonnes; MMO, 2021). Landings of herring, blue whiting, Indo-pacific sailfish, and pilchards were all < 1 tonne (MMO, 2021). Of these species, only herring exhibit a demersal life history stage and therefore could be directly impacted by the proposed Project; the remainder are entirely pelagic throughout their life cycle.

Sprat

53. Sprat (*Sprattus sprattus)* is a short-lived, small-bodied pelagic schooling species that is relatively abundant in shallow waters, with the highest abundances in the Celtic Sea Ecoregion found between 20 m and 40 m depth (Heessen *et al*., 2015). This species is thought to be an intermediate, multiple batch spawner, releasing batches of eggs into the water column (Heessen *et al*., 2015). They are an important food resource for a number of commercially important predatory fish, seabirds, and marine mammals. They are widely distributed in shelf waters, typically within the 50 m depth contour and in inshore waters (ICES, 2014).
54. Recent Cefas PELTIC surveys in the Celtic Sea and Bristol Channel indicate that sprat are the dominant pelagic fish species in inshore waters along the Welsh coastline, although nearly all specimens were of age one and therefore are relatively young individuals (van der Kooij *et al*., 2018; Cefas, 2020a). However, in the most recent survey undertaken in 2020, higher numbers of sprat were found inshore towards the northern Cornwall coastline, at Lyme Bay, compared to previous survey years (south of the Project) (Cefas, 2020a).

Bluefin tuna

55. Atlantic bluefin tuna (*Thunnus thynnus)* have also recently been observed in the Study Area following historic population declines (Horton *et al*., 2021). Recent surveys of the Western English Channel and the Celtic Sea observed 989 individuals from 2014-2019 (Horton *et al*., 2021). Sightings were primarily in the Celtic Sea and English Channel, but many were also observed near the proposed Project in the Western Bristol Channel (Horton *et al*., 2021).

Herring

56. Herring (*Clupea harengus*) is an important commercial species and represents a significant prey species for many predators, including large gadoids (such as cod), dogfish, sharks, marine mammals and birds (ICES, 2006). Herring is a pelagic fish and is found mostly in continental shelf areas to depths of 200 m (Whitehead, 1986). Juveniles are generally distributed

separately from adults, being found in shallower water, migrating into deeper waters to join the adult stock after two years.

57. Herring is a demersal spawner, with females each releasing a maximum of approximately 50,000 eggs near the seabed, forming dense mats, typically on coarse and solid substrates like gravel or maerl (Hessen *et al*., 2015). Herring are considered to be synchronous single-batch spawners and spawning can occur in episodes which are weeks apart (Heessen et al., 2015; Dempsey and Bamber, 1983). During the larval stage, herring can drift over large distances before concentrating in nursery areas (Heessen *et al*., 2015). Once developed into juvenile fish, herring aggregate into shoals which migrate into estuaries and shallow waters where they remain for six months to a year (Dipper, 2001). Adults are mostly found along the continental shelf at water depths up to 200 m (Whitehead, 1986). Juveniles are generally distributed separately from adults, occurring in shallower waters and migrating to deeper waters to join adult stocks after two years.

58. Preliminary findings of surveys in the Bristol Channel have indicated that herring are common, with catches primarily comprising 3-8 year-old individuals (North Devon Marine Pioneer, 2019). More recent PELTIC surveys have also identified the presence of small numbers of juvenile herring in the inner Bristol Channel (Cefas, 2020a).

20.5.6. Demersal Species

59. The demersal assemblage of the Celtic Seas ecoregion is characterised by sandeel spp. (Amodytidae), hake, haddock, whiting, pout (*Trisopterus* spp), anglerfish, dab (*Limanda limanda)*, plaice (*Pleuronectes platessa)*, sole (Soleoidei), lemon sole (*Microstomus kitt)*, and megrim (*Lepidorhombus whiffiagonis)* (ICES, 2021a).

Sandeel

60. Sandeel are small demersal fish which spend a large proportion of the year buried in the sediment, only emerging into the water column for a brief spawning period in the winter and for an extended feeding period during the spring and summer months (Van der Kooij *et al.,* 2008). They are an important element of the food chain in the North Atlantic, serving as a prey item for other fish species, sea birds, and marine mammals. Species foraging on sandeel include cod, herring, Atlantic salmon (*Salmo salar)*, mackerel, grey seal (*Halichoerus grypus)*, harbour seal (*Phoca vitulina)*, harbour porpoise (*Phocoena phocoena)*, and the puffin (*Fratercula arctica)* (Dipper, 2001).

61. The distribution of sandeel (referring to all species within the genus *Ammodytes* spp) is highly patchy due to their preference for sandy habitats in well oxygenated waters, favouring coarse sand with fine to medium gravel and a low silt content (Holland *et al*., 2005; Greenstreet *et al*., 2010; Heessen *et al*., 2015). Populations are also associated with seabed morphological features such as subtidal sandbanks (Marine Space Ltd *et al.,* 2013a). However, this species is broadly found from inshore waters down to the shallow sublittoral zone (i.e. to 70 m depths). Benthic habitat mapping for the proposed Project indicates that suitable habitat for sandeel may be present. The proposed Project falls within a large swath of deep circalittoral sand (EUNIS A5.27), transitioning to 'deep circalittoral coarse sediment' (EUNIS A5.15) and 'circalittoral coarse sediment' (EUNIS A5.14) towards the Bristol Channel (see **Figure 19-1, Figure 19-3, Figure 19-4** and **Figure 19-5** in **Chapter 19: Benthic Ecology**), which may be suitable for sandeel. The most recent assessment of sandeel distribution near the Study Area reported no catches in ICES area VII from 2004 onwards, but a mean total catch of 1,876 tonnes from 1994-2003 (ICES, 2018). The most recently reported landing data by ICES rectangle indicates that all landed sandeel from 2018-2022 occurred only in ICES subdivision

VII.f and statistical rectangle 28E4, 29E4 and 29E6 (MMO, 2023). Between this time period, the mean landed weight of sandeel was 2766 tonnes (MMO, 2023).

Other Demersal Species

62. Hake, haddock, whiting, pout, anglerfish, dab, plaice, sole, lemon sole, and megrim are all common demersal species in the Study Area (ICES, 2021a). Each contribute significantly to commercial fisheries in the region, particularly haddock. They are a widely distributed and are important prey items for larger fish as juveniles, with seals also known to eat larger haddock (ICES, 2006).

20.5.7. Diadromous Species

63. Diadromous fish carry out seasonal migrations between bodies of freshwater and seawater. Those species known to migrate through the Study Area include Atlantic salmon, sea trout (brown trout), sea lamprey, river lamprey, Allis shad, twaite shad, and European eel.

Atlantic Salmon

64. Atlantic salmon are an anadromous[2] migratory species, which during their lifetime utilises both marine and freshwater habitats. Spawning of salmon typically occurs in November or December, in the upper reaches of rivers in gravelly substrate (Heessen *et al*., 2015; NASCO, 2012). Once the eggs hatch, the resultant larvae known as 'alevins' remain within the interstitial gravels (Heessen *et al*., 2015). The transition from larvae to parr occurs in the first summer in southern streams (Potter and Dare, 2003) or up to a year in upland systems. Following the parr life stage[3], salmon physically and morphologically change into the next life stage, known as a 'smolt'. This is preceding migration to the ocean following one to five years in freshwater. The migration of smolt down-river to the ocean usually occurs from spring to early summer, generally occurring earlier in the season for larger smolt (Thorstad *et al*., 2012; Heessen *et al*., 2015). Once salmon have spent another one to five years at sea, the adults then return to their spawning rivers, which in the UK usually peaks in June to August and October to December (Cowx and Fraser, 2003).

65. There are relatively few detailed studies of adult salmon migration in the Celtic Sea and Bristol Channel, although it appears that the majority of individuals remain nearby in tidal water of their home estuary and the wider Bristol Channel (Swain, 1982). In open coastal waters, salmon typically spend 72% to 86% of their time in surface waters (0 m to 5 m), but often dive, sometimes to depths of >20 m (6% to 9% of the time). It also appears that this behaviour persists late into the migration on the return to home waters (Godfrey *et al*., 2014).

66. Salmon are protected as an Annex II species and are a qualifying feature of the Afon Teifi/River Teifi SAC approximately 48.1 km north from the Study Area, with several 'Principal Salmon Rivers' having also been identified in the wider area of the proposed Project. These include the River Tywi, River Taf, and River Severn, to the east of the Project, and the Eastern Cleddau and Western Cleddau rivers, to the west of the Project (see **Figure 20-1**).

67. The most recent assessment of the Eastern Cleddau and Western Cleddau rivers reported an approximate mean of 57 individuals from rod catches and a mean of 6.5 from net catches from 2006-2015 (NRW, 2018a). In the River Tywi, mean rod and net catches were >500

[2] Anadromous fish are diadromous fish that migrate from the sea into freshwater for spawning. This distinguishes them from catadromous fish, such as eels which migrate in the opposite direction, moving from freshwater to spawn in the sea.

[3] The parr life stage of a salmon is a juvenile life stage where individuals experience rapid growth in freshwater habitats, before migrating to the ocean as smolt. For further information on the life cycle of a salmon, see https://www.cefas.co.uk/iys/salmon-life-cycle/.

individuals from 2006-2015 (NRW, 2018b). In the River Taf, mean salmon catches were >80 individuals from 2006-2015 (NRW, 2018c).

68. The most recent assessment of salmon stocks and fisheries in England and Wales was prepared for ICES in 2020 (Cefas, 2020b). They assess two stock components: fish that mature after one winter at sea and (1SW) and those that mature after two or more winters at sea (MSW). Between 2006 and 2015, 184 MSW and 34 1SW salmon were caught in the River Severn, 293 MSW and 186 1SW in the River Tywi; i4 MSW and 16 1SW in the East and West Cleddau, and ten MSW and seven 1SW salmon were caught in the River Taf.

69. The Environment Agency (2021) has published a collection of information from fisheries monitoring surveys on rivers, lakes, and transitional and coastal waters (TraC). Less than two individuals of salmon were recorded in the TraC surveys between 2000-2019 in the Bristol Channel (which feeds into the River Severn, River Tywi and River Taf).

Sea Trout (Brown Trout)

70. Sea or brown trout (*Salmo trutta*), display a broad range of life history traits, with individuals that complete their lifecycle in freshwater, those that predominately inhabit estuarine waters, and those that exhibit full anadromy (Harris, 2017). Sea trout exhibit a similar life cycle to Atlantic salmon though the adult marine stage of sea trout is shortened both spatially and temporally, with some migration back to freshwater environments after only a very short period of time feeding at sea, whilst 'maidens' only return to freshwater after a minimum of one year at sea (Gargan *et al*., 2006). Adult sea trout returning to freshwater to spawn (which usually occurs during autumn or winter) are more likely to stray from natal rivers compared to salmon (Heessen *et al*., 2015).

71. Unlike salmon, sea trout is not an Annex II species, but it is recognised in the national Biodiversity Action Plan (NRW, 2023). Two-thirds of the sea trout stocks in Wales are identified as 'at risk', 'probably at risk', or similarly classified (NRW, 2023). No sea trout were recorded in the TraC surveys between 2000-2019 in the Bristol Channel. Assessment of rivers near the proposed Project reported an approximate mean of 410 individuals from rod catches and a mean of 1.4 from net catches from 2006-2015 in the Eastern and Western Cleddaus (NRW, 2018a), mean rod and net catches of >2000 individuals from 2006-2015 in the River Tywi (NRW, 2018b), and mean salmon catches of >200 individuals from 2006-2015 in the River Taf (NRW, 2018c).

Sea and River Lamprey

72. Sea lamprey (*Petromyzon marinus*) and river lamprey (*Lampetra fluviatilis*) are both anadromous migratory species. After spending several years in the marine environment, adults return to freshwater to spawn in spring and early summer (Laughton and Burns, 2003).

73. Sea lamprey are widely dispersed in the open sea as they are solitary feeders, being rarely found in coastal and estuarine waters (Moore *et al*., 2003). The distribution of sea lamprey is chiefly defined by their host river (Waldman *et al*., 2008) and they are often found at considerable depths in deeper offshore waters (Moore *et al*., 2003).

74. In contrast, river lamprey are usually found in coastal water, estuaries and accessible rivers and juveniles are often found in large congregations (Maitland, 2003). Distribution in the UK appears to be mainly in Wales, Northern Ireland and southern Scotland (**Figure 20-3**). River lamprey generally spend one to two years in estuaries, then move upstream in the autumn, between October and December (Zancolli *et al*., 2018) to overwinter in freshwater habitats before spawning further upstream between April and June (Heessen *et al*., 2015).

75. Sea lamprey spawn when the water temperature reaches at least 15°C and they normally migrate into freshwater from April to June and then spawn from late May to June (Zancolli *et al*., 2018). The migration to sea can vary from river to river, although the metamorphosis of larvae into adults, occurs between July and September (Maitland, 2003).

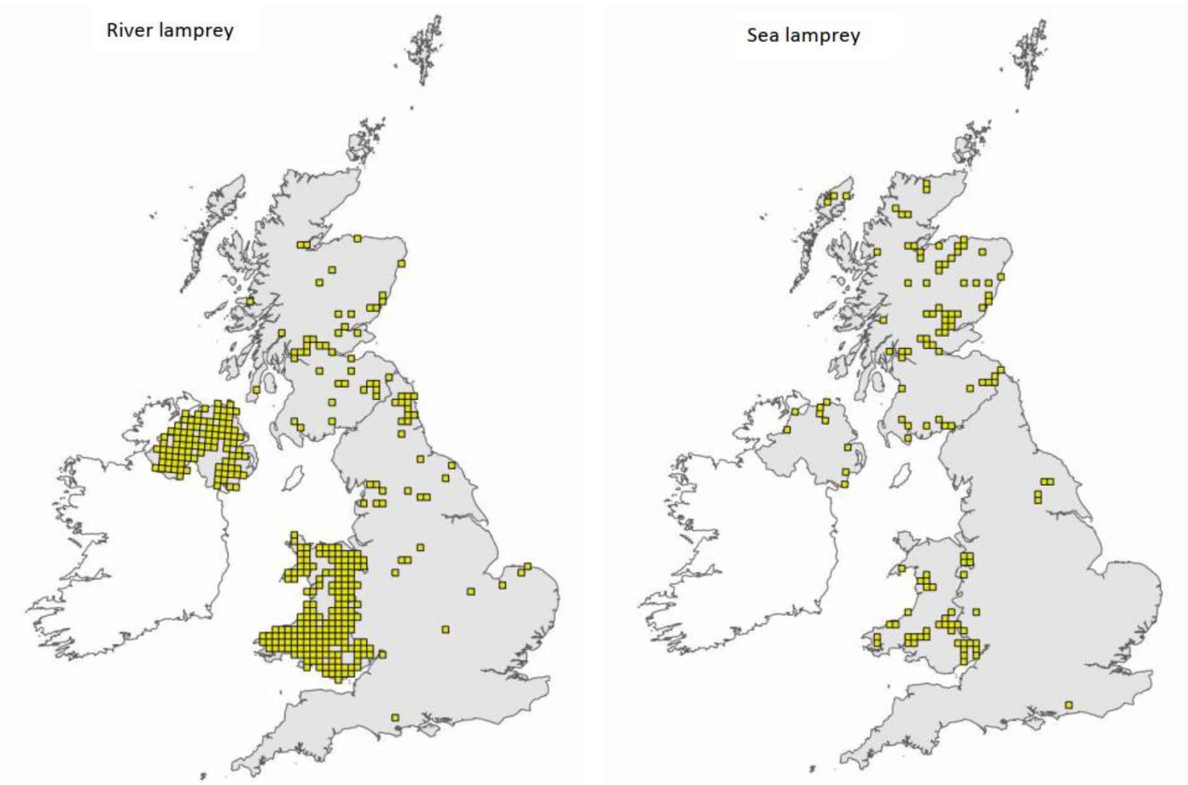

Figure 20-3. UK distribution of river lamprey and sea lamprey. Data source: (JNCC, 2018a; JNCC, 2018b)

76. Sea lamprey and river lamprey are protected as Annex II species and are primary or qualifying feature of the following relevant designated sites:
    - Sir Benfro Forol/Pembrokeshire Marine SAC;
    - Bae Caerfyrddin ac Aberoedd/Carmarthen Bay and Estuaries SAC;
    - Afonydd Cleddau/Cleddau River SAC;
    - Afon Teifi/River Teifi SAC;
    - Afon Tywi/River Tywi SAC; and,
    - Mor Hafren/Severn Estuary SAC.
77. Less than 20 individuals were recorded in the TraC surveys between 2000-2019 in the Bristol Channel. There was little additional information found about these species in the Study Area. In general, sea and river lamprey were of unfavourable status, not meeting their density targets, for either their marine or freshwater populations (Countryside Council for Wales, 2012a and 2012b; NRW, 2018d, 2018e, and 2018f).

Allis and Twaite Shad

78. Allis (*Alosa alosa*) and twaite (*Alosa fallax*) shad are characteristically similar anadromous fish species from the herring family (Clupeidae). They often hybridise and most available records

are for twaite shad, as the species are difficult to distinguish and allis shad alone are quite rare (NRW 2018d). Between April and June, these species migrate from the sea to spawn, releasing eggs into the water column which subsequently sink to the substrate and settle interstitially between coarse sediments. Few individuals (n < 20) of shad were recorded in the TraC surveys between 2000-2019 in the Bristol Channel.

79. Much of the UK twaite shad population occurs near Wales in the Bristol Channel (NRW 2018d). Twaite shad are known only to occur in several rivers in Wales and along the England/Wales border in the Severn Estuary where extensive areas suitable for spawning have been identified. Twaite shad from the river Severn are also known undertake long range migration across the Celtic sea, including to the Taw-Torridge Estuary on the north Devon coastline (Davies *et al*., 2020b).

80. Twaite and allis shad are protected as Annex II species and are present as a primary or qualifying features in:

- Sir Benfro Forol/Pembrokeshire Marine SAC (0.0 km away);
- Bae Caerfyrddin ac Aberoedd/Carmarthen Bay and Estuaries SAC (23.5 km away);
- Afon Tywi/River Tywi SAC (53.0 km away); and,
- Mor Hafren/Severn Estuary SAC (135 km away).

81. Not much is known about shad in the Pembrokeshire Marine SAC, but data indicate that important habitats for shad are extensive (NRW,2018d). The water column is considered to be suitable habitat (i.e. including abundant, suitable prey and adequate water quality) and of high quality (NRW, 2018d).

82. In the Carmarthen Bay and Estuaries SAC, Twaite shad migrate through the bay to reach spawning sites in the River Tywi, which is known to host a large spawning population of twaite shad. It is also suggested that twaite shad feed in inshore waters of the bay as the Taf-Tywi-Gwendraeth estuary is thought to be a nursery ground.

83. In the River Tywi SAC, a significant spawning population of twaite shad occurs. Spawning sites occur in the lower reaches of the river, with water quality and spawning activity considered adequate for the population to be self-sustaining.

84. In the Severn Estuary SAC, there is significant genetic evidence of hybridisation between Wye, Usk, Tywi populations (NRW 2018f). The population within the River Severn itself has limited data available, but it is believed to be reduced compared to historic levels due to the presence of various weirs restricting access to ~10% of the formerly accessible river length (NRW 2018f). A trend assessment of available data suggests a decline since the 1980s, although this is based on a single sampling location (NRW 2018f).

European Eel

85. The European eel (*Anguilla Anguilla*) is a catadromous[4] migratory species, undertaking an extensive migration to spawn in the Sargasso Sea. Early life stages are spent travelling across shelf seas using tidal stream transport, eventually migrating upstream into freshwater (Heessen *et al*., 2015). Eels migrate upstream into freshwater predominately during spring but may continue to do so until early Autumn.

86. Once within freshwater habitats, eels remain for five to 15 years, before they begin their downstream migration through rivers and estuaries towards spawning grounds, predominately between August and December (Behrmann-Godel and Eckmann, 2003; Tesch,

[4] A diadromous species that migrates from freshwater to seawater to spawn.

2003; Chadwick *et al*., 2007), with spawning occurring mainly in spring (Righton *et al*., 2016). Some eels do not migrate fully into freshwater but inhabit estuaries before returning to spawning grounds.

87. According to the NBN (2021) Atlas, there are many records of European eel in Pembrokeshire, therefore it can be considered that the species may overlap with the Study Area. In TraC surveys undertaken between 1997-2019 in the Bristol Channel, a mean of 75 individuals were caught, with annual catches ranging from 0-358 individuals (Environment Agency, 2021).

Elasmobranchs

88. The following elasmobranch species are considered important in relation to the proposed Project. A number of species of elasmobranch are known to occur within the Study Area including angelshark, basking shark, skates and rays. Elasmobranchs are recognised as having particular sensitivity to electro-magnetic fields (EMF) and they are known to use electro-sensory perception for the detection of prey and predator avoidance and location of mates as well as orientation and migration behaviour (Hutchison *et al*., 2018).

Angelshark

89. Angelshark (*Squatina squatina*) are a flat, demersal shark species common in coastal waters and throughout the continental and insular shelf of the northeast and eastern central Atlantic (OSPAR, 2010). They burrow in soft sediments to ambush other bottom-dwelling fish species (Barker *et al*., 2020). The Celtic Sea ecoregion is near the northern extent of the angelshark range and recent studies have proven that several locations are important habitats within the Celtic Sea, including Wales (Barker *et al*. 2022).

90. Based on retrospective analyses of all records of angelshark in Welsh and adjacent waters between 1970 and 2016, a 70% decline in abundance and a reduction in distribution was observed in Wales, with a central core population occurring in Cardigan Bay (Barker *et al*., 2022; Hiddink *et al*., 2019). The cause for their decline remains debated but it is likely to at least partially be a result of bycatch (Hiddink *et al*., 2019). As such, the angelshark is now protected in the UK under Schedule 5 of the Wildlife and Countryside Act and specifically in Wales under the Environment (Wales) Act 2016. It is also included on the list of Threatened species and currently listed as 'Critically Endangered' on the IUCN Red List.

91. Angelshark typically prefer mud or sandy seabed habitats at depths of 5 – 150 m, occasionally inhabiting estuaries and brackish waters (OSPAR, 2010). A recent study which collated data for a 208-year time series analysis of angelshark in Wales and the Irish Sea found highly variable depth ranges with the majority of records (67%) observed on sandy habitats (e.g. 'sand', 'coarse grained sand'; Barker *et al*. 2022). Angelshark are known to burrow in soft sediments to ambush their prey (Barker *et al*. 2020), reportedly feeding on a variety of demersal species such as dab, mackerel, plaice, whiting, sole, other elasmobranchs, crustaceans, and molluscs (Barker *et al*., 2022).

92. Wales has been identified as an important area for angelshark in UK waters (Barker *et al*., 2022). The greatest concentration of individuals occurs in Cardigan Bay, with notable aggregations in Carmarthen Bay and the outer Severn Estuary (Barker *et al*. 2022; approximately 16 km and 118 km from the Offshore Study Area respectively). Furthermore, the 98% of the records occurred within 6 nm of the coastline, however, their distribution was observed among coastal sites, further suggesting variation in habitat suitability (Barker *et al*. 2022).

93. The primary benthic habitats in the Study Area are 'sublittoral coarse sediment' (EUNIS A5.1) and 'sublittoral sand' (EUNIS A5.2; see **Chapter 19: Benthic Ecology**). With over 1,600

angelshark observed around the Bristol Channel and Cardigan Bay since 1942 (Barker *et al*., 2020) and the potential for suitable habitat, it is likely that angelshark will occur within the Study Area, especially in coastal waters near the landfall.

Basking Shark

94. Basking sharks (*Cetorhinus maximus*) are common in British coastal waters, but are most frequently sited off Western Scotland, Southwest England, and Wales. They are considered to be of a single stock and management unit, the Northeast Atlantic. In UK waters, basking sharks are typically observed in localised aggregations or ‘hotspots,’ in locations where surface sightings are frequent in summer months (Austin *et al*., 2019). Basking sharks in Northeast Atlantic waters are considered to have a relatively large stock size, although exact estimates are not known (ICES, 2023). This follows a rapid decline in numbers around 1988 due to fishing pressure (ICES, 2023; Wilding *et al*., 2020). Basking shark are currently protected in the UK under schedule 5 of the Wildlife and Countryside Act and listed as ‘Endangered’ on the IUCN Red List (Rigby *et al*., 2018).
95. Basking sharks are filter feeders, feeding on zooplankton in the water column, and are known to travel across great horizontal distances for seasonal migrations (Wilding *et al*., 2020). The distribution of basking sharks is influenced by a variety of environmental factors, including sea surface temperature and presence of fronts, where zooplankton is typically found in its greatest abundances (Austin *et al*., 2019). These factors were recently used to conduct ecological niche modelling for basking shark in UK waters, to predict habitat suitability. Areas of habitat suitability identified near the proposed Project include the Irish Sea (as far south as the Cardigan Bay and west Pembrokeshire coast) and Cornwall (Austin *et al*., 2019). Some areas of habitat suitability were identified within the Celtic Sea, but the area as a whole was not identified as suitable (Austin *et al*., 2019).
96. Despite the designation of a management unit in the Northeast Atlantic, a comprehensive assessment of the UK basking shark population has not been completed and formal survey data is sparse. The most recent population estimate is ca. 19,000 individuals across Scotland and Ireland but is not representative of the whole ecoregion (Gore *et al*., 2013; Stevens and Sinclair, 2021). Most information on basking shark distribution is related to opportunistic sightings. The two most comprehensive datasets come from the Basking Shark Project, which covers sightings from 1987-2006, and the Shark Trust, which recorded sightings from 1995-2021. Both organisations reported >10,000 sightings in the UK with a distinct seasonality (Stevens and Sinclair, 2021). Sightings typically peaked in summer (May-August) with a confirmation of presence around southwest England and Wales (Bloomfield and Solandt, 2008; Stevens and Sinclair, 2021). Other smaller organisations corroborate these findings, with telemetry data also suggesting migrations between southwest England and western Scotland (Stevens and Sinclair, 2021).
97. Although suitable habitat was not identified for the basking shark within the immediate vicinity of the proposed Project, suitable habitat was identified within the wider Study Area (southern Irish Sea). Sharks tagged within the Irish Sea indicated localised coastal movements around the Isle of Man and Irish Sea, but also migrations further afield (Dolton *et al*., 2020), with median straight-line distances travelled of 541 km (Dolton *et al*., 2020). Other tagging studies have indicated that basking sharks spend considerable time in the Celtic Sea and Western Approaches (Sims *et al*., 2005); one individual was recorded moving into the Bristol Channel (Sims *et al*., 2005), which is in line with a small number of opportunistic sightings in the immediate proposed Project area (n=3; Stevens and Sinclair, 2021).

98. When considering nearby habitat suitability in conjunction with identified migration routes, it is likely that basking shark will occur near the proposed Project, especially during summer months. This is supported by site specific surveys which observed 13 individuals within the Study Area (Blue Gem Wind, 2021). Site specific surveys conducted by HiDEF over two years between 2020 and 2022 also identified six basking sharks in the Study Area (HiDEF, 2022).

Other Elasmobranchs

99. The blue shark (*Prionace glauca*) can be found around most of the British coastline but more commonly in the warmer waters around the southern coast and particularly off south-west Cornwall (Wildlife Trusts, 2023). This species is a pelagic species that visits UK seas in summer months, following the Atlantic North Equatorial Current. They are mostly observed in waters more than 10 km offshore. However, three individuals were recorded in a two-year survey conducted by HiDEF in the Study Area (HiDEF, 2022). Blue sharks are active predators and feed mainly on small fish and squid though they may also feed on fish that live near the seabed. This species is a popular target for recreational fishing and blue shark fishing trips are offered in many areas including from the Pembrokeshire coast. The blue shark is a species of principal importance in Wales, designated under the Environment (Wales) Act, 2016.

100. Recent assessments of shark and ray bycatch in the Celtic Sea and Bristol Channel have indicated a variety of other shark and ray species inhabit the region. Some fisheries have operated in the region which have targeted spurdog (*Squalus acanthias*), porbeagle (*Lamna nasus*), and blue shark (Hunter *et al*., 2015). However, these species are not considered to represent important fisheries in the present day (**Chapter 26: Commercial Fisheries**). Surveys of the nearby English Channel reported lesser-spotted dogfish (*Scyliorhinus canicular*), greater spotted dogfish (*S. stellaris*), tope (*Galeorhinus galeus*), and smooth-hound (*Mustelus mustelus*) (Martin *et al.,* 2012). Therefore, there is the potential for these species to be present in the Study Area. Spurdog and tope are species of principal importance in Wales.

101. Ray species caught in this region include thornback ray (*Raja clavata*), blonde ray (*R. brachyura*), and small-eyed ray (*R. microocellata*)*,* with the area also appearing to be important for juveniles of all three species (Hunter *et al*., 2015). Anecdotal evidence from fishermen indicates that different species aggregate in different areas, suggesting sediment preferences (Hunter *et al*., 2015).

102. Surveys of the nearby English Channel reported common stingray (*Dasyatis pastinaca*), blonde stingray, thornback ray, small-eyed ray, spotted ray (*R. montagui*), and undulate ray (*R. undulata*), Furthermore, the benthic habitat within the Study Area is primarily soft sediment (see **Chapter 19: Benthic Ecology**). Sharks, skates, and rays typically prefer soft seabed, mud, and sand (Martin *et al*. 2012). Given the proximity of the Study Area to the English Channel and the presence of preferred habitat, it is possible these species may also occur near the proposed Project.

20.5.8. Shellfish

103. The shellfish industry is of significant local importance to south Wales and there are valuable potting grounds for lobster, crab, and whelk around the Pembrokeshire coast.

Nephrops

104. Norway lobster (*Nephrops norvegicus*) is distributed according to the extent of cohesive muddy sediments in which they construct their burrows (Howard, 1989). The type of sediment also dictates the structure of the *Nephrops* populations, with areas of sandy mud having higher population densities and smaller sized individuals, whilst fine sediment is characterised by lower densities of larger-bodied individuals (Farmer, 1974).

105. The Study Area falls within important spawning and nursery ground for this species (Coull *et al*., 1998). However, BGS Seabed Sediment data (1:250,000) shows that both sandy mud and finer sediments do not overlap with the OfECC or Array Area and are also typically not present in the wider Study Area which is dominated by coarser sediments (BGS, 2024). Therefore, *Nephrops* individuals are only expected to be present in very small densities in the Study Area, if present at all.

European Lobster

106. The European lobster (*Homarus gammurus*), is generally found from the intertidal zone to depths of 60 m. This species exhibits site fidelity although home extents can range between 2 km and 10 km (Bannister *et al*., 1994). Females can spawn annually or follow a bi-annual pattern, with reproduction taking place during the summer (Atema, 1986). They do not make extensive migrations when buried (carrying eggs attached to its tail or exterior part) and hatching takes place in spring and early summer on the same grounds (Pawson, 1995).

107. Lobsters are solitary animals and prefer rocky substrates where they can build and inhabit holes and tunnels (Wilson, 2008). There is a large amount of rocky habitat, and thus suitable lobster habitat, present in the intertidal and subtidal zones of the Study Area (including Freshwater West), including Annex I rocky reef (designated as part of the Pembroke Marine SAC), circalittoral rock and high energy rock habitats, as identified in **Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19D: Drop down video survey 2024**). Therefore, the numbers of lobster present in the intertidal and nearshore areas of the Study Area are expected to be high due to the presence of suitable habitat. Despite this, the OfECC route avoids areas of rocky habitat within nearshore areas within Freshwater West.

108. Based on landings data collected by the MMO between 2020 and 2022, lobster abundance in the Study Area is slightly lower than abundance in deeper waters in the Celtic Sea outside of the Study Area (MMO, 2023). However, this could be a result of reduced effort.

Brown Crab

109. The brown (edible) crab (*Cancer pagurus*) is a targeted commercial species most abundant on rocky grounds, where it hides in holes and crevices. The crab is generally found in shallow water close to shorelines, although it can be found in water as deep as 100 m. Brown crabs breed in the spring and summer, the female crabs becoming gravid, carrying their eggs under the abdomen. South Wales has a large inshore population of brown crab (Klaoudatos *et al*., 2013), facilitated by the widespread intertidal and subtidal rocky habitats present along its coastline. However, it is not the most abundant crab species present on the South Wales coast, with the green crab (*Carcinus maenas*) considered to be present in higher numbers (Young and Elliott, 2020).

110. Crab Fishery Units have been defined for this species, with the Study Area falling within the 'Celtic Sea' unit, which encompasses the northern Celtic Sea and Bristol Channel. Stock assessments of brown crab in the Celtic Sea suggest that females have a higher abundance than male crabs (Cefas, 2020d). Landings (measures in tonnes) of brown crab in the Celtic Sea have remained stable since 2010, although landings within the Study Area appear to be higher than other locations within the Celtic Sea, such as the deeper waters of the Bristol Channel. Overall, brown crab is expected to be present in large numbers in the Study Area.

Spider Crab

111. Spider crab (*Maja squinado*) is the largest spider crab species in UK inshore waters. Females are brooders, carrying ca 150,000 eggs, having one or two broods per year. Spider

crabs typically inhabit mixed substrata and coarse sand and are particularly common around the southern and western coasts of England and Wales. Spider crab can be found on the southwest coast of Wales throughout the year. However, abundances increase during the spring and summer when individuals migrate inshore, and decrease when they return to deeper waters in the autumn and winter (Moore *et al*., 2023). Numbers of spider crab have increased around the coast of Wales over the past couple of decades, including on the southwest coast, making them a nuisance species.

112. The Study Area is dominated by coarse sand and when considering the apparent abundance of spider crabs on the southwest Wales coastline, spider crab is expected to be present in the Study Area in high numbers. Spider crabs were found to be present at several locations in the benthic characterisation study, identified from drop-down video (DDV) image analysis (**Appendix 19B: Offshore 2023 Benthic Survey Report**).

Common Whelk

113. The common whelk (*Buccinum undatum*) is a large whelk species, common off all British coasts. They typically inhabit muddy sand, gravel, and rock up to 1200 m, and may even be present in brackish waters in the intertidal. Breeding takes place from October to May, whilst spawning occurs in November.

114. Their eggs attach to rocks, shells and stones in protective capsules grouped together in large masses of over 2000 eggs (DECC, 2016). Due to the presence of rock and sand with some small contributions of gravel and mud in the intertidal and subtidal regions of the Study Area, common whelk is expected to be present. However, a recent assessment of bycatch from lobster and crab 'pot' fisheries in the Celtic Sea and Bristol Channel found that common whelk occurs frequently in these waters but only in small numbers of between one and five individuals per pot (Moore *et al*., 2023). Despite this, common whelk represent a significant fishery in the Bristol Channel (Devon and Severn IFCA, 2023) and the Study Area as a whole, with whelk being the top landed species (by weight in tonnes) in the Study Area in 2022 (**Table 20-12**).

Scallops

115. Scallops favour clean firm sand, fine or sandy gravel and depressions in the seabed but are occasionally found on muddy sand. They are active, epibenthic suspension feeders that occur at depths of between 10 – 110 m particularly in sheltered areas close to faster currents (Marshall, 2008). Scallops spawning times vary from spring to autumn with some populations exhibiting two spawning peaks during this time. Female scallops are very fecund and can release up to two million eggs per spawning period. Larvae are planktonic for 30 days and may disperse long distances. The larvae then settle onto hydrozoans and/or bryozoans until they reach a size of approximately 1-5 mm. They then detach and settle onto the seabed (CEFAS, 2021).

116. Scallops, including great scallops and king scallops, are known to be present off the Pembrokeshire coastline and within the Skomer Island MCZ (Lock *et al*., 2017). Skomer Island MCZ is considered to be a hotspot for king scallop, following a prohibition of scallop collecting which was implemented in 1990 (Lock *et al*., 2017; Massey *et al*., 2022).

117. The Study Area, including the Array Area and much of the OfECC is dominated by sandy habitats, and therefore, scallops are expected to be present within the red line boundary. However, there does not appear to be any recent commercial fishing of scallops within the Study Area outside of the Skomer Island MCZ. A stock of king scallops was identified in the Celtic Sea (in the approaches to the Bristol Channel) in an assessment of scallop stock

status in selected English coastal waters by Cefas in 2018 (Cefas, 2021) but this is considered to be outside of the Study Area.

Other Shellfish

118. Several shellfish waters have been identified in the Study Area on the English and Welsh coasts:

- Taw-Torridge Estuary;
- Camel Estuary;
- Milford Haven Cleddau;
- Taf, Tywi, and Gwendraeth;
- Burry Inlet; and,
- Swansea Bay.

119. The Taw-Torridge Estuary has been identified as an important area for blue mussels (*Mytilus* spp.) and Pacific oyster (*Crassostrea gigas*)*;* the Camel Estuary hosts shellfisheries for mussels and Pacific oyster; the shellfisheries of Milford Haven include native oysters (*Ostrea edulis*) and Pacific; Taf, Tywi, and Gwendraeth were classified for common cockle (*Cerastoderma edule*)*;* Burry Inlet was classified for common cockle, and mussels; Swansea Bay was classified for mussels (CEFAS, 2020c).

120. The offshore benthic characterisation study (**Appendix 19B: Offshore Benthic Survey Report**) also identified crabs (*Ebalia* spp.), rugose squat lobster (*Munida rugosa*), the common hermit crab (*Pagurus bernhardus*) and caridean shrimp (*Caridea* spp.) scattered across the Study Area and within the Offshore Project Development Area using imagery analysis. Blue mussel beds (*Mytilus edulis*) were also observed attached to biogenic reef in nearshore waters on approach to the landfall at Freshwater West.

20.5.9. Spawning and Nursery Grounds

Spawning Grounds

121. The occurrence, distribution and abundance of many fish and shellfish within the Study Area is determined by their propensity to aggregate within specific areas to spawn (lay or release their eggs). ‘Spawning grounds’ are defined by the species behaviour, and therefore may cover a wide area, or by specific habitat preferences (e.g. gravel), which may restrict spatial extent. Fish exhibit several modes of reproduction, the most common being broadcast spawning, where eggs and sperm are released into the water column (Ellis *et al*., 2012). Other species deposit egg-cases (e.g. dogfish and whelk) or egg mats onto the seafloor (e.g. herring), making them particularly vulnerable to seabed disturbance.

122. Fisheries sensitivity maps (Coull *et al*., 1998; Ellis *et al*., 2012) indicate that the proposed Project is located within important spawning grounds for sandeel (*Ammodytidae*) and Atlantic herring (**Figure 20-4** and **Figure 20-5**) and several other species (**Table 20-15**). A recent assessment of spawning grounds in Welsh waters near the proposed Offshore Development Area collated data from ichthyoplankton surveys and acoustic trawl surveys also found evidence of spawning for herring within the Study Area (Campanella and van der Kooij, 2021).

Table 20-15. Important spawning grounds which fall within the Study Area

Common name	Species name	Ellis *et al*., 2012	Coull *et al*., 1998
Atlantic cod	*Gadus morhua*	High intensity	Yes
Plaice	*Pleuronectes platessa*	High intensity	Yes
Sandeels	Ammodytidae	High intensity	No
Sole	*Solea solea*	High intensity	Yes
Horse mackerel	*Trachurus trachurus*	Low intensity	No
Ling	*Molva molva*	Low intensity	N/A
Nephrops	*Nephrops norvegicus*	N/A	Yes
Sprat	*Sprattus sprattus*	N/A	Yes
Whiting	*Merlangius merlangus*	Low intensity	Yes
European hake	*Merluccius merluccius*	Low intensity	N/A
Mackerel	*Scomber scombrus*	Low intensity	N/A
Herring	*Clupea harengus*	No	Yes
Lemon Sole	*Microstomus kitt*	N/A	Yes

123. Due to their ecological importance as prey items, association with the seabed, and their sensitivity to seabed disturbance due to the requirement and preference for specific habitat and sediment types, further assessment of herring spawning grounds and preferred sandeel habitat is provided below. This was agreed with NRW (A) during the scoping opinion (**Table 20-5**).

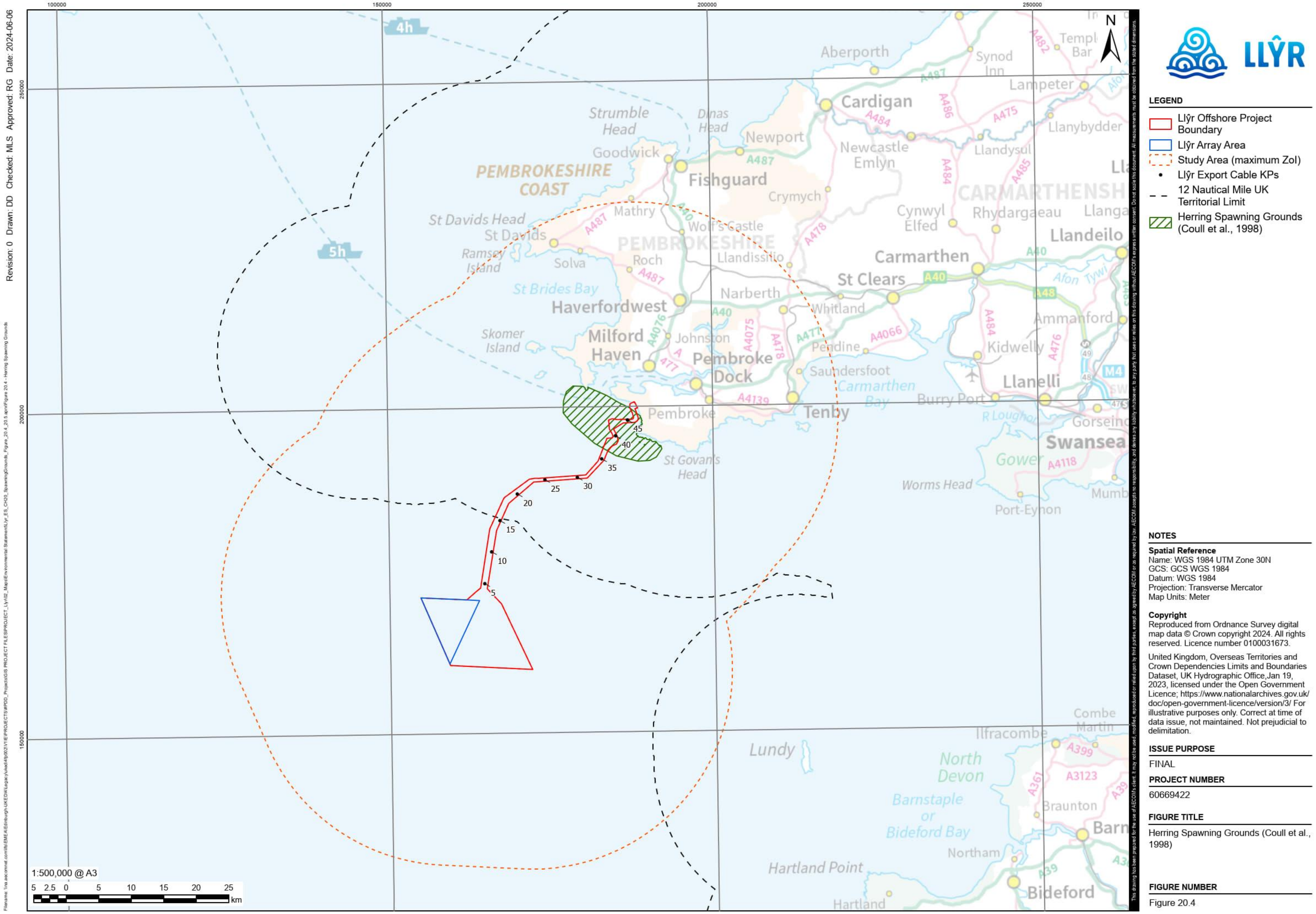

Figure 20-4. Herring spawning grounds in the Study Area (Coull et al., 1998)

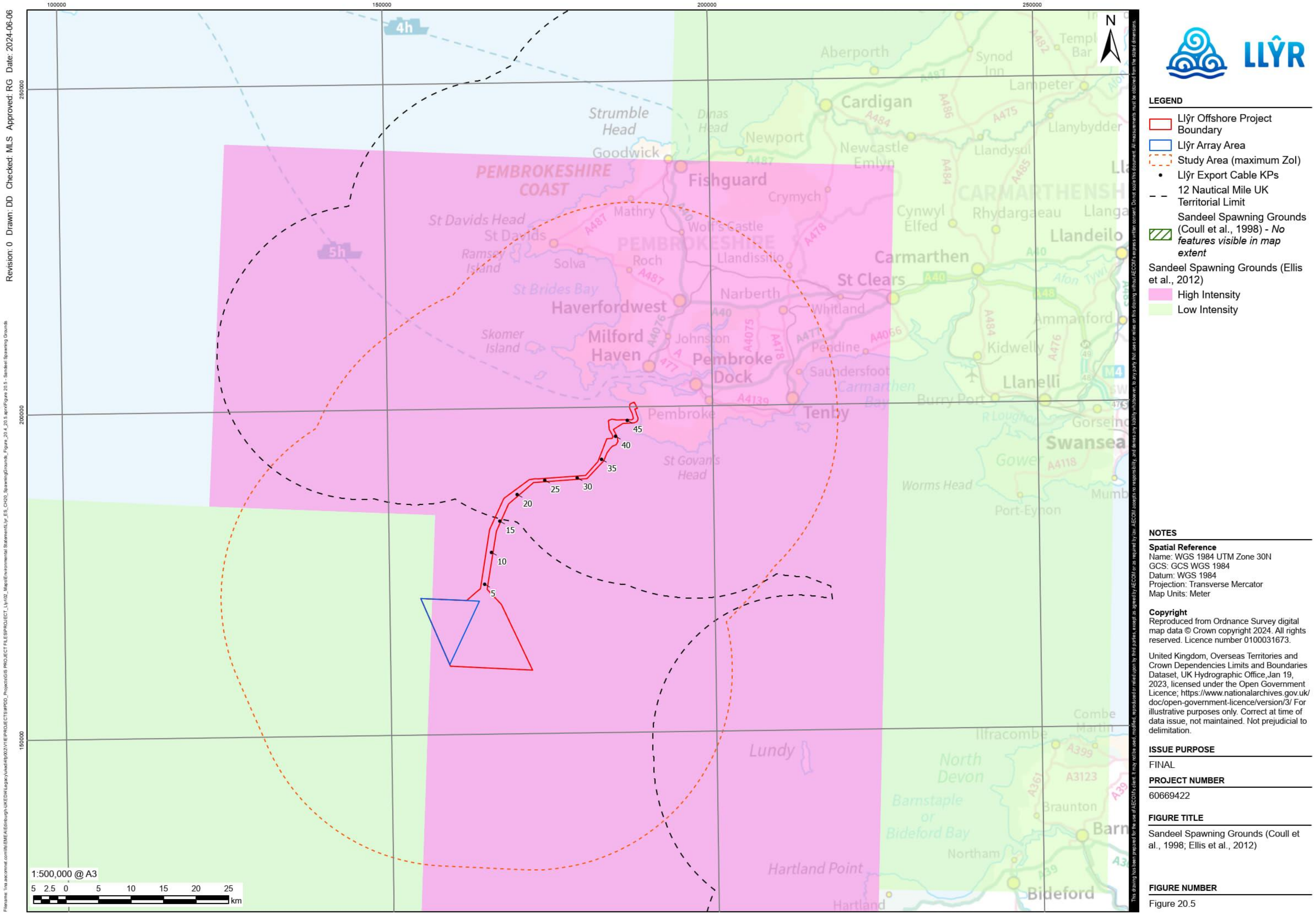

Figure 20-5. Sandeel spawning grounds in the Study Area (Coull et al., 1998; Ellis et al., 2012)

Herring

124. Herring populations are split into several main spawning stocks in UK waters including the Buchan stock, Banks/Dogger stock and North West Scotland stock, none of which overlap with the Study Area. However, a smaller, discrete herring spawning stock occurs in the Celtic Sea, with spawning occurring during autumn and winter (ICES, 2018). In Wales, recent surveys of herring spawning observed the same seasonality (Campanella and van der Kooij, 2021). A recent assessment of herring in the Study Area reported intermediate hotspot values in the Celtic Sea, extending from Milford Haven to the north Cornwall coastline at the mouth of the Bristol Channel, thought to be partly due to the presence of spawning grounds located in the coastal waters of the northern Celtic Sea, and the distribution of adult herring in offshore waters. The greatest hotspot values observed were in the Irish Sea and Isle of Man (Campanella and van der Kooij, 2021). Anecdotal evidence from fishermen in the Bristol Channel also indicates that herring spawn locally in the channel (North Devon Marine Pioneer, 2019), with small areas of suitable habitat identified in the nearshore benthic characterisation survey in the Study Area (**Appendix 19A: Nearshore 2023 Benthic Survey Report**).

125. The most recent assessment of herring spawning in the Celtic Sea, estimated the spawning stock to be 36,000 tonnes in 2017, which has been declining from 2011, leading to the closure of the fishery (ICES, 2018; Campanella and van der Kooij, 2021). However, Davies *et al*. (2020a) identified several genetically different stocks in the Celtic Sea, partly indicated by differing vertebral counts. One of these stocks is located in the Milford Haven, which are spring spawners and are genetically and morphologically different from other stocks in several ways, including having a lower vertebral count. A separate stock in Freshwater East also spawns in the spring. However, stocks elsewhere including in Aberystwyth and Clovelly are autumn spawners.

126. Herring spawning grounds have previously been identified within Milford Haven in Clarke (1984; cited in Davies *et al*., 2020a), Clarke and King (1985) and Barne *et al*. (1995). These spawning grounds were considered likely to be located upstream of Cleddau Bridge, particularly Burton Point, and in relatively shallow water (15-40 m), although some have been observed up to 200 m (Whitehead, 1986; ICES, 2018; Davies *et al*., 2020a). Davies *et al*. (2020a) confirmed the presence of spawning grounds upstream of Milford Haven, however the main spawning ground was identified in Castle Reach, where 87.4% of fish were observed in an active spawning state. This population was found to be spawning in conditions with reduced salinity which suggests some local adaption has occurred. There was no evidence of spawning occurring at Burton Point. However, compared to numbers of larvae previously identified in Castle Reach by Clarke (1984; cited in Davies *et al*., 2020a) (approximately 3,000 larvae), numbers identified by Davies *et al*. (2020a) in Castle Reach were much lower with a total of 110 larvae found across 433 hauls.

127. There is currently no evidence to suggest that there are any additional spawning populations in Milford Haven, including further downstream within Angle Bay and Freshwater West. However, it has been suggested that herring from upstream of Milford Haven can feed along the coastline of South Wales (Clarke, 1984; cited in Davies *et al*., 2020a). Additionally, although a genetically distinct population of spring spawning Atlantic herring have been identified within Freshwater East, the relationship of between the Freshwater East stock and the Milford Haven Stock is currently unknown, suggesting there is potential for a spatial overlap between the two populations.

128. Spawning grounds for herring are located on gravel and similar habitats (such as coarse sand, maerl, and shell) where the water is well-oxygenated and there is a low

proportion of fine sediment (Ellis *et al*., 2012). Despite the lack of formal surveys for herring distribution within the Study Area, the proposed Project falls within a large swath of ‘deep circalittoral sand’ (EUNIS A5.27), transitioning to ‘deep circalittoral coarse sediment’ (EUNIS A5.15) and ‘circalittoral coarse sediment’ (EUNIS A5.14) towards the Bristol Channel (see **Chapter 19: Benthic Ecology**), which may be suitable for herring spawning based on parameters specified by Reach *et al*. (2013). The benthic characterisation study identified only one area of suitable herring spawning habitat in the nearshore areas of the Study Area on approach to the landfall at Freshwater West (**Table 20-16**; **Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**). Therefore, the area in which the proposed Project is located is not considered to represent important herring spawning habitat based on the results of the benthic characterisation study.

Table 20-16. Herring spawning ground preference habitat according to habitat composition (Reach et al., 2013)

% Particle Contribution	Habitat Preference (Folk 1954)	N of Stations
< 5 % mud, > 50 % gravel	Preferred (Prime)	1
< 5 % mud, > 25 % gravel	Preferred (Sub-Prime)	0
< 5 % mud, > 10 % gravel	Marginal	0
> 5 % mud, < 10 % gravel	Unsuitable	34

Detailed Spawning Analysis (Herring)

129. Further detailed suitability assessments of Atlantic herring potential spawning habitat have been undertaken based on the methods provided within MarineSpace *et al*. (2013a) guidance, which expands upon existing work from Reach *et al*. (2013) and Latto *et al*. (2013). Seabed sediments such as those identified in the benthic characterisation study can be used to identify habitat suitability. However, a range of data sources have been identified by MarineSpace (2013a) which should also be considered when undertaking a detailed assessment (**Table 20-17**).

Table 20-17. Screening of data sources used as part of the confidence assessment for herring, with assumptions and limitations

Data source	Data Type	Screening In/Out for use within this spawning assessment	Assumptions / Limitations	Herring spawning confidence score
British Geological Survey (BGS) – 1:250,000	Substrate Folk Classification	In	The area for which data were requested was initially based on the ICES rectangles surrounding the Offshore Project Boundary (31E4, 31E5, 32E4 and 32E5). The area was then reduced to provide more focus on the proposed Project, but still ensured that the maximum ZoI of 0.5 km was encompassed (based on sediment dispersion modelling from **Chapter 18: Physical Environment** for sand and coarse sediment).	Preferred = 3 Marginal = 2
Vessel Monitoring System (VMS) – Vessels greater than 15 m – 2017 to 2020	Fishing fleet	In	VMS data are derived from MMO fishing activity data, more specifically the total weight of fish that were caught by vessels greater than 15 m over the period of 2017 to 2020. In each of the VMS spatial rectangles, the total weight caught was used to determine whether different types of fishing gear were used in each area from 2017 to 2020. Gear types were not defined in previous years and thus earlier data were not included. Herring are a pelagic species and therefore pelagic gear types were chosen: • Gillnets and entangling nets (not specified); • Gillnets (not specified); • Encircling gillnets; • Driftnets; • Set gillnets (anchored);	2

Data source	Data Type	Screening In/Out for use within this spawning assessment	Assumptions / Limitations	Herring spawning confidence score
			• Otter trawls (not specified); • Otter trawls – midwater; • Otter twin trawls; • With purse lines (purse seines); • Purse seine – one boat; • Purse seine – two boats; and • Pair trawls – midwater.	
Coull *et al*. (1998)	Spawning grounds	In	Data from Coull *et al*. (1998) showing important herring spawning grounds were used. Ellis *et al*. (2012) has not been considered due to the following comment by Reach *et al.* (2013): *Ellis et al. (2012) updated the distribution of fish larvae and information presented in Coull et al. (1998) but they related the mapping of this information to the ICES sub-rectangles in which they were sampled. In effect the resolution of effective mapping of these data for environmental considerations has been reduced (although it is useful as a fisheries management tool). For assessment at a regional-scale and in relation to Atlantic Herring the focused habitat-related data from Coull et al. (1998) support more meaningful analysis.*	3
International Herring Larvae Surveys (IHLS) – 2008 to 2017	Spawning grounds (herring only)	Out	The IHLS surveys did not cover the Celtic Sea and Study Area. Therefore, although the IHLS data is recommended in the guidance produced by MarineSpace, the data cannot be applied to this assessment.	n/a

130. BGS seabed sediment data (1:250,000)[5] was used to determine areas of 'preferred' (sediment Folk classifications: 'Gravel' and 'sandy Gravel') and 'marginal' (sediment Folk classifications: 'gravelly Sand') herring spawning habitat, as per Reach *et al*. (2013) guidance. **Figure 20-6** shows that the nearshore section of OfECC (approximately KP 31 to KP 49) is within 'marginal' habitat for herring, with the remaining OfECC and Array Area located within unsuitable habitat. Areas of 'preferred' habitat are present in the Study Area but do not overlap with the Offshore Development Area. 'Marginal' habitat is considered to have a 'very low' confidence score and is a poor indicator of potential habitat suitability for herring spawning. These results also do not conform with the grab sampling data from the benthic characterisation study which identified a small area of 'preferred' sediment at the landfall and 'unsuitable' sediment elsewhere (**Table 20-16**).

131. VMS data were analysed to show the areas within the Study Area where pelagic gear types have been used for fishing. It has not been possible to crop the data for the herring spawning season as the data do not include timeframes for when the fishing occurred. There was a small overlap between the VMS targeted areas and the area of marginal herring spawning sediment (BGS Seabed Sediment data) located at the entrance to Milford Haven (**Figure 20-7**). The area targeted by UK pelagic trawlers within the Study Area is located in ICES rectangle 32E4. However, pelagic gear types target several other fish species in addition to herring. For example, in ICES rectangle 32E4, MMO landings data for 2016 – 2020 reported herring as representing only 0.01% of total landed weight for the drift and fixed net gear type, which is the only gear type used to target herring in rectangle 32E4. Furthermore, the annual catches, catch per landing (kg) and the size of the fishing fleet targeting herring in Milford Haven have decreased considerably since the late 1970s and early 1980s due to a combination of reduced stock levels and lack of market demand (Davies *et al*., 2020a). Therefore, the VMS data is considered to provide a low confidence indicator of herring spawning in the Study Area.

'Confidence' Assessment ('Heat')

132. An analysis of the extent of low, medium, high and very high confidence of herring spawning is shown in a heat map as per MarineSpace *et al.* (2013a) guidance (**Figure 20-8**). The area and percentage over which each confidence category is present within the proposed Project ZoIs for the OfECC and Array Area and is summarised in **Table 20-18**. The following definitions for the Project ZoIs of potential seabed sediment disturbance have been used to define the area over which the confidence scores are provided (based on the ZoIs provided in **Table 20-27**):

- Primary Impact Zone (PIZ): The zone within which impacts resulting from the direct disturbance to seabed habitats, such as from dragging the boulder clearance plough over the seabed surface occur – also known as the direct impact zone; and
- Secondary Impact Zone (SIZ): The footprint of effects arising as a result of the proposed construction and pre-construction activities not associated with the PIZ – also known as the indirect impact zone.

133. The highest confidence score for herring spawning in the Study Area was six which is classed as high confidence. This was located in the nearshore on approach to Milford Haven (**Figure 20-8**). The offshore section of the OfECC (KP 0 to KP 30) and the entire Array Area is not shown by the data to have suitable sediment and therefore it is determined that herring spawning grounds are not present at these locations but have the potential to exist in

[5] https://www.bgs.ac.uk/datasets/marine-sediments-250k/

nearshore waters. The remaining Study Area is characterised by low confidence herring spawning grounds.

Table 20-18. Percentage and area of herring spawning confidence values within the PIZ and SIZ Assessment Area

Herring Spawning Confidence	Area (km^2)		Percentage of Route (%)	
	PIZ	SIZ	PIZ	SIZ
Offshore Export Cable Corridor				
Very High	0	0	0	0
High	0.57	10.93	23.36	22.42
Medium	0	0.23	0	0.47
Low	0.28	5.70	11.56	11.69
No Score	1.59	31.90	65.08	65.42
Total	2.44	48.76	100	100
Array Area				
Very High	0	0	0	0
High	0	0	0	0
Medium	0	0	0	0
Low	0	0	0	0
No Score	44.91	61.12	100	100
Total	44.91	61.12	100	100

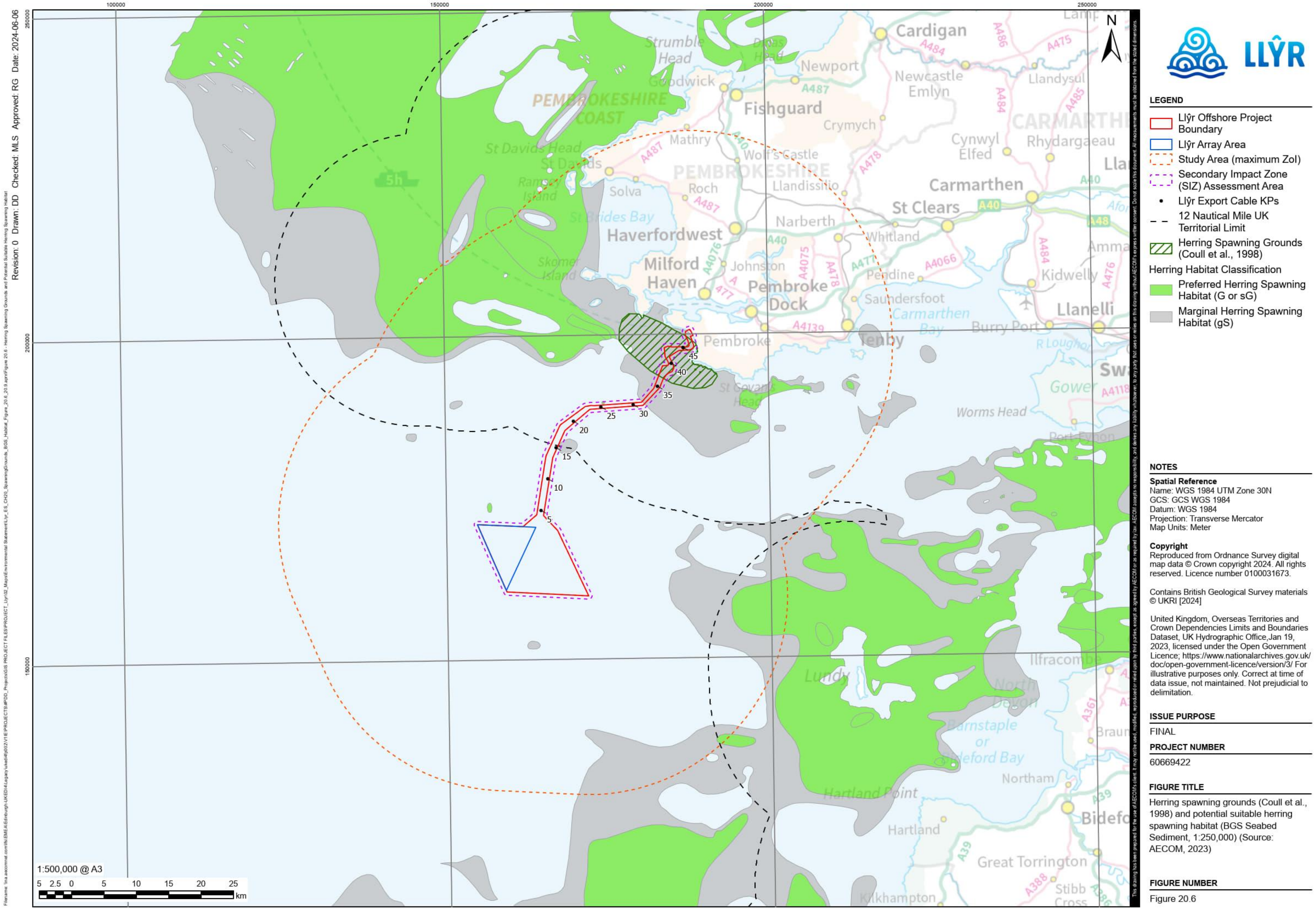

Figure 20-6. Potential herring spawning habitat derived from BGS seabed sediment data (1:250,000) (Source: AECOM, 2023)

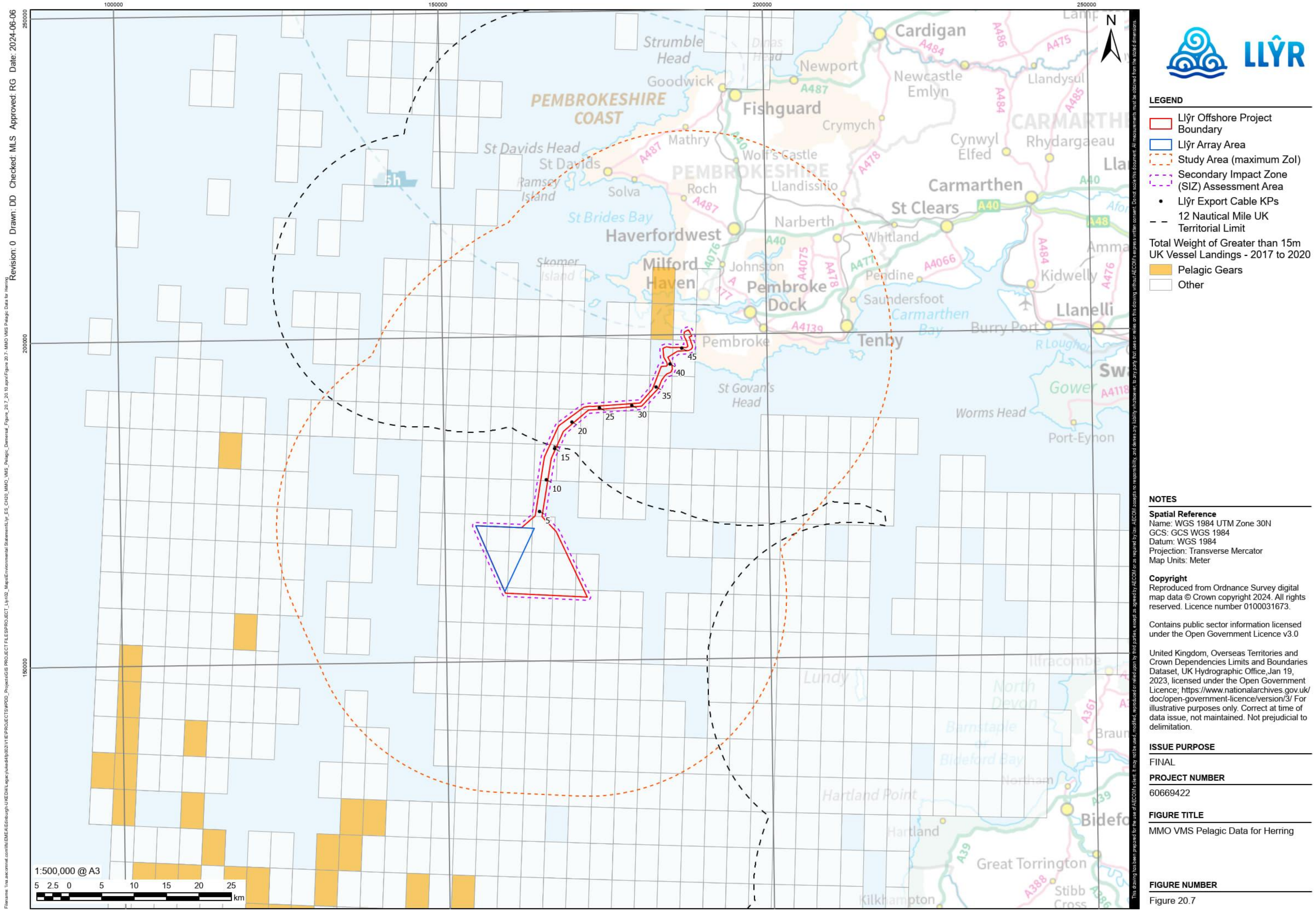

Figure 20-7. MMO VMS pelagic data for herring

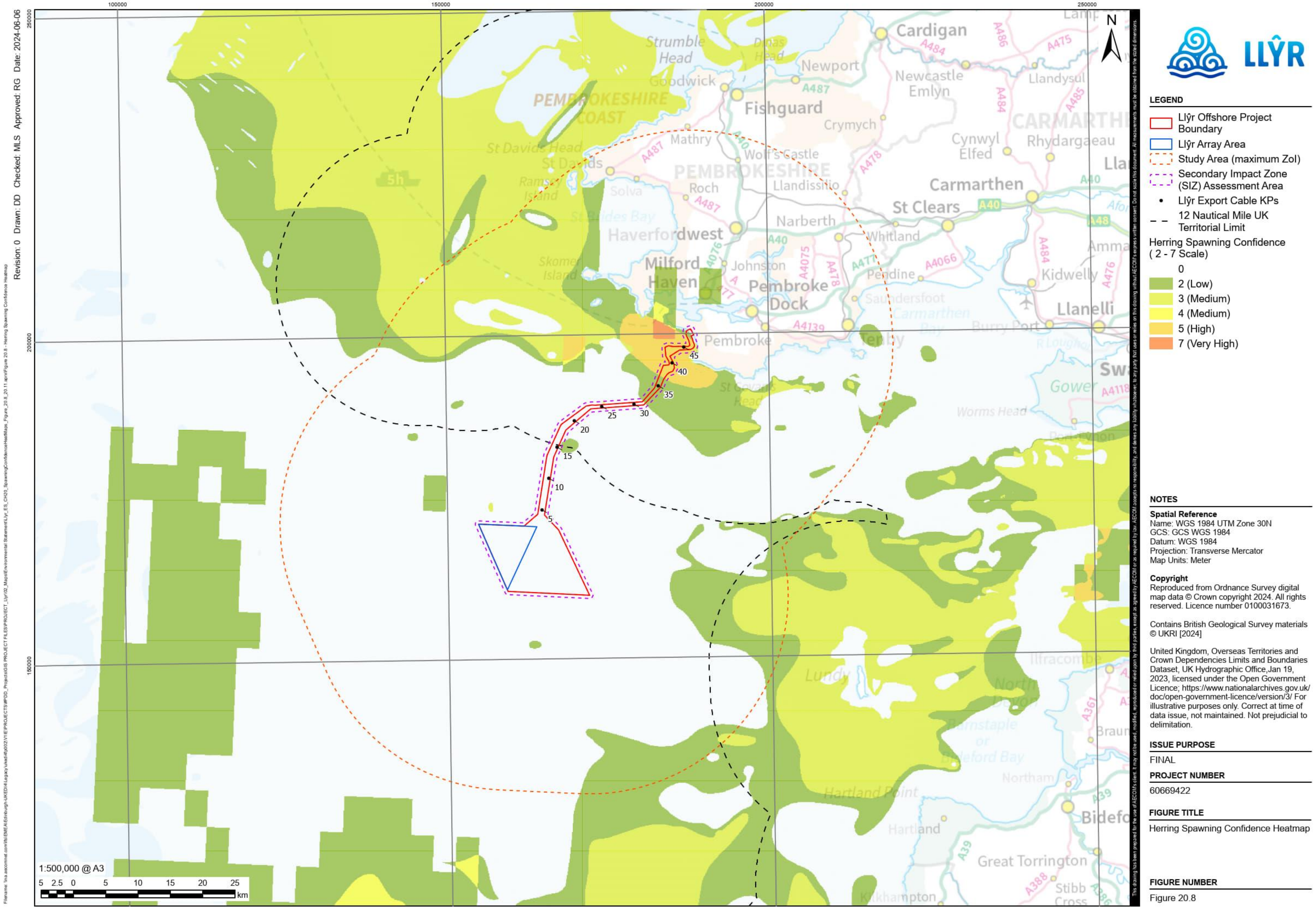

Figure 20-8. Herring spawning confidence heatmap

Sandeel

134. Sandeel spawn on the seabed, and therefore their eggs are demersal and remain on the seabed. Sandeel are known to have a high sensitivity to seabed disturbance. Spawning periods vary by species, with the broad spawning season considered to be November – February (Campanella and van der Kooij, 2021). In the Study Area, a hotspot for adult sandeel was identified in the Celtic Sea from the Western English Channel, including the coast of north Cornwall, up to the Bristol Channel, further south of Milford Haven. This hotspot for adult sandeel, identified by Campanella and van der Kooij, 2021) is considered to be a reasonable indication of sandeel spawning habitat. However, the hotspot avoids the shallower waters of the Study Area and is more concentrated in deeper waters.

135. There are some gaps in knowledge regarding the populations of adult sandeels, and therefore spawning grounds, in the Celtic Sea and Bristol Channel (Campanella and van der Kooij, 2021). However, due to strong site fidelity exhibited by sandeel, several local populations are expected to exist in the Celtic Sea. Therefore, it is also anticipated that there is the potential for sandeel to exist and spawn in Milford Haven.

136. Sandbanks and other sandy areas are known to be important habitat for sandeel, which typically prefer depths between 30 m and 70 m but are known to occur at depths of 15 m and 120 m, and burrow into these sandy habitats and use interstitial water to ventilate their gills. Fine sediment has the potential to clog their gills and therefore, sand eels have a very specific habitat requirement, meaning their distribution is often patchy (Holland *et al*., 2005; Jensen *et al*., 2011).

137. Suitable sandeel habitat has been identified as consisting of substrate which contains a high percentage of medium to coarse sand (particle size of 0.25 mm to 2 mm), with a mud content of less than 10% (particles <63 µm). A gravel component is also considered to be suitable for sandeel habitat. The inclusion of gravel means that using Folk classifications (Folk, 1954) can often over represent the suitability of habitat for sandeel; however, this is used as a precautionary approach. Latto *et al*. (2013) states that the Folk classification divisions which best describes the preferred habitat for sandeel species in UK waters, are: sand – S; slightly gravelly sand – (g)S; and gravelly sand – gS. The following Folk classification sediment divisions are considered to be marginal habitat (accorded less confidence than the preferred habitat) for sandeel species in UK waters: sandy gravel – sG. Guidelines for suitable habitat are presented in **Table 20-19**.

Table 20-19. Sandeel preference habitat according to sediment composition (Latto et al., 2013)

% Particle Contribution	Habitat Sediment Classification	Folk 1954 Classification
< 1 % mud, > 85 % Sand	Preferred	Sand
< 4 % mud, > 70 % Sand	Preferred	Gravelly Sand and Slightly Gravelly Sand
<10 % mud, > 50 % Sand	Marginal	Sandy Gravel
>10 % mud, < 50 % Sand	Unsuitable	Other

138. Latto *et al.* (2013) has adapted the definitions for sandeel grounds sediment types provided by Greenstreet *et al*. (2010), which use sediment particle size. This method utilises

the sediment fraction percentage by weight of the sample, separating into two distinct fractions: silt and fine sand (particle sizes >0.25 mm) and medium to coarse sand (particles sizes 0.25 mm to 2.0 mm). Therefore, removing the coarse >2 mm fraction that can often over represent the suitability of habitat. However, the definitions provided by Latto *et al.* (2013) allow easier comparisons with other assessments where PSA data is not available, such as for BGS sediment data (1:250,000).

139. The Study Area falls within a large swath of deep circalittoral sand (EUNIS A5.27), transitioning to ‘deep circalittoral coarse sediment’ (EUNIS A5.15) and ‘circalittoral coarse sediment’ (EUNIS A5.14) towards the Bristol Channel (see **Chapter 19: Benthic Ecology**). The benthic study characterisation study assessed the presence of suitable habitat for sandeel at different grab sampling stations in both nearshore and offshore sections of the Study Area, using the sandeel grounds sediment definitions provided by Latto *et al.* (2013). The assessment identified 21 stations in the Study Area to be preferred (prime and sub-prime) habitat for sandeel across both the nearshore (on the approach to the landfall) and offshore waters in both the OfECC and the Array Area (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**; **Table 20-20**). There were also seven stations classified as marginal sandeel habitat and seven as unsuitable.

Table 20-20. Sandeel spawning ground preference habitat according to sediment composition

% Particle Contribution	Habitat Sediment Classification	Number of Stations	Area Identified (OfECC / Array Area)
< 5 % mud, > 50 % gravel	Preferred	6	Both
< 5 % mud, > 25 % gravel	Preferred (sub-prime)	15	Both
< 5 % mud, > 10 % gravel	Marginal	7	Both
> 5 % mud, < 10 % gravel	Unsuitable	7	Both

140. Data by Coull *et al*. (1998) do not consider the Study Area to be important for sandeel. However, Ellis *et al*. (2012) shows that the Study Area has higher abundances of larvae recorded and represents high intensity spawning grounds. Despite this, there were no sandeel individuals observed during the benthic characterisation study.

141. Although the results of a benthic characterisation study show areas of preferred habitat to be present in the Array Area, habitat data from EMODnet (2023) show coarse sediment to be widespread in the Celtic Sea and not limited to the Array Area.

Detailed Spawning Assessment (Sandeel)

142. Further detailed suitability assessments of sandeel potential spawning habitat have been undertaken based on the methods provided within MarineSpace *et al.* (2013b) guidance, which expands upon existing work from Reach *et al.* (2013) and Latto *et al.* (2013). Seabed sediments such as those identified in the benthic characterisation study can be used to identify habitat suitability. However, a range of data sources have been identified by MarineSpace *et al*. (2013b) which should also be considered when undertaking a detailed assessment (**Table 20-21**).

Table 20-21. Screening of data sources used as part of the confidence assessment for sandeel, with assumptions and limitations

Data source	Data Type	Screening In/Out	Assumptions / Limitations	Sandeel confidence score
British Geological Survey (BGS) – 1:250,000	Substrate Folk Classification	In	The area for which data were requested was initially based on the ICES rectangles surrounding the Offshore Project Boundary (31E4, 31E5, 32E4 and 32E5). The area was then reduced to provide more focus on the proposed Project, but still ensured that the maximum ZoI of 0.5 km was encompassed (based on sediment dispersion modelling from **Chapter 18: Physical Environment** for sand and coarse sediment).	Preferred = 4 Marginal = 2
Vessel Monitoring System (VMS) – Vessels greater than 15 m – 2017 to 2020	Fishing fleet	In	VMS data are derived from MMO fishing activity data, more specifically the total weight of fish that were caught by vessels greater than 15 m over the period of 2017 to 2020. In each of the VMS spatial rectangles, the total weight caught was used to determine whether different types of fishing gear were used in each area from 2017 to 2020. Gear types were not defined in previous years and thus earlier data were not included. For sandeel, the total weight of fish caught by demersal gears was selected from the generic field which represented all the relevant gear types.	2
Coull *et al*. (1998)	Spawning grounds	In	Data from Coull *et al*. (1998) showing important sandeel spawning grounds were used. Ellis *et al*. (2012) has not been considered due to the following comment by Reach *et al.* (2013): *Ellis et al. (2012) updated the distribution of fish larvae and information presented in Coull et al. (1998) but they related the mapping of this information to the ICES sub-rectangles in*	3

Data source	Data Type	Screening In/Out	Assumptions / Limitations	Sandeel confidence score
			which they were sampled. In effect the resolution of effective mapping of these data for environmental considerations has been reduced (although it is useful as a fisheries management tool). For assessment at a regional-scale and in relation to Atlantic Herring the focused habitat-related data from Coull et al. (1998) support more meaningful analysis.	

143. BGS sediment data (1:250,000) was used to further determine the areas of 'preferred' (sediment Folk classifications: 'sand', 'slightly gravelly sand', and 'gravelly sand') and 'marginal' (sediment Folk classifications: 'sandy gravel') sandeel spawning habitat, based on guidance by MarineSpace *et al*. (2013b). With the exception of one very small patch of discrete 'unsuitable' habitat, sandeel 'preferred' habitat was identified throughout the Offshore Development Area (**Figure 20-9**), conforming with data shown by Ellis *et al.* (2012) (**Figure 20-5**). Sandeel 'preferred' habitat was present across the majority of the Study Area, with small areas of 'marginal' and 'unsuitable' habitat present to the east and west of the Offshore Development Area within the Study Area (**Figure 20-6**). This suggests that the area within the Offshore Development Area i.e. both the Array Area and OfECC, and the majority of the surrounding Study Area are suitable for potential sandeel spawning.

144. VMS data from 2017 to 2020 were analysed to show the areas around the Offshore Development Area where demersal fishing gear types have been used to target sandeel. A large proportion of the Offshore Development Area overlaps with VMS targeted areas for demersal gear types (**Figure 20-10**), as well as the wider Study Area. However, demersal fishing gear does not solely target sandeel and therefore the VMS data are considered to only provide 'low' confidence when indicating spawning grounds.

'Confidence' Assessment ('Heat')

145. An analysis of the extent of low, medium, high and very high confidence of sandeel spawning is shown in a heat map in **Figure 20-11**. The area and percentage over which each confidence category is present within the proposed Project ZoIs for the OfECC and Array Area (Primary Impact Zone (PIZ)[6] and Secondary Impact Zone (SIZ)[7]) is summarised in **Table 20-22**.

146. The highest confidence scores for sandeel spawning in the Study Area was four and five which is classed as medium and high confidence (**Figure 20-11**). High and medium confidence spawning was present through a large proportion of the Offshore Development Area, particularly for the Array Area. Therefore, it is determined that there is potential for sandeel spawning grounds to be present throughout much of the Offshore Development Area and within the Project ZoI. However, these areas compared to the wider Study Area are still considered to be very small in comparison to the availability of suitable sandeel spawning habitat in the Celtic Sea, as indicated by the high confidence scores recorded.

Table 20-22. Percentage and area of sandeel spawning confidence values within the PIZ and SIZ Assessment Area

Sandeel Spawning Confidence	Area (km^2)		Percentage of Route (%)	
	PIZ	SIZ	PIZ	SIZ
Offshore Export Cable Corridor				
Very High	0	0	0	0
High	1.00	20.01	41.17	41.20
Medium	1.43	28.11	58.83	57.88
Low	0	0.39	0	0.80
No Score	0	0.05	0	0.11

[6] The zone within which impacts resulting from the direct disturbance to seabed habitats, such as from the dragging the boulder clearance plough over the seabed surface occur – also known as the direct impact zone.
[7] The footprint of effects arising as a result of the proposed installation and pre-installation activities not associated with the PIZ – also known as the indirect impact zone.

Sandeel Spawning Confidence	Area (km²)		Percentage of Route (%)	
	PIZ	SIZ	PIZ	SIZ
Total	2.44	48.57	100	100
Array Area				
Very High	0	0	0	0
High	41.62	53.62	92.69	87.74
Medium	3.28	7.49	7.31	12.26
Low	0	0	0	0
No Score	0	0	0	0
Total	44.91	61.12	100	100

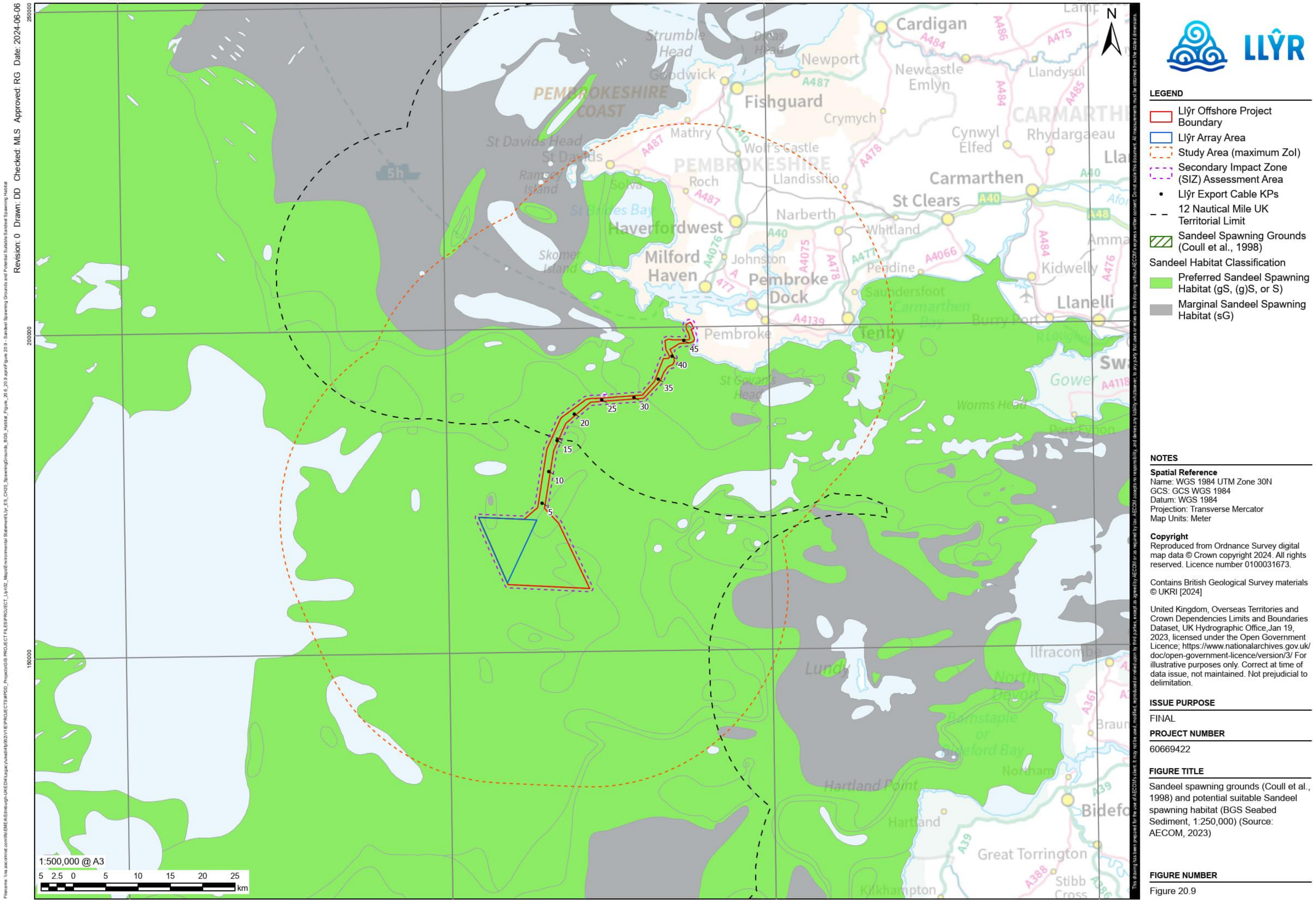

Figure 20-9. Potential sandeel spawning habitat, derived from BGS seabed sediment data (1:250,000) (Source: AECOM, 2023)

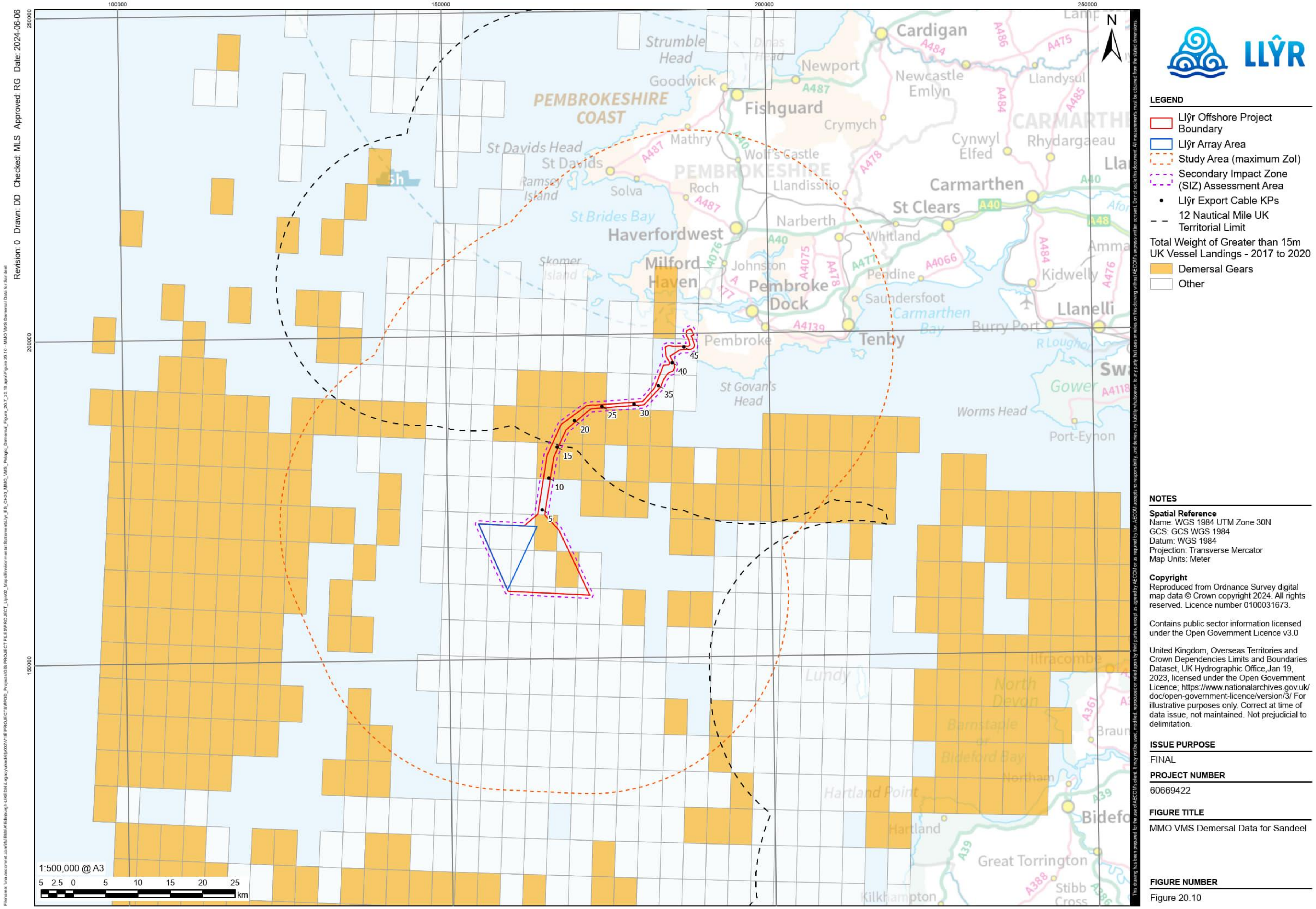

Figure 20-10. MMO VMS demersal data for sandeel

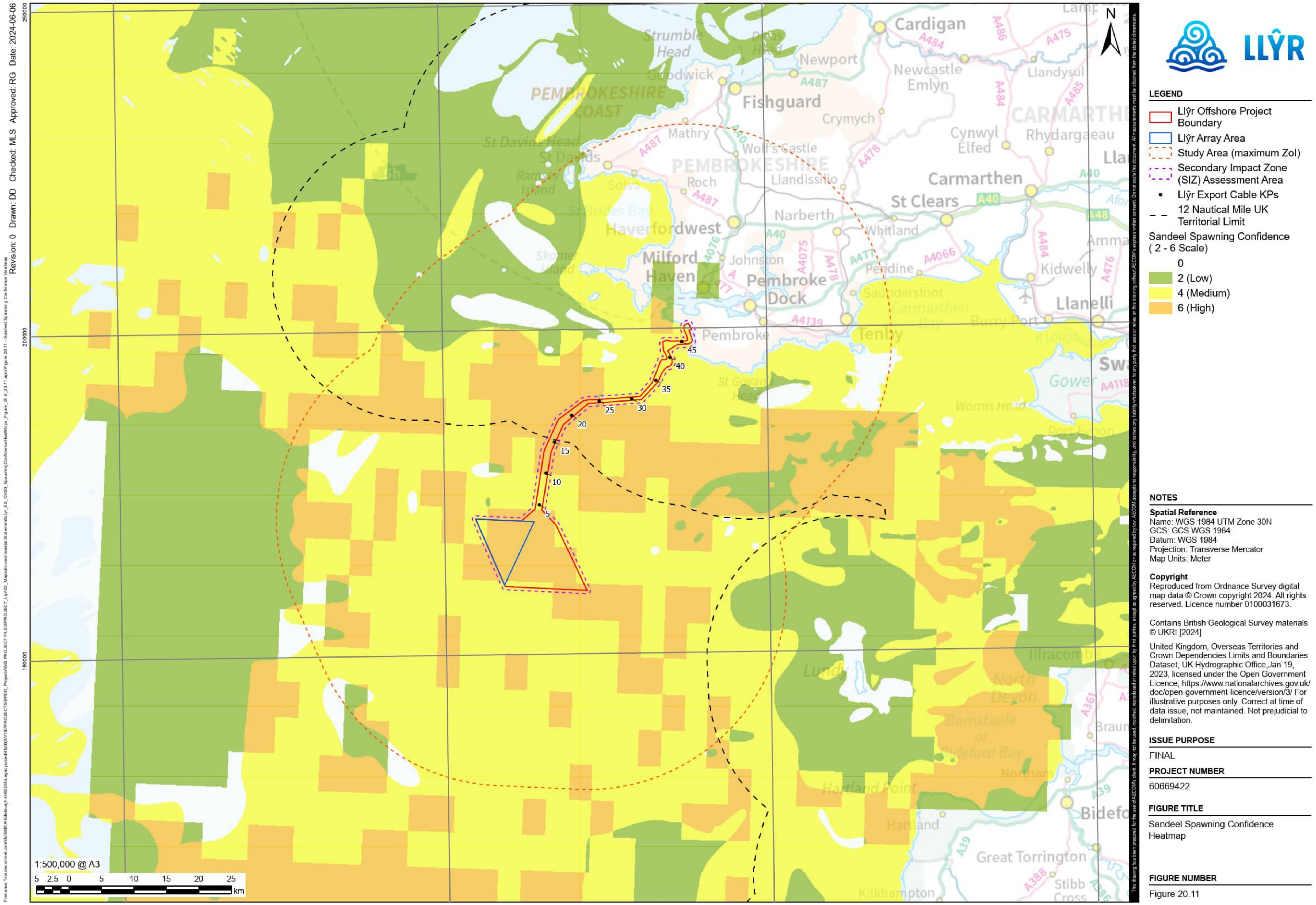

Figure 20-11. Sandeel spawning confidence heatmap

Nursery Grounds

147. Nursery grounds are areas where juveniles occur at higher densities and experience reduced rates of predation and elevated growth rates compared to other habitat (Ellis *et al*., 2012). Within the Study Area, low-intensity nursery grounds were identified for sandeel, sole, plaice, mackerel, horse mackerel, anglerfish, herring, hake, and whiting (**Table 20-23**).

Table 20-23. Important nursery grounds which fall within the Study Area

Common name	Species name	Nursery grounds (Ellis *et al*., 2012)	Nursery grounds (Coull *et al*., 1998)
Plaice	*Pleuronectes platessa*	Low intensity	Yes
Sandeel	Ammodytidae	Low intensity	No
Horse mackerel	*Trachurus trachurus*	Widespread	N/A
Sole	*Solea solea*	Low intensity	Yes
Mackerel	*Scomber scombrus*	Low intensity	No
Nephrops	*Nephrops norvegicus*	N/A	Yes
Whiting	*Merlangius merlangus*	Low intensity	Yes
Anglerfish	*Lophius piscatorius*	Low intensity	N/A
Herring	*Clupea harengus*	Low intensity	No
Ling	*Molva molva*	No	N/A
Hake	*Merluccius merluccius*	Low intensity	N/A
Lemon sole	*Microstomus kitts*	N/A	Yes
Sprat	*Sprattus sprattus*	N/A	No

148. An updated assessment of spawning and nursery grounds in Western UK waters indicates that the Study Area hosts nursery grounds for herring, sprat, sardine, anchovy, sandeel, horse mackerel, mackerel, whiting, and cod (Campanella and van der Kooij, 2021). Juvenile herring were found to be widespread in the Study Area, with the Bristol Channel being identified for the first time as a nursey ground for herring. A recent survey of small pelagic fish in the Bristol Channel also found high densities of sprat (PELTIC). Further assessment has indicated that the Bristol Channel supports persistent high densities of juvenile sprat, with sporadic or absent records in the western English Channel and southern Celtic Sea. The Celtic Sea was also recognised as a hotspot for sandeel juveniles and adults, although more important areas of spawning were observed in the central Irish Sea and western English Channel (Campanella and van der Kooij, 2021).

149. Aires *et al*. (2014) provides fish sensitivity maps showing the areas with the highest probability of aggregations of 0 group fish (fish within the first year of their lives). This study reported high probabilities of presence within the Study Area for whiting, horse mackerel, mackerel, and hake, with a patchy distribution of moderate probability for herring, mackerel, sprat, and anglerfish (Aires *et al*., 2014). Sprat were also found to be distinctly distributed, with 0 group and 1 group fish (fish within the first and second years of their lives) prominent within the Celtic Sea and Bristol Channel and older age classes inhabiting the Western English Channel (ICES, 2021b). Recent Cefas PELTIC surveys of the small pelagic fish assemblage of the Bristol Channel indicated high numbers of one year old sprat in Lyme Bay and the English Channel, as well as juvenile herring within the inner Bristol Channel (Cefas, 2020a).

150. However, due to their ecological importance as prey items, their association with the seabed, and their preference and requirements for specific habitats and sediment types, only herring and sandeel nursery grounds are considered further in this assessment. The nursery

grounds for herring and sandeel, as shown in data by Coull *et al*. (1998) and Ellis *et al*. (2012) are shown in **Figure 20-12** and **Figure 20-13**.

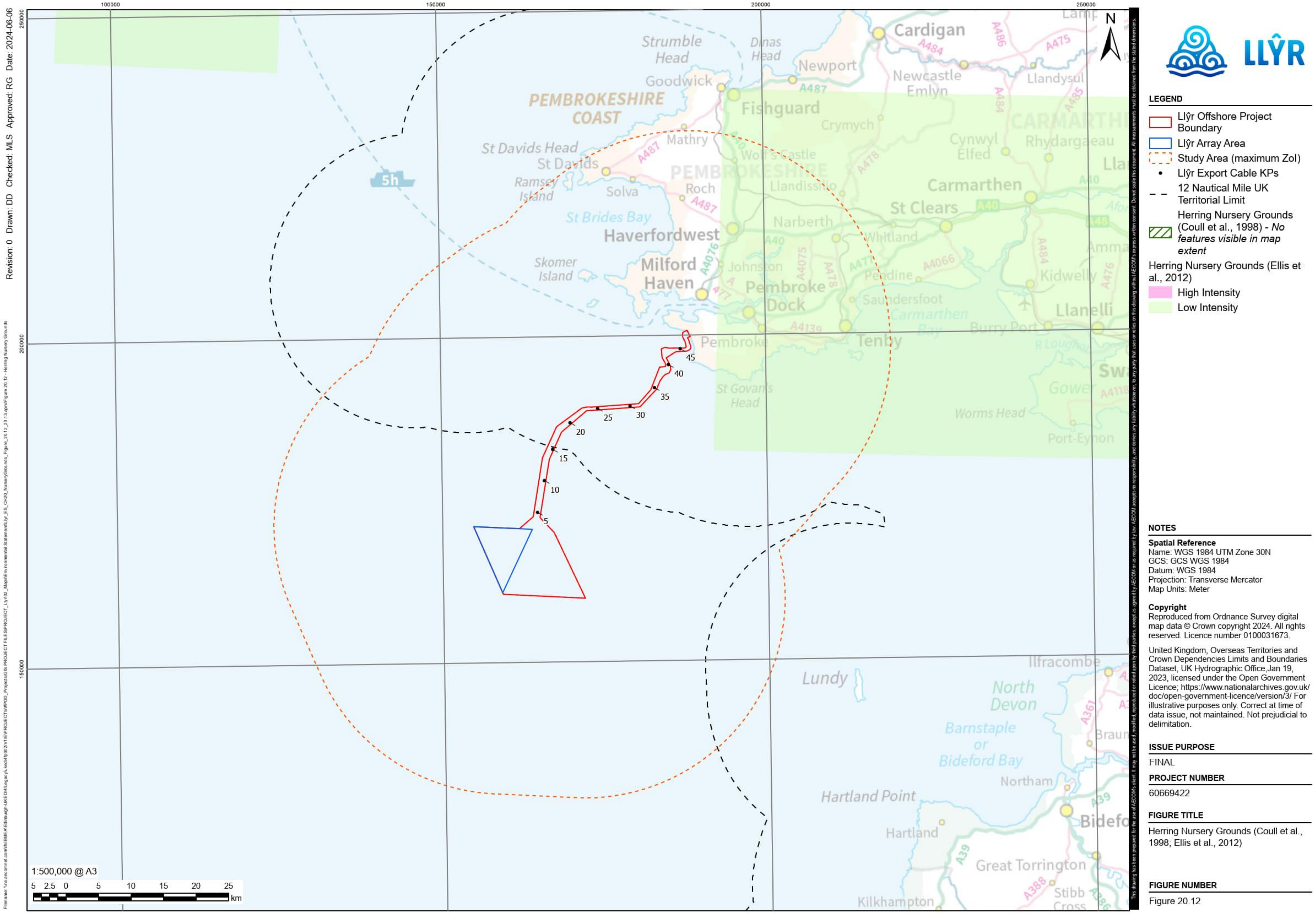

Figure 20-12. Herring nursery grounds (Coull et al., 1998; Ellis et al., 2012)

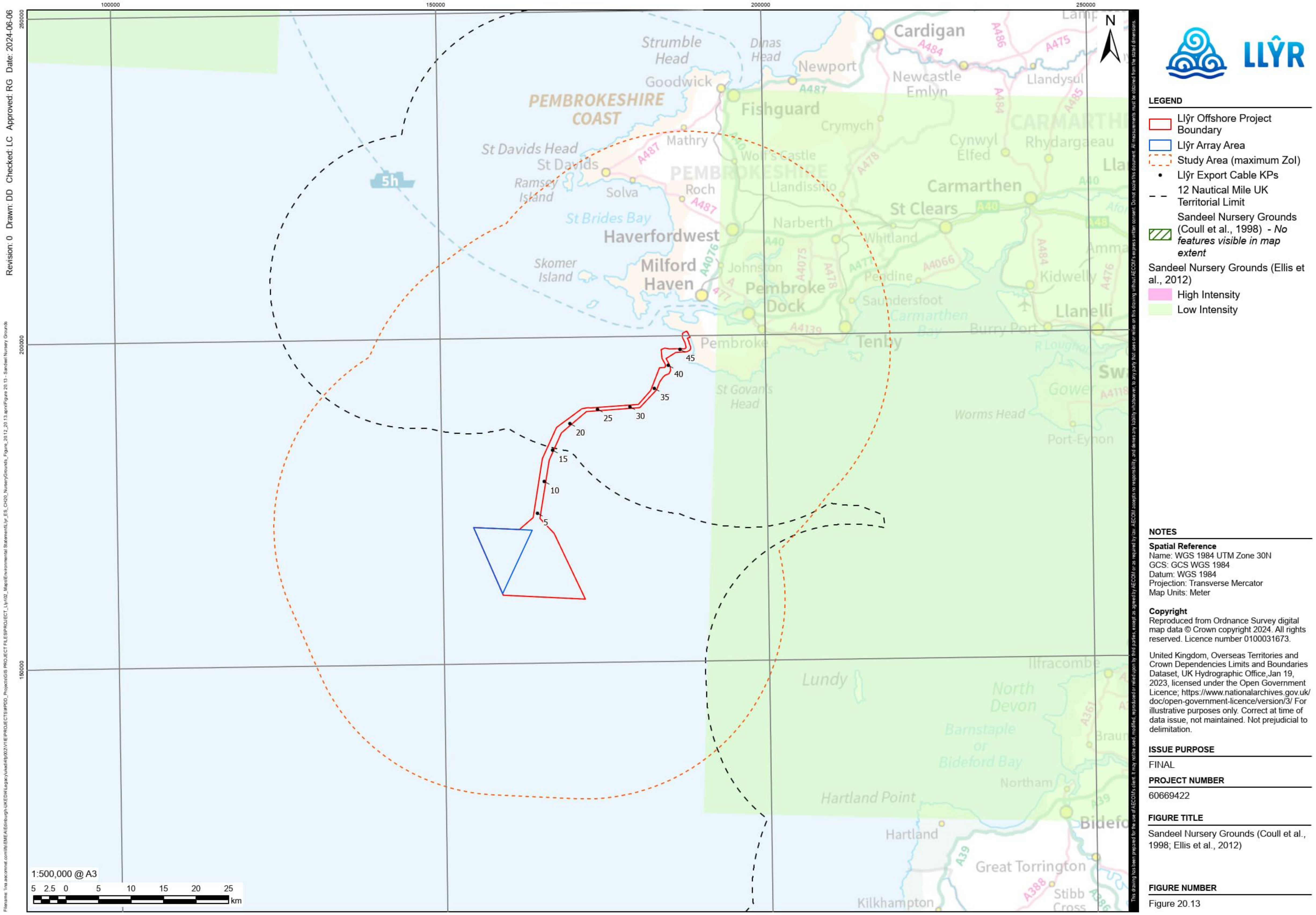

Figure 20-13. Sandeel nursery grounds (Coull et al., 1998; Ellis et al., 2012)

20.5.10. Summary of Receptors

151. The fish and shellfish receptors taken forward for consideration in this assessment along with their associated value have been determined based upon potential presence and activity / receptor interactions within the Study Area as well as their importance, including conservation importance, ecological (prey species) importance and commercial importance (**Table 20-24**). The approach to defining value is based on guidance from CIEEM (2018) and considers the importance of the receptor and their sensitivity.

152. Within the impact assessment, those species considered to have the greatest sensitivity to a particular effect have been assessed at the species level, whereas those species with lower sensitivity have been assessed either at a high taxonomic level (e.g., elasmobranchs) or by functional group (e.g., demersal, pelagic and migratory) as appropriate.

Table 20-24. Fish and shellfish ecology receptors considered and their assigned importance/value

Receptor group	Species	Rationale	Value
Migratory species	Atlantic salmon, sea trout (brown trout), sea and river lamprey, Allis shad, twaite shad, and European eel	Species of international or national conservation importance; Sea lamprey, river lamprey, Allis shad, twaite shad, and Atlantic salmon are qualifying features of designated SACs or listed as Annex II species (including sea trout); European eel listed as 'critically endangered' on the IUCN Red List; Species sensitive to underwater noise disturbance and EMF; and Some species valuable economically (commercial species).	Very high
Pelagic fish species	Herring	National conservation importance; Presence of spawning and nursery grounds in the Study Area (spawning grounds identified at mouth of Milford Haven); Marginal and preferred spawning habitat identified along the OfECC (although limited); Sensitive to habitat disturbance and underwater noise; and Commercially and ecologically (prey species) important.	High
	Sprat	Dominant pelagic fish species in inshore waters along the Welsh coastline;	Low

		Sensitive to underwater noise; and Commercially and ecologically (prey species) important.	
	Bluefin tuna	On the OSPAR list of threatened and/or declining species; and Commercially and ecologically (prey species) important.	High
Demersal fish species	Sandeel	National conservation importance (lesser sandeel a Priority Marine Feature (PMF)); High intensity spawning and nursery area overlapping the OfECC and Array Area; Preferred spawning habitat identified at multiple locations within the Study Area; Sensitive to increased suspended sediment concentration (SSC), smothering and habitat disturbance and/or loss; and Commercially and ecologically (prey species) important).	High
	Hake, haddock, whiting, pout, anglerfish, dab, plaice, sole, lemon sole, and megrim	Widely distributed in the Study Area; Important prey items for larger fish and seals; Presence of spawning and nursery grounds; Sensitive to increased SSC and underwater noise; and Valuable economically (commercial species).	Low
Elasmobranchs	Basking shark and angelshark	Wildlife and Countryside Act 1981 and NERC 2006 Species of Principal Importance / Section 7 of the Environment Act (Wales) 2016; and Areas of habitat suitability identified within the Study Area.	High
	All elasmobranchs	Fisheries have operated in the Study Area which have targeted spurdog, porbeagle, and blue shark, whilst other species of rays, such as thornback ray, blonde ray, and small-eyed ray are known to be present in the Study Area;	Medium

		Some species are demersal and therefore considered sensitive to increased turbidity; Species of demersal spawners present, such as thornback ray, and therefore considered sensitive to smothering and habitat disturbance and/or loss; Sensitive to EMF effects; Spurdog, tope, and blue shark are species of principal importance in Wales; and Some species valuable economically (commercial species).	
Shellfish of commercial and/or conservation importance		There are important spawning and nursery grounds for Norway lobster which fall within the Study Area; Some species and life stages are epibenthic or demersal and therefore sensitive to increased turbidity, smothering and EMF effects; and Norway lobster, European lobster, crabs, common whelks, and scallops valuable economically (commercial species).	Medium
General fish and shellfish communities		Common, ubiquitous and of low commercial importance; Some species and life stages are demersal and therefore considered sensitive to increased turbidity and smothering; and Considered to have a high tolerance to change given their distribution and abundance.	Low

20.5.11. *Future Baseline*

153. This section considers the changes to the baseline conditions described above that might occur during the time period over which the proposed Project will be in place. It considers changes that might occur in the absence of the proposed Project being constructed.

154. The Offshore Energy Strategic Environmental Assessment 3 (OESEA 3) (DECC, 2016a), reports that there have been substantial changes in the fish communities in the north-east Atlantic over several decades. Fish species will undergo natural variation in population size, largely as a result of year-to-year variation in recruitment success. These population trends will be influenced by human exploitation (i.e. over fishing) and broad-scale climatic and hydrological variations.

155. As well as coming under severe pressure from anthropogenic factors (i.e. fishing), fish communities are likely to be affected by future climate change through a rise in sea temperatures (DECC, 2016a). Climate change may influence fish distribution and abundance by affecting growth rates, recruitment rates, behaviour, survival and responses to changes at other trophic levels (Rijnsdrop *et al*., 2009).

156. Habitat requirements are likely to play a significant role in vulnerability to climate change, with demersal spawning species such as herring being vulnerable at different stages in their life cycles (Rijnsdorp *et al*., 2009). For shellfish species, it is expected that a change in sea temperatures will affect the settlement of bivalve species and could alter the distribution of migratory crustaceans.

157. A decline in sandeel populations around the UK has been adversely correlated with a rise in sea temperatures (Heath *et al*., 2012). In addition, increasing freshwater temperatures over the past four decades have implications for the survival rates of juvenile diadromous fish, although not necessarily negative ones (Simpson *et al*., 2013). Salmon populations have been declining as a result of warmer sea temperatures, while twaite shad and sea lamprey demonstrate increased larval survival due to warmer temperatures.

158. Although rising sea temperatures can have adverse effects on certain individual fish species i.e. sandeel, assessments have also found that species richness in the seas around the UK has increased (DECC, 2016b). The increase in species richness, along with an increase in small southerly species is possibly influenced by the release of predation pressure from large, exploited commercial fish, acting in combination with the changing climate (Hiddink and ter Hofstede, 2008; DECC, 2016).

159. Many fish are subject to pressure from commercial fisheries which target commercially valuable species and, potentially, non-target species (Rijnsdorp *et al*., 2009). It is expected that fishing pressure will enhance the effects of climate change. This has already been observed off the southwest coast of Britain, where commercially exploitable warm water species (i.e. skates and rays) have been unable to respond to more favourable conditions due to increased fishing pressure (DECC, 2016b; Genner *et al.,* 2004; 2010). See **Chapter 25: Commercial Fisheries** for further information on commercial species in the Study Area.

160. On this basis, it is expected that fish species observed within the Study Area will respond differently to pressures from climate change and commercial fishing. Species like salmon and sandeel are likely to decline, whereas populations of sea lamprey and twaite shad may increase. Corresponding to a rise in sea temperatures, southern warm water fish species are likely to increase their distribution northwards. However, this increase is may be counteracted by predicted increases in fish exploitation.

161. The Greenlink Interconnector was not under construction during the writing of the baseline, however, its construction is due to be finalised prior to the commencement of the construction of the proposed Project and therefore this will result in a change to the future baseline.

162. The Greenlink interconnector project is also located in Freshwater West (**Figure 20-15**). Greenlink has reported an area of habitat loss totalling 161,000 m^2 and includes the placement of hard substrate on suitable habitat for both herring and sandeel spawning. However, this project has concluded that it would have a negligible and minor effect (not significant) for sandeel and herring spawning habitats, respectively. This conclusion was based on the small area of herring and sandeel habitat effected compared to the wide availability within the Irish and Celtic Sea region. The proposed Project is considered to result in the permanent loss of habitat of 91,184 m^2 (**Section 20.8.2**), which includes habitat identified as potentially suitable to both herring and sandeel. The habitats which could be lost by both projects are relatively homogenous, with sediments dominated by sand with varying compositions of gravel, considered to be suitable for either herring or sandeel spawning. Compared to the extent of this habitat in the wider Study Area and Celtic Sea, the loss of habitat is still considered to be very small. Furthermore, the placement of the hard substrates for each project will be in discrete locations and will not overlap.

163. The Greenlink Interconnector will also result in heat emissions and EMF from the cables. However, although this project is close to the proposed Project, any effects will be highly localised to the cables themselves and not result in an increase in emissions that will effect fish and shellfish receptors. Greenlink has reported that EMF produced by this project will be reduced to background levels within 2 m of the cable. EMF emissions for the proposed Project alone, was assessed as resulting in no significant effects (**Section 20.8.2**).

20.6 Scope of the Assessment

164. An EIA Scoping Report for the proposed Project was submitted to NRW Marine Licensing Team (MLT) in April 2022. The Scoping Report was also shared with relevant consultees, inviting comment on the proposed approach adopted by the Applicant. A Scoping Opinion was provided to the Applicant by NRW MLT in July 2022. Based on the Scoping Opinion received, and further consultation undertaken, potential impacts on fish and shellfish scoped into the assessment are listed below in **Table 20-25**. No impacts were scoped out of the assessment.

165. As set out in **Section 20.4.1**, this assessment considers the design parameters of the proposed Project which are predicted to result in the greatest environmental impact, known as the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question. Given that the realistic worst case scenario is based on the design option (or combination of options) that represents the greatest potential for change, confidence can be held that the development of any alternative options within the design parameters will give rise to effects no greater or worse than those included in this impact assessment.

166. Accordingly, the design scenarios identified in **Table 20-25** have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group within the fish and shellfish Study Area. These scenarios have been selected from the details provided in **Chapter 04: Description of the Projects**.

Table 20-25. Design scenario considered for the assessment

Potential impact	Design scenario	Justification
Construction		
Temporary direct loss and physical disturbance to fish habitats	**OfECC** Total area of temporary habitat disturbance is **3,071,148 m^2** based on the following assumptions: HDD breakout point (10 m wide x 5 m long per bore) gives a total for 2 bores = 100 m^2; Sandwave levelling for a total length of 10,351 m and width of 30 m = total disturbance of 310,524 m^2 per cable = 621,048 m^2 in total; Disturbance swathe of 25 m for construction of two cables, including clearance activities such as pre-grapnel run and boulder clearance over 49 km total length = (49,000 x 2 x 25) = 2,450,000 m^2.	Worst-case scenario which could result in a large area of temporary disturbance to sensitive species and habitats that may take a long time to recover. Clearance activities, such as pre-grapnel run and boulder clearance are considered to represent a WCS disturbance swathe, with cable installation activities to fall within this width.
	Array Area If burial is possible (and no cable protection is required so that only temporary habitat disturbance occurs) the entire distance of the IACs in contact with the seabed of 17.10 km would be disturbed in a swathe of up to 25 m during burial, giving a total area of temporary disturbance of **427,500 m^2**.	The IAC will be installed by either cable lay on the surface with cable protection – resulting in habitat loss, by burial which would cause temporary habitat disturbance, or will be dynamic in the water column. Construction may involve a combination of the two but to ensure the WCS is assessed each type is considered for the entire IAC route.

Potential impact	Design scenario	Justification
Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition	High increases in SSC up to 500 m away from disturbance from construction activities, particularly in areas of fine particulate matter, thereafter, reducing towards the 14 km tidal excursion buffer. This is based on a WCS of sediment being disturbed 500 m along the entire OfECC cable length of 17.10 km and the entire Array Area boundary plus a 500 m buffer. It is assumed that other disturbance activities, such as sand wave clearance is encompassed as part of this disturbance area.	This worst-case scenario could result in the smothering of sensitive habitat and species such as sandeel and herring spawning. The use of the entire Array Area as an initial boundary for where sediment will be dispersed from is a WCS, as disturbance will be concentrated to activities associated with the location of the IACs and anchors.
Changes to marine water quality from the use of drilling fluids at HDD break-out points and resuspension of sediment contamination during seabed installation works	HDD fluids could easily spill at the breakout location and enter the marine environment and settle to fish and shellfish habitats and species. The total drill cuttings volume for the HDD works will be up to 1,700 m^3 based on the volume of drill cuttings per cable (445 m^3), 660 mm diameter of the ducts plus a 25% bulking factor.	The addition of HDD into the marine environment could negatively affect fish and shellfish receptors.
Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils	Accidental release of pollutants and planned release of wastewater from a minimum of twelve Project vessels.	The addition of pollutants and wastewater into the marine environment could negatively affect fish and shellfish receptors.
Underwater noise and vibration	Use of a sub-bottom profiler (as part of pre-construction geophysical surveys) which operates at a frequency (0.5 – 12 kHz) within the hearing range of fish; Impact piling for installation of pin piles to anchor WTGs into place at a sound pressure level of 235 re 1 µPa @ 1 m. Worst-case scenario of 4 hours of piling per site, with a pile diameter of 3 m and hammer power of 800 kJ;	The reasonable worst-case scenario presented is for underwater noise disturbance, expected to be generated by the use of an SBP, impact piling, and UXO clearance.

Potential impact	Design scenario	Justification
	UXO assessment has used the assumed range of charge weights (25 to 794 kg) provided as part of the nearby Erebus OWF (~20 km to the northwest of the Llŷr Project Area); All other construction activities expected to occur at frequencies outside of the hearing range of fish.	
Operation and maintenance		
Permanent direct loss and physical disturbance to fish and shellfish habitats	**OfECC** Placement of cable and scour protection, such as rock berms, concrete mattresses and grout bags, resulting in a maximum footprint of **35,100 m²** (2 cables total): 50 m² of protection, such as rock placement and/or concrete mattresses, per bore at HDD exit point = total area of 100 m²; Cable protection (excluding crossings) in OfECC over a total distance of 1,600 m per cable, with a worst-case scenario berm width of 5 m. Total area is 1,600 m x 5 m x 2 cables = 16,000 m² in total for two cables; Four cable crossings each requiring protection (none required for Greenlink) of 200 m length and 5 m width = 4 crossings x 200 m x 5 m width x 2 cables = 8,000 m²); and Articulated piping = 11,000 m per cable. Thus, for both cables a distance of 22,000 m. Each pipe is 500 mm in diameter and so the total area of cables on the seabed is 11,000 m².	**OfECC** This is a reasonable worst-case scenario as it represents the design scenario with the greatest potential for habitat loss, including maximum cable protection requirements and maximum scour protection requirements. No other design scenario would result in greater permanent loss of fish and shellfish habitats.
	Array Area Total habitat loss = **56,084 m²**. This is based on the following calculations:	**Array Area**

Potential impact	Design scenario	Justification
	Assuming a worst-case scenario of 20% cable protection of the 17,100 m of IAC, with a berm width of 5 m, the total area of cable protection would be 3,420 m x 5 m = 17,100 m^2; Potential placement of anchor scour protection at 80 anchors (i.e. 8 per 10 WTGs), each of 310 m^2 = total scour protection of 24,800 m^2; Placement of 25 clump weights (4 m^2 each) per mooring line, 8 mooring lines per x 10 WTGs is a total area of (25 x 4 x 8 x 10) 8,000 m^2; Drag embedment anchor or drilled pile anchors on seabed with max footprint of 76.5 m^2 with 8 anchors max per WTG = 6,120 m^2; and Subsea connector 64 m^2.	Cable protection is estimated to be required on a maximum of 20% of the IAC as a worst-case scenario (WCS). WCS assumes total of 310 m^2 of scour protection at each anchor and assumes additional area lost to drilled pile anchors.
Increase in thermal emissions from cable operation	**OfECC** Two 66 kV or 132 kV electricity export cables transmitting electricity from the WTGs to the shore over a maximum distance of 49 km. The temperature increase from direct burial laying in the sediment is considered to be up to 50°C in the direct vicinity of the cable but this decreases rapidly with distance from the cable and within 30 cm of the sediment surface, the temperature increase is estimated to be within 2°C. For unburied cables any temperature increase will be rapidly attenuated in water and unlikely to have an effect. **Array Area** A total of 11 IACs within the Array Area, will connect the turbines together with a total length of 17.10 km.	Thermal emissions are known to have the potential to affect the foraging and migratory success and behaviour and these values represent the worst-case scenario for emissions of EMF.
Effects of electromagnetic field (EMF) emissions	**OfECC**	EMF emissions are known to have the potential to affect the foraging and

Potential impact	Design scenario	Justification
	Maximum EMF strength predicted to result from the operation of the export cables at a buried depth of 1.2 m (minimum burial depth of 0.8 m), when a receptor is 0 m from the seabed, is 2.6 µT (microtesla); and **Array Area** It is proposed that inter-array cables will either be buried in the seabed or dynamic in the water column. In the event that the inter-array cables are exposed in the water column, the maximum EMF strength at the surface of the cables has been calculated as ~5.2 mT (millitesla).	migratory success and behaviour and these values represent the worst-case scenario for emissions of EMF. The target burial depth is 1.2 m; however, the minimum burial depth is 0.8 m.
Disturbance effects to fish (such as barrier effects, collision and entanglement) from the presence of floating offshore structures and associated tethering systems	Array Area Presence of up to ten WTGs, anchors and cable protection, presenting barriers to fish and shellfish, which could also result in increased collision rates and entanglement with tethering systems.	The reasonable worst-case scenario presented is for the presence of ten WTGs and the associated tethering systems and offshore structures which could present as a barrier effect or increase collision and entanglement.
Underwater noise and vibration	Vibration from rotating machinery in the WTGs, transmitted into the water column, at an operating frequency of < 1kHz; and Metal cable snapping, producing an SEL_{cum} of 157 dB re 1 µPa^{2}s over 24 hours at 150 m.	The reasonable worst-case scenario presented is for underwater sound disturbance, expected to be generated by vibration from rotating machinery, and metal cable snapping.
Effects to fish and shellfish from maintenance activities	Carried out using the same or similar methods to cable installation. This will consist of maintenance of the OfECC and Array Area, with use of vessels and potential for addition cable protection. A WCS is for up to 5 cable repairs assumed to be required over the lifetime of the proposed Project.	The reasonable WCS during maintenance is expected to generate impacts at no greater magnitude than during cable installation.

Potential impact	Design scenario	Justification
Decommissioning		
Potential effects the same as cable installation. *However, impact pathways likely to occur for decommissioning activities are the following:* *Temporary direct loss and physical disturbance to fish habitats;* *Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition;* *Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils; and* *Underwater noise and vibration.*	Decommissioning will involve the removal of all proposed Project infrastructure, including buried cables. Although some elements such as the pin piles, will be cut and left in situ.	The removal of all infrastructure from the seabed is considered to be the worst-case scenario in relation to fish and shellfish ecology.

20.6.1. *Impacts Scoped Out of Assessment*

167. There were no impacts in relation to fish and shellfish which were scoped out of the assessment during EIA scoping.

20.6.2. *Assessment Assumptions and Limitations*

168. For many species, the understanding of spawning and nursery grounds is largely derived from the information published by Coull *et al*. (1998) and Ellis *et al*. (2012) which remain key data sources for UK waters. However, it is important to recognise the principal limitations of these sources in the context of the proposed Project.

169. Firstly, although for many pelagic and demersal fish species, the underlying data sets provide good coverage of the Study Area, for others, notably elasmobranchs, insufficient data has precluded the delineation of spawning grounds. Secondly, it is acknowledged that more recent and localised trends in fish abundance, distribution and behaviours may not be fully represented by these figures, due to the historic and widescale nature of the supporting data sets which are now very old. Thirdly, the data presented within these sources is based on survey data which is not fully supported for coastal waters and water less than 30 m deep. Ellis *et al.* (2012) also reported issues of quality assurance with the data used, particularly relating to taxonomic identification and survey design (gear type, location of stations, and timings of surveys).

170. Noting these limitations, a high-level site-specific appraisal of habitat suitability has been undertaken in accordance with the habitat assessment criteria outlined in MarineSpace *et al*. (2013a) for herring (*Clupea harengus*) and sandeel (*Ammoytidae* spp.) (Fugro, 2021) which, owing to their life history strategies, may be vulnerable to effects from the proposed Project. Findings of this benthic survey are presented in **Spawning and Nursery Grounds**. Finally, the durations of the spawning seasons reported by Coull *et al*. (1998) and Ellis *et al.* (2012) represent the maximum seasons. The timing and duration of spawning for many species' is dependent on a range of factors (e.g. stock, water temperature) and so in reality, variations may occur within the indicative windows provided.

171. Although Coull *et al*. (1998) and Ellis *et al*. (2012) data sources provide indicative information on sensitivities for spawning and nursery grounds, it is important to use a range of information. For example, information on Atlantic herring spawning grounds inside the Pembrokeshire Marine SAC, as well as in the coastal areas has been provided by the work undertaken by Davies *et al.* (2020a). Other data sources referenced include the PELTIC surveys conducted by Cefas in the Celtic Sea, and the recent reports by Campanella & van der Kooij (2021) on spawning and nursery grounds in Welsh and surroundings waters.

172. Fish, being mobile species, exhibit varying spatial and temporal patterns. Survey data often only provides a seasonal specific description of the composition, abundance and distribution of fish and shellfish communities; with these, a number of factors are expected to vary both within and between years.

173. Despite a detailed review of literature, there remains a paucity of information related to migratory fish species, particularly for those life stages which occur fully in marine environments. In the absence of robust data, the precautionary principle has been applied and the migratory routes of these species has been considered over larger distances, using a regional approach (**Section 20.4.3**).

174. The high biophysical connectivity and dynamic nature of marine environments mean that although the baseline described and characterised is considered to be relatively stable, it

will continue to change in response to global trends both in climate change and anthropogenic activities (e.g. ocean acidification, fisheries, eutrophication, offshore development) (Teal, 2011).

175. While acknowledging these limitations, every effort has been made to obtain data concerning the existing environment and to accurately predict the likely environmental effect of the proposed Project. It is considered that the baseline information collected and used for this assessment is representative of the Study Area and sufficiently robust.

20.7 Embedded Mitigation, Management Plans and Best Practice

176. As part of the project design process, a number of designed-in measures have been proposed to reduce the potential for impacts on fish and shellfish (see **Table 20-26**). The design of the proposed Project therefore includes embedded mitigation measures (which includes various management plans) that will be produced as conditions of consent and which will further mitigate potential impacts. This approach has been employed in order to demonstrate commitment to mitigation measures by including them in the design of the proposed Project and as such these measures have been considered within the assessment presented in **Section 20.8** below. Assessment of sensitivity, magnitude and therefore significance includes the implementation of these measures.

Table 20-26. Mitigation measures, management plans and best practice adopted as part of the proposed Project

Embedded Mitigation Measures, Management Plans and Best Practice	Justification
Design Embedded Measures	
Micro-siting of the OfECC.	Micro-siting enables the avoidance of sensitive habitats (including reef habitat). Additional surveys were undertaken in 2024 (**Appendix 19D: Drop down video survey 2024**) to define a route that avoids designating features of the Pembroke Marine SAC (by determining the presence of Annex I reef and sandbanks). For example, the OfECC has since been updated, to avoid Turbot Bank and other Annex I features.
Comprehensive pre-application ecological surveys have been conducted within the Array Area and OfECC (Offshore Development Area).	Pre-application ecological surveys have identified areas of ecological importance within the Study Area, including areas of potential herring spawning and sandeel habitat.
Scour protection and other protection measures for buried or seabed surface laid infrastructure are common infrastructure in the marine environment. The engineering design of such protection (in terms of the armour unit or clast material and dimensions, and the overall shape and structure of the protection), will take account of the environmental setting it is being located in.	Good engineering design practice will actively minimise the potential for local sediment erosion (causing scour), accretion (causing burial) and general interaction with ambient flows (to minimise the potential for erosion of the protective clasts).

Embedded Mitigation Measures, Management Plans and Best Practice	Justification
For example, iron encased articulated pipe protection will be used to protect the cables in areas of constrained routeing options within the OfECC, such as but not limited to the 6.2 km of offshore export cables nearest to shore (between KP 48 and KP 41.8).	
HDD drilling fluids will be tested and selected to curtail environmental damage and potential leakage. This chiefly includes using biodegradable substances that Pose Little or No Risk to the Environment (PLONOR) and adequate contamination testing and drilling fluid disposal.	The use of non-toxic drilling fluid will reduce impacts to the marine environment, including fish and shellfish receptors.
Where possible, vessels will operate with dynamic positioning.	Dynamic positioning will minimise anchor disturbance on the seabed in potentially sensitive ecological areas.
Rock placement will only be used where necessary.	This will aid in avoiding the placement of rocks in habitats which otherwise consist of soft, sandy sediments, and will reduce the amount of permanent habitat loss.
Management Plans	
To prevent disturbance by suspended sediment on benthic habitats and thus some fish and shellfish receptors in the jet trenching phase of cable installation 'OSPAR Commission Guidelines on Best Environmental Practice' in Cable Laying and Operation must be adhered to. This includes to minimise the number of export cables that require trenching, avoiding sensitive fish and shellfish habitats in the route design and coordinating trenching activity to not coincide with critical life stages of fish species such as reproductive events like spawning.	This is considered to reduce the effect of construction and operation on fish and shellfish habitats and species, particularly those which are sensitive to increased suspended sediment concentrations.
A Project Environmental Management Plan (PEMP) and Construction Environmental Monitoring Plan (CEMP) including an Emergency Spill Response Plan and Waste Management Plan will be undertaken by the contractor. Appropriate Health, Safety, and Environment (HSE) procedures (identified in the CEMP) will also be implemented, with strict weather and personnel limits to reduce any risk of accidental spillage.	A PEMP and CEMP will assist In further reducing impacts to fish and shellfish receptors during any accidental spills or leaks.
A Shipboard Oil Pollution Emergency Plans (SOPEP) will be in place and adhered to under MARPOL Annex I requirements for all vessels.	Implementing a SOPEP will reduce the influence any pollution incidents from Project vessels could have on fish and shellfish receptors in the Study Area.

Embedded Mitigation Measures, Management Plans and Best Practice	Justification
Planned effluent dischargers will be compliant with MARPOL Annex IV 'Prevention of Pollution from Ships' standards.	This will ensure that any discharges are within MARPOL standards to reduce risk to fish and shellfish receptors.

20.8 Assessment of Environmental Effects

177. The impacts and effects (both beneficial and adverse) associated with the construction, operation and maintenance, and decommissioning of the Projects are outlined in **Table 20-27** and the sections below. The assessments take into account the embedded mitigation, management plans, and best practice measures described in **Section 20.7**. These ZoIs represent the zone over which the proposed activities could influence ecological features. The ZoI takes into consideration the realistic worst-case design scenario (provided in **Table 20-25**) as well as the different sensitivities of receptors and any relevant modelling undertaken as part of the Project.

178. **Table 20-28** outlines the different elements of the Offshore Development Area which have been assessed for each impact pathway, as well as the specific functional groups considered and their sensitivities for each impact pathway.

Table 20-27. Summary of impact pathways and ZoIs

Potential impact	Zone of Influence
Construction phase	
Temporary direct loss and physical disturbance to fish habitats	50 m based on maximum worst-case scenario disturbance diameter from ploughs. This is considered to be the PIZ[8], as per the herring and sandeel spawning assessment definitions provided by MarineSpace *et al.* (2013a and 2013b) guidelines.
Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition	Footprint of the proposed Project plus a 500 m buffer (based on sediment dispersion modelling calculations of measurable SSC increase, and measurable but lesser thickness of deposition). This is considered to be the SIZ[9], as per the herring and sandeel spawning assessment definitions provided by MarineSpace *et al.* (2013a and 2013b) guidelines.
Impact from changes to marine water quality from the mobilisation of contaminants	14 km (based on maximum tidal excursion on a mean tide, located in the nearshore area around the landfall and outside Milford Haven)

[8] PIZ: The zone within which impacts resulting from the direct disturbance to seabed habitats, such as from the dragging the boulder clearance plough over the seabed surface occur – also known as the direct impact zone.
[9] SIZ: The footprint of effects arising as a result of the proposed installation and pre-installation activities not associated with the PIZ – also known as the indirect impact zone.

Potential impact	Zone of Influence
Impact from changes to marine water quality from the use of drilling fluids at HDD break-out points	14 km (based on maximum tidal excursion on a mean tide, located in the nearshore area around the landfall and outside Milford Haven)
Impact from changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils	14 km (based on maximum tidal excursion on a mean tide, located in the nearshore area around the landfall and outside Milford Haven)
Underwater noise and vibration	Low level behavioural disturbance distance from noise sources generated by proposed Project activities to a maximum estimated distance of 31 km (based on underwater noise modelling for impact piling). An application for a separate Marine Licence in respect of UXO clearance will be made post submission, when the exact number and type of detonations have been established. However, an initial impact assessment of the effect of UXO detonation is included.
Operational phase	
Permanent direct loss and physical disturbance to fish and shellfish habitats	10 m based maximum width of cable and scour protection for two cables
Increase in thermal emissions from cable operation	The footprint of the proposed Project and up to approximately 1 m away dependent on the heat carrying capacity of the cable.
Effects of electromagnetic field (EMF) emissions	At 2 m EMF effects are reduced to negligible.
Disturbance effects to fish (such as barrier effects, collision and entanglement) from the presence of floating offshore structures and associated tethering systems	Footprint of the proposed Project where exposed surfaces and chains/cables are present.
Underwater sound and vibration	Disturbance from sound sources generated by proposed Project activities to a maximum estimated distance of 1 km (based on Popper *et al*., 2014 thresholds).
Effects to fish and shellfish from maintenance activities	See construction phase, noting that durations and extents of activities will be significantly reduced.
Decommissioning phase	
Potential effects the same as cable construction	Anticipated to be the same as the construction phase.

Table 20-28. Sensitivities of receptors to construction, operational and decommissioning impacts

Impact pathway	Location	Receptor	Sensitivity
Construction Phase			
Temporary direct loss and physical disturbance to fish habitats	Offshore Development Area	Herring	High
		Sandeel	High
		Shellfish	Medium to high
		Other marine fish	Low
Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition	Offshore Development Area	Herring	High
		Sandeel	Medium
		Diadromous fish	Medium
		Shellfish	Low
		Other marine fish	Low
Changes to marine water quality from the mobilisation of contaminants	Offshore Development Area	Fish and shellfish receptors	Low
Changes to marine water quality from the use of drilling fluids at HDD break-out points	OfECC only	Fish and shellfish receptors	Medium
Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils	Offshore Development Area	Fish and shellfish receptors	High
Underwater noise and vibration effects to fish and shellfish	Offshore Development Area	Marine fish	Low to high
	Offshore Development Area	Shellfish	Low
Operational Impacts			

Impact pathway	Location	Receptor	Sensitivity
Permanent direct loss and physical disturbance to fish and shellfish habitats	Offshore Development Area	Herring	High
		Sandeel	High
		Shellfish	Low
		Other Marine Fish	Low to medium
	Offshore Development Area	Herring and sandeel spawning grounds	Medium
		Shellfish	Low
Increase in thermal emissions from cable operation	Offshore Development Area	Herring and sandeel spawning grounds	Medium
		Shellfish	Low
Effects of EMF emissions	Offshore Development Area	Diadromous fish	Low
		Pelagic fish	Low
		Demersal fish	Low to medium
		Elasmobranchs	Medium
		Spawning, eggs, larvae and juvenile fish	Low
		Shellfish	Low
Disturbance effects to fish (such as barrier effects, collision and entanglement) from the presence of floating offshore structures and associated tethering systems	Array Area only	Fish and shellfish	Low
Underwater noise and vibration–- Vibration from the rotating	Array Area only	Fish and shellfish	Low to high

Impact pathway	Location	Receptor	Sensitivity
machinery in WTGs, transmitted into the water column			
Underwater noise and vibration–- Metal cable snapping	Offshore Development Area	Fish and shellfish	Low to high
Effects to fish and shellfish from maintenance activities	Offshore Development Area	Marine fish	Low to high
Decommissioning			
Temporary direct loss and physical disturbance to fish habitats	Same as construction	Same as above	Same as above
Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition	Same as construction	Same as above	Same as above
Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils	Same as construction	Same as above	Same as above
Underwater noise and vibration	Same as construction	Same as above	Same as above

20.8.1. *Construction Effects*

Temporary Direct Loss and Physical Disturbance to Fish Habitats

179. There are a number of construction activities that may cause temporary loss and/or physical disturbance to seabed habitats that could be important for fish and shellfish species (e.g. herring and sandeel) and damage less mobile receptors (e.g. eggs, larvae or some shellfish). The functional groups which have been considered as part of this impact pathway and a summary of their sensitivities are listed in **Table 20-28**.

180. Sensitivity to effects of habitat disturbance varies between receptors; mobile species and life stages have a greater capacity to accommodate such changes through movement to undisturbed areas while sessile or less mobile species/life stages are far less tolerant of disturbance, which may result in physical damage in some instances.

181. Migratory fish (e.g. salmon, sea trout, sea and river lamprey and European eel) are not considered to have functional associations with seabed habitats due to their life history strategies and transient presence within the Offshore Development Area, therefore potential effects of habitat disturbance and/or loss are not considered for this receptor group.

182. Pelagic spawners are considered to have low sensitivity to the temporary disturbance of the construction activities as recruitment of these species would be largely unaffected by direct disturbance of the seabed. As no distinguishable change from baseline conditions is expected for these pelagic receptors, they have been scoped out in relation to this effect.

183. Demersal species (e.g., cod, whiting, dover sole, plaice and sandeel) and demersal life stages (e.g., eggs, larvae, juveniles) are the most sensitive to effects from temporary direct loss of seabed habitat and physical disturbance. Herring and sandeel are likely to be particularly sensitive to removal and degradation of spawning habitat because of their specific sediment requirements.

184. Displacement is considered the most likely effect to adult life stages of demersal species from temporary direct loss and physical disturbance, although some physiological damage and/or mortality of less mobile shellfish species and demersal life stages such as eggs and, to a lesser extent larva of some species which exhibit high site fidelity, is probable.

All Offshore Infrastructure (OfECC and Array Area)

OfECC

185. The following activities could cause temporary disturbance within the OfECC:

- HDD pit excavation;
- Sand wave levelling (SWL) pre-installation – geotechnical survey data and design refinements will discern whether sand wave levelling is necessary (see **Figure 20-14)** for indicative sand wave levelling locations); and
- Cable burial for two cables electricity export cables using either jet-burial (preferred method) or cable plough.

186. Total area of potential disturbance within the OfECC has been calculated as 3,071,148 m^2.

Array Area

187. Activities occurring within the Array Area which could cause temporary disturbance, and the area of disturbance for each, include;

- Cable burial for 17.10 km of inter-array cable (cables not anticipated to be buried but this has been included to represent a worst-case scenario); and
- Installation of turbine anchors and mooring lines, various different methods may be used, but drilling of the anchors into the seabed is considered in this pathway as the worst-case scenario.

188. Total area of potential disturbance within the Array Area has been calculated as 427,500 m^2.

Overall

189. The total area of predicted temporary physical disturbance to habitats across the OfECC and Array Area has been calculated as 3.50 km^2 (3,498,648 m^2).

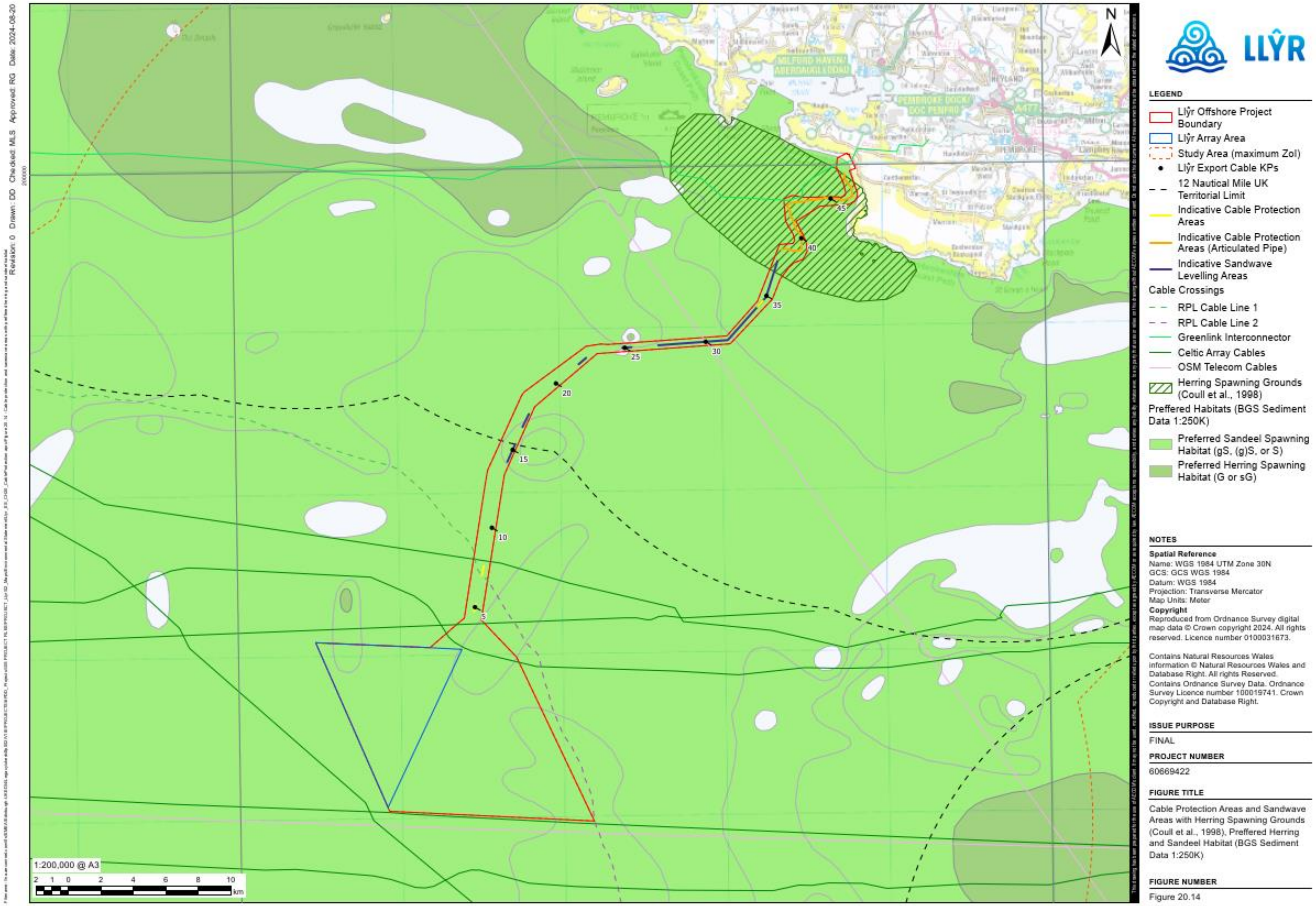

Figure 20-14. Cable protection areas and sand wave levelling areas with preferred herring and sandeel habitat

Herring

Magnitude of Impact

190. Cable preparation and installation activities which have the potential to temporarily disturb habitat, overlap an area identified as important herring spawning grounds by Coull *et al.* (1998) towards the mouth of the Milford Haven (as part of the OfECC – from KP 37 to KP 48). This area was also analysed as representing high to very high confidence in herring spawning. Despite this, this area was recorded as marginal herring spawning habitat, according to BGS sediment data (from KP 31 to KP 49). Marginal spawning habitat consists of the sediment class 'gravelly Sand', which is considered to have adequate sediment structure but is less favourable than preferred habitat. Furthermore, herring spawning has been identified as occurring further upstream in the Milford Haven rather than at the mouth of the estuary where there is potential for disturbance (Davies *et al.,* 2020a). There is no overlap of potential herring habitat associated with the Array Area and therefore no temporary loss of habitat associated with this element of the proposed Project.

191. Temporary disturbance as a result of cable construction activities overlapping this area of marginal herring spawning habitat, represents an area of 0.85 km^2 (or Primary Impact Zone (PIZ)[10], according to the MarineSpace, 2013, guidance on assessing effects on herring spawning habitat), which includes 0.33 km^2 of sand wave levelling. The spatial extent of temporary disturbance to herring grounds is considered low in the context of alternative available habitat surrounding the OfECC. This includes a large area of nearby habitat to the northwest of the cable corridor, which was identified as preferred habitat for herring spawning. Overall, the magnitude of effect to herring spawning grounds is considered to be **low**.

Sensitivity of Receptor

192. Herring are considered to be of high value (**Table 20-24**), representing an important food source for seabirds and marine mammals. Furthermore, herring spawning grounds are considered to have a **high** sensitivity to temporary physical disturbance, due to the potential for their egg mats, which have been laid on the seafloor, to be removed.

193. Herring lack site specific fidelity to spawning sites at a local-scale, which is driven in-part by the mobility of sediments in the nearshore. Given the location of the Project to the coastline, where the cable route overlaps potential herring spawning habitat, seabed sediments are expected to have a degree of instability. This is likely to improve the recovery time of this habitat following disturbance. Furthermore, the cable will be buried (rather than suffer scarring, such as that associated with dredging), meaning that the habitat at this location will return to previous conditions and will be available for herring to spawn at this location in the succeeding spawning period.

Significance of the Effect

194. Although the OfECC preparation and cable installation activities do occur within potential herring spawning grounds, disturbance of these habitats will be highly localised and temporary. This disturbance is unlikely to have a significant effect on overall herring abundance given the wider availability of more important spawning areas within the Study Area, the recoverability of the habitat, and the potential for spawning to occur at these

[10] The zone within which impacts resulting from the direct disturbance to seabed habitats, such as from the dragging the boulder clearance plough over the seabed surface occur – also known as the direct impact zone.

locations in the subsequent spawning season. Thus, the effect is predicted to be **minor** and therefore **Not Significant**.

Sandeel

Magnitude of Impact

195. The OfECC and Array Area passes through high intensity spawning grounds for sandeel, as designated by Ellis *et al.* (2012), with much of the offshore infrastructure passing through preferred habitat for sandeel (sand, gravelly sand, and slightly gravelly sand – as identified by BGS Sediment Data). Overall, the OfECC and Array Area was determined to comprise either medium or high confidence in sandeel habitat. These were not considered as very high confidence, due to the Study Area not being defined as an important spawning ground for sandeel by Coull *et al.* (1998).

196. Although the OfECC and Array Area overlaps with preferred habitat for sandeel, this habitat is widespread and found throughout the Celtic Sea. Hotspot maps for the presence of juvenile and adult sandeel within the Study Area were found to be more concentrated further towards the Bristol Channel and along the Cornwall coastline and less so in the location of the OfECC and Array Area (Campanella and van der Kooij, 2021).

197. Cable construction activities as part of the OfECC, are expected to result in the temporary physical disturbance of preferred sandeel habitat of an area of 2.44 km^2 (or PIZ, according to the MarineSpace, 2013, guidance on assessing effects on sandeel habitat), which includes 0.62 km^2 of sand wave levelling. The PIZ for the Array Area, overlaps a total of 0.43 km^2 of preferred sandeel habitat. This is considered small in the context of the wider availability of suitable sandeel habitat within the Study Area (which covers the majority of this area, see **Figure 20-14**), which is considered potentially more important for sandeel. Overall, the magnitude of effect to sandeel from temporary physical disturbance is considered to be **low**.

Sensitivity of Receptor

198. Sandeel are considered to be of high value, representing an important food source for seabirds and marine mammals. Furthermore, sandeel are partly benthic species, spending much of their life histories buried in the seabed, particularly in Autumn where they remain buried in the seabed, only briefly emerging to spawn between November and February. Due to their association with the seabed, including the deposition of their egg matts, sandeel are considered to have a **high** sensitivity to temporary physical disturbance. Furthermore, the high site fidelity exhibited by sandeel also increases its potential sensitivity to benthic habitat loss at sub-population levels (Jensen *et al.,* 2011).

199. However, sand is a highly dynamic sediment type (particularly in nearshore areas) and is expected to recover to normal conditions following disturbance. The cables will be buried (rather than suffer scarring, such as that associated with dredging), meaning that any sandeel habitat will return to previous conditions and will be available for sandeel at this location following disturbance.

Significance of the Effect

200. Overall, disturbance effects to sandeel are considered to be temporary, localised and small in spatial extent compared to the wide availability of alternative habitat within the Study Area. Therefore, the effect is predicted to be **minor** and **Not Significant**.

Shellfish

Magnitude of Impact

201. The temporary disturbance to shellfish habitat as a result of the OfECC and Array Area construction activities will be temporary and localised in nature and based on the small-scale disturbance footprint is predicted to be of **low** magnitude. This is compared to the wide availability of suitable shellfish habitat surrounding the OfECC and Array Area.

202. The OfECC and Array Area does not overlap with any identified rocky habitat, which would be suitable for species such as crabs and European lobster. The OfECC has been updated since the benthic surveys in 2022 / 2023 (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**), to avoid Turbot Bank, and additional surveys were undertaken in 2024 (**Appendix 19D: Drop down video survey 2024**) to define a route that avoids the designating features of the Pembroke Marine SAC (by determine the presence of Annex I reef and sandbanks). This survey identified a potential 'gap' through Annex I reef between KP 48 and KP 41.8, in which the cable would be installed so that it avoids these designated features.

203. The OfECC and Array Area overlaps with sediment comprised of predominantly sand and gravelly sand and therefore shellfish species such as scallops are most likely to be present and susceptible to temporary disturbance. Despite this, sand is widespread within the Study Area, meaning that there is a wide availability of alternative habitat for shellfish species.

Sensitivity of Receptor

204. Shellfish species including scallops and crab are more limited in their mobility than fish and are often less able to avoid or move away from areas where habitat disturbance is occurring. Some species are able to disperse over very short distances, while others are sessile. Due to these physiological constraints to dispersal, shellfish at all life stages are considered to have a **medium to high** sensitivity to physical damage associated with the route preparation and cable installation works (Tyler-Walters, 2007; Neal and Wilson, 2008; and Perry and Jackson, 2017).

Significance of the Effect

205. Due to the temporary and localised nature of construction activities and the small-scale disturbance footprint, the physical disturbance and/or temporary loss of shellfish habitat is predicted to be **negligible** and therefore **Not Significant**.

Other Marine Fish

Magnitude of Impact

206. Whilst other marine fish may be present (such as demersal fish species or species which deposit egg-cases and eggs or angelshark which can burrow in soft sediments), and some temporary avoidance of the affected area around the cable preparation and installation works is expected, disturbance will be temporary, short-term and limited in spatial extent. Thus, the impact of temporary physical disturbance to habitat is predicted to be of **negligible** magnitude.

Sensitivity of Receptor

207. All remaining fish receptors are considered to have a low to very high value and **low** sensitivity to temporary physical disturbance.

Significance of the Effect

208. Overall, disturbance associated with OfECC and Array Area construction activities will be temporary, short-term and limited in spatial extent. Thus, the impact of physical disturbance to and/or temporary loss of habitat is predicted to be **negligible** and **Not Significant**.

209.

Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition

All Offshore Infrastructure (OfECC and Array Area)

210. Construction activities associated with the proposed Project, such as ploughing and jet trenching, have the potential to temporarily increase SSC, through the disturbance of sediment and the subsequent creation of sediment plumes in the water column which can travel away from the Offshore Development Area before depositing sediment elsewhere on the seabed. These activities include cable burial and route clearance and preparation activities.

211. Several potential effects can arise from increased SSC and sediment deposition, including the clogging of gills and feeding apparatus, reduced feeding success of visual predators due to decreased visibility, the mortality of eggs and larvae which have a lower tolerance to turbid conditions, and effects related to toxic conditions if sediment-bound contaminants are disturbed. Fish migration and movement between important areas such as spawning and feeding grounds could also be impacted. The functional groups which have been considered as part of this impact pathway and a summary of their sensitivities are listed in **Table 20-28**.

212. The largest sediment plumes and highest levels of increased SSC are associated with the disturbance of sediments which have a high proportion of particulate matter, such as muds and clays. Such sediments remain in suspension for the longest and therefore travel the furthest distance from the source of disturbance, settling to the seabed more slowly. In comparison, coarser materials such as sand and gravel are expected to settle more quickly within a few hours of disturbance and within only a few tens of metres from the source (**Table 20-29; Chapter 18: Physical Environment**). The highest percentage of sediment in the OfECC and in the Array Area is made up of sand, suggesting that the majority of sediment particles which may be disturbed during construction are of a larger particle size. Therefore, impacts will be short term with sediment likely to settle to the seabed within hours of the disturbance.

213. The extent of sediment dispersion resulting from proposed Project pre-construction and construction activities has been calculated in **Chapter 18: Physical Environment**. The results of the assessment identified four main zones of effect based on the distance from the activity causing disturbance, which are summarised in **Table 20-29** (see **Chapter 18: Physical Environment,** see Section 18.9.1 for further detail).

Table 20-29. Zones of effect of increased SSC from offshore construction disturbance

Zone including distance from disturbance	At time of disturbance	More than one hour after end of disturbance
0 m – 50 m Zone of highest SSC increase and greatest likely thickness of	• Very high SSC increase (tens to hundreds of thousands of mg/l);	• No change to SSC; and • No measurable ongoing deposition.

Zone including distance from disturbance	At time of disturbance	More than one hour after end of disturbance
deposition. All gravel sized sediment likely deposited in this zone and large proportion of sands that are not resuspended high into the water column	• Lasting for duration of active disturbance plus up to 30 minutes following end of disturbance; • Sands and gravels may deposit in local thicknesses of tens of centimetres to several metres; and • Fine sediment unlikely to deposit in measurable thickness.	
50 m – 500 m Measurable SSC increase, measurable but lesser thickness of deposition. Mainly sands that are released or resuspended higher in water column and resettling to seabed	• High SSC increase (hundreds to low thousands of mg/l); • Duration of active disturbance plus up to 30 minutes following end of disturbance; • Sands and gravels may deposit in local thicknesses of tens of centimetres; and • Fine sediment unlikely to deposit in measurable thickness.	• No change to SSC; and • No measurable ongoing deposition.
500 m to tidal excursion buffer Lesser but measurable SSC increase, no measurable thickness of deposition. Mainly fines maintained in suspension for more than one tidal cycle.	• Low to intermediate SSC increase (tens to low hundreds of mg/l); • SSC caused by remaining fines in suspension; • Narrow plume (tens to few hundred metres wide); • SSC rapidly dispersing to ambient levels within one day after end of active disturbance; and • Fine sediment unlikely to deposit in measurable thickness.	**One to six hours after end of active disturbance** • Decreasing to low SSC (tens of mg/l); • Fine sediment unlikely to deposit in measurable thickness. **Six to 24 hours after end of active disturbance** • Decreasing gradually to background levels through dispersion; • Fine sediment unlikely to deposit in measurable thickness; and • No measurable change from baseline SSC after 24 to 48 hours following end of activities.
Beyond tidal excursion buffer	No expected impact or change to SSC nor a measurable sediment deposition.	N/A

214. Based on modelling undertaken, any measurable change in suspended sediment concentrations during construction will be temporary and localised, with the majority of

sediment consisting of sands and gravels which are expected to have deposited in tens of centimetres thickness on the seabed between 50 – 500 m away of the source of disturbance. Only 6% of the surveyed sediments across nearshore and offshore sections of the Offshore Project Boundary consisted of mud and therefore there is the potential for a very fine layer of mud to be deposited beyond 500 m during construction (**Chapter 19: Benthic Ecology, Section 7.5**). However, beyond 500 m it is expected that there will only be a low to intermediate increase in SSC (dispersing to ambient levels within one day following the activity), with fine sediment unlikely to deposit in any measurable thickness.

215. For the purpose of this assessment, the zone over which potential effects are likely to occur as a result of increased SSC and sediment deposition is within 500 m of disturbance. Referring to MarineSpace (2013) guidance on assessing effects to herring spawning and sandeel habitat, this is considered to be the Secondary Impact Zone (SIZ)[11] (**Figure 20-6** and **Figure 20-9**).

216. Several methods are incorporated into the cable layout design to minimise turbidity during the construction phase of the proposed Project. These are outlined in **Section 20.7** in further detail. Taking this into consideration, further assessment of the effect of increased SSC on fish and shellfish in the OfECC and Array Area is provided in the relevant sections below.

217. The sensitivity of fish species to conditions of increased SSC varies depending on whether they are demersal or pelagic, and their life stage. Some fish species occupying the subtidal and offshore waters of the Study Area are pelagic and/or of low sensitivity. These species have not been considered further within the assessment. However, herring and sandeel are demersal spawners and are regarded as being moderately sensitive to smothering effects from SSC, which can have implications on spawning success and recruitment (Kjelland *et al.,* 2015). Therefore, these species are considered further below. Other receptor groups assessed include shellfish and diadromous fish.

Herring

<u>*Magnitude of Impact*</u>

218. The SIZ area for cable preparation and installation activities as part of the OfECC, overlaps an area of 16.65 km^2 identified as marginal herring spawning habitat (from KP 31 to KP 49), in the nearshore area close to the mouth of the Milford Haven. The SIZ also included 0.02 km^2 of preferred spawning habitat, which represents a very small patch located near to KP 25. This area was analysed as having high to very high confidence in herring spawning. However, herring spawning is considered to occur further upstream in the Milford Haven rather than at the mouth of the estuary where there is potential for disturbance (Davies *et al.,* 2020a).

219. The area of potential disturbance from sediment deposition is considered small in the context of the wider availability of nearby suitable herring spawning habitat, such as a larger area of preferred habitat for herring spawning to the northwest of the OfECC. Furthermore, the majority of the sediment disturbed by construction and pre-construction activities will be deposited locally within 50 m (rather than up to 500 m, where there will be negligible levels of deposition), with thicknesses of up to tens of centimetres. The magnitude is therefore considered to be **low**.

[11] The footprint of effects arising as a result of the proposed installation and pre-installation activities not associated with the PIZ – also known as the indirect impact zone.

Sensitivity of Receptor

220. Sediment deposition on developing herring eggs has the potential to reduce oxygenation over the spawning period, with the potential to reduce the spawning success of the eggs due to limited gas exchange (Frost and Diele, 2022; Moyano *et al.,* 2023). Therefore, herring are considered to have a **high** sensitivity to increased SSC and sediment deposition.

221. Juvenile herring and spawning adults are highly adaptable to disturbance with a high rate of recoverability as they will return to spawning habitats once the disturbance has stopped. Furthermore, the area of suitable herring habitat over which sediment may be deposited, is likely to be dynamic given its location in the nearshore and the absence of fine silts. Deposited sediment is expected to be redistributed over short timescales, with recoverability of the spawning grounds anticipated.

Significance of the Effect

222. Although the OfECC preparation and installation does occur within potential herring spawning habitat, disturbance of these habitats will be highly localised and temporary. This disturbance is unlikely to have a significant effect on overall herring abundance given the wider availability of more important spawning habitat within the Study Area, the recoverability of the habitat, and the potential for spawning to occur at these locations in the subsequent spawning season. Thus, the effect is predicted to be **minor** and therefore **Not Significant**.

Sandeel

Magnitude of Impact

223. The SIZ area for cable preparation and installation activities as part of the OfECC, overlaps an area of 48.11 km^2 identified as predominantly preferred sandeel habitat, present across much of the cable route. The SIZ area for the Array Area, overlaps an area of 61.12 km^2 of preferred sandeel habitat.

224. Suitable sandeel spawning habitat identified in the nearshore and offshore benthic characterisation study (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**) is considered to overlap within the zone of highest SSC increase and sediment deposition (**Table 20-29**). However, based on the calculations provided in **Table 20-29**, this is only expected to last for the duration of the disturbance and for 30 minutes following the end of disturbance. Furthermore, the majority of the sediment disturbed by construction and pre-construction activities will be deposited locally within 50 m (rather than up to 500 m, where there will be negligible levels of deposition), with thicknesses of up to tens of centimetres. Therefore, the magnitude is assessed as **low**.

Sensitivity of Receptor

225. Sandeel eggs have the potential to be physiologically damaged due to increased SSC with the potential for mortality to occur for eggs in the vicinity of the sediment plume.

226. However, sandeel are a burrowing species, spending the majority of the year under the surface of the sediment (Van der Kooij, *et al.*, 2008). For example, the lesser sandeel (*Ammodytes tobianus*) spends the winter buried 20 – 50 cm deep in sand (Rowley, 2008). Eggs are also laid in the sand where they stick to sand grains, often in shallow waters (Rowley, 2008; Ruiz, 2008) where wave action is considered to regularly disturb the surrounding sediment.

227. As sandeel species spend a large proportion of time buried under sand, there is expected to be some habituation to increased levels of SSC and smothering, and habitats

would recover following potential disturbance. Therefore, sandeel are considered to be a receptor of high value and their sensitivity is assessed as **medium**.

Significance of the Effect

228. The area of potential sandeel spawning habitat disturbed as a result of increased SSC and deposition from the proposed Project construction activities is small in extent compared to the wide availability of preferred spawning habitat within the Study Area. Furthermore, sandeel are expected to have a degree of habituation to increased levels of SSC and smothering, particularly as the sediment to be disturbed as a result of the Project will also be predominantly sand. Overall, the impact is expected to be **minor** and **Not Significant.**

Diadromous Fish

Magnitude of Impact

229. The increase in SSC, turbidity and deposition associated with the proposed Project construction activities has the potential to be a barrier to migration between marine and freshwater environments. However, the majority of these species identified as part of the baseline have been shown to spend the majority of their time in the upper reaches of the water column, so are unlikely to encounter mobilised sediment which is most likely to occur in the bottom 5 m of the water column (**Chapter 18: Physical Environment**).

230. In addition, most of the rivers in the Study Area used by migratory fish are located more than 500 m away from the Offshore Development Area (such as the Milford haven) and therefore fall outside of the zone where increased SSC is likely to be highest (greatest SSC and deposition to occur within 50 m of the cable route). Due to the short-term nature of any increase in SSC occurring during the construction of the offshore project components, the magnitude of impacts of increased SSC is predicted to be **negligible**.

Sensitivity of the Receptor

231. The Offshore Development Area is located in the vicinity of several estuaries and rivers including the Milford Haven waterway, the Bristol Channel, River Teifi, River Tywi, River Taf, Eastern Cleddau, Western Cleddau and River Severn, which are used by migratory fish such as salmon, brown trout, sea and river lamprey, European eels and allis and twaite shad. Salmonids can be sensitive to increased SSC through the reduce vision of prey (Abbotsford, 2021). Such species are considered to be of **medium** sensitivity to increased SS, and of very high value.

Significance of the Effect

232. The increase in SSC, turbidity and deposition associated with the proposed Project construction activities will not result in a barrier to migration between marine and freshwater environments, with the nearest river mouth (Milford Haven), occurring outside of the ZoI for the Project. The effect to migratory fish species is predicted to be **negligible** and therefore **Not Significant**.

Shellfish

Magnitude of Impact

233. The increase in SSC is only expected to last for the duration of the disturbance and for 30 minutes following the end of the disturbance and therefore is likely to be very short-term. In addition, as the Study Area is dominated by sand and gravel, the highest increase in SSC is expected to occur within 50 m of the disturbance and therefore is anticipated to be very localised, with only small-scale increases in SSC and deposition expected beyond 50 m.

234. The overall magnitude of impacts to shellfish of commercial/conservation importance and shellfish beds created by an increase in SSC and deposition is considered to be **negligible**.

Sensitivity of the Receptor

235. Many crustacean species, including the edible crab and Nephrops which are present in the Study Area are known to have low sensitivity to, and be tolerant of, short-term increases in turbidity and SSC. Increased turbidity can affect shellfish foraging times, for example crabs have been observed spending more time searching for prey in periods of increased SSC due to decreased visual acuity (Wang, 2021). This can lead to avoidance behaviour when conditions become unfavourable to increase feeding success elsewhere (Neal & Wilson, 2008). Berried crustacean species including the edible crab and European lobster, also present in the Study Area, remain sedentary during egg-bearing, meaning they may be more sensitive to increased SSC and turbidity. During egg-bearing, avoidance of sediment disturbance may be more difficult. The eggs that are laid also require sufficient regular aeration, meaning a high level of deposition and smothering may have implications, making them likely to be highly sensitive to substantial levels of sediment deposition.

236. Mobile shellfish including crabs, scallops and lobsters are thought to tolerate a smothering depth of 5 cm over a month (Neal & Wilson, 2008). They can exhibit avoidance behaviour when conditions become unfavourable by moving away from the affected area and returning once the disturbance has stopped. Due to their mobility, adults are considered to have low sensitivity to increased SSC and its associated impacts.

237. Blue mussel beds were identified under the footprint of the proposed Project associated with biogenic reef on approach to the landfall at Freshwater West, identified in an area of rocky reef habitat (**Appendix 19A: Nearshore 2023 Benthic Survey Report;** and **Appendix 19D: Drop down video survey 2024**). Blue mussel exhibit suspension feeding to ingest organic particulates and dissolved organic matter (Tyler-Walters et al., 2022). Due to their feeding technique, they are usually found in areas of high suspended particulate matter and therefore are also regularly subjected to low-level smothering. In addition, the mussel beds in the Offshore Project Boundary are located in shallow waters where exposure to wave action and therefore disturbed sediments is expected to be high. Blue mussel beds were identified in an area of rocky habitat in the nearshore benthic characterisation study and additional habitat survey in Freshwater West (**Appendix 19A: Nearshore 2023 Benthic Survey Report;** and **Appendix 19D: Drop down video survey 2024**) and therefore the amount of suspended sediment such as sand and silt is expected to be very minor.

238. Overall, shellfish are considered a medium value receptor and are assessed as having a **low** sensitivity to increased SSC and deposition.

Significance of the Effect

239. Any deposition of sediment associated with the proposed Project, will be highly localised and short in duration and temporary. Shellfish species which may be present nearby will either be mobile and can move away from the area of disturbance or be habituated to sediment deposition and increased SSC, particularly those species which rely on suspension feeding. Overall, the effect is determined to be **negligible** and therefore **Not Significant.**

Other Marine Fish

240. The effects to all remaining fish and shellfish species identified in the Study Area, including general communities, caused by increased SSC is predicted to be of **negligible** magnitude for the construction phase of the proposed Project. Combined with the low to medium value of fish and shellfish and **low** sensitivity, the duration of temporary increased

SSC, and subsequent deposition of sediment, the effect is predicted to be **negligible** and therefore **Not Significant**.

Impact From Changes to Marine Water Quality From the Mobilisation Of Contaminants

All Offshore Infrastructure (OfECC and Array Area)

241. Sediment-bound contaminants including heavy metals and PAHs could have detrimental impacts on fish and shellfish when present in concentrations above relevant thresholds and resuspended during disturbance to the seabed. Impacts can include cell apoptosis in fish immune systems (Reynaud and Deschaux, 2006). During the nearshore and offshore benthic characterisation study (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**), arsenic was the only heavy metal to exceed Cefas Action Level (AL) 1. Naphthalene was the only PAH to exceed the Canadian Sediment Quality Guidelines (CSQG) threshold effect level (TEL). Elevated concentrations of arsenic and naphthalene occurred across the Offshore Development Area, but particularly in stations in the Array Area (See **Appendix 19B: Offshore 2023 Benthic Survey Report** and **Chapter 19: Benthic Ecology** for further information).

Magnitude of Impact

242. Contaminants are expected to be associated with finer materials such as silts and clays which make up a very low percentage of the total sediment composition in the Study Area compared to sands and gravels, which dominate. The majority of the sediment disturbed by construction and pre-construction activities will be deposited within 50 m, with limited measurable deposition of fine sediments beyond this distance and only a slight increase in SSC. The dilution processes over this distance are expected to result in very little or no detectable changes beyond 50 m, and therefore the area of affect is considered to be very small, with dilution of contaminants expected to occur rapidly if present. The magnitude of impact is therefore assessed as **negligible**.

Sensitivity of the Receptor

243. Natural disturbance to the sediment such as during storm events and periods of strong wave action will mobilise contaminants and subject fish and shellfish to temporary and localised changes in water quality. As a result, fish and shellfish will have a tolerance to moderate changes in the surrounding water quality, particularly those which are mobile and can easily move away from an area of disturbance. Therefore, sensitivity is assessed as **low**.

Significance of the Effect

244. Contaminants within the Study Area are low in concentration and limited in extent and if disturbed are unlikely to be above the occurred under natural conditions. Overall, the effect on fish and shellfish receptors from the disturbance of sediment-bound contaminants is **negligible** and therefore **Not Significant**.

Impact from Changes to Marine Water Quality from the Use of Drilling Fluids at HDD Break-Out Points

OfECC

245. The use of drilling fluids at the HDD breakout points in the intertidal zone of Freshwater West (see **Table 20-25**) could result in decreased water quality that can have effects on the health of fish and shellfish populations.

246. Any drilling fluids used will be selected from the OSPAR List of Substances/Preparations Used and Discharged Offshore (2021) which are considered to Pose

Little or No Risk to the Environment (PLONOR). Bentonite is a commonly used drilling fluid which consists predominantly of clay minerals and is therefore biological inert (OSPAR, 2019). A review by Aslan *et al*. (2019) found no lethal effects in molluscs and bivalves resulting from the use of bentonite, in realistic discharge conditions in an open marine environment.

Magnitude of Impact

247. Several measures will be adopted to minimise any release of drilling fluid, including adhering to relevant guidance and the use of inert muds (which are PLONAR) (see **Section 20.7**). HDD is expected to occur in the subtidal zone of Freshwater West, in areas of shallow water, where there is considerable wave action and tidal water movement. Constituents of the drilling fluids, including silt-clay sized particles such as bentonite have a maximum theoretical range of approximately 14 km, which is the tidal excursion on a mean tide in the nearshore area around the landfall and outside Milford Haven. However, discharged drilling fluid is expected to be subject to immediate dilution processes and rapid dispersal over this distance which will result in no detectable change from the baseline beyond 500 m (see **Chapter 18: Physical Environment,** see Section 18.9.1 for further detail). Any drilled solids released are also predicted to settle rapidly in the vicinity of the breakout and therefore, any effects are expected to be localised.

248. The drilling fluid discharges from HDD operations will be a small number of single events over a short period of time and rapidly dispersed in an open sea coastal environment. Only receptors in the immediate vicinity of the HDD breakouts are likely to be in contact with drilling fluids, which pose little or no risk to the environment.

249. Overall, the magnitude of impact to all fish and shellfish receptors from HDD fluids is predicted to be **negligible**.

Sensitivity of the Receptor

250. Sensitivity to the release of drilling fluids will vary between fish and shellfish receptors depending on species, life history and life stage. During the early life stages of pelagic species (e.g. eggs and larvae) sensitivity to toxicity in the water column is considered to be high. However, the bentonite used for the drilling fluid will be biologically inert and is considered as PLONAR. Juvenile and adult fish are highly mobile and therefore could temporarily move away from the affected area. Displaced individuals are likely to return once drilling fluids have dispersed, making them less sensitive. Due to the distance of the HDD breakout areas from any important rivers, migratory fish species are also considered to have low sensitivity to drilling fluid release. Overall, taking into consideration the low to very high value of receptors, sensitivity is assessed as **medium**.

Significance of the Effect

251. The drilling fluid used will be PLONAR, with the volume to be discharged in a worst-case scenario being very small (1,700 m^3). This is expected to be rapidly dispersed over a short period of time. Overall, the effect is considered to be **negligible** and therefore **Not Significant**.

Impact from Changes to Marine Water Quality as a Result of Accidental Leaks and Spills from Vessels, Including Loss of Fuel Oils

All Offshore Infrastructure (OfECC and Array Area)

252. The accidental release of fuels and oils and other pollutants could occur from the vessels associated with construction activities and any support vessels present. An accidental release of fuels and oils has the potential to negatively affect water quality in the Study Area, with subsequent impacts to fish and shellfish species and habitats. Vessels could have cleaning

fluids, oils, and hydraulic fluids onboard (as well as fuels), which could be accidentally discharged, releasing hydrocarbons and chemical pollutants into the surrounding seawater.

Magnitude of Impact

253. Minor spills could occur through several activities including leaking hydraulic hoses or during refuelling. However, such spills are expected to be small, consisting of only a few litres. If released into the marine environment these minor spills are expected to undergo rapid dispersion and evaporation when subjected to wave action, wind, currents and light, as well as degradation via bacterial action. Consequently, any small releases are likely to break up and disperse in a short space of time, resulting in little impact to the marine environment.

254. Larger spills, such as during collisions between vessels, have the potential to impact fish and shellfish, particularly if the spill is in shallow water. As part of proposed management plans in place to reduce the risk of collisions, vessels will be required to comply with the International Regulations for Preventing Collisions at Sea (1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (MARPOL Convention 73/78) specifically including compliance with Annex IV on pollution by sewage and prevention of air pollution by ships; and Annex V on pollution by garbage from ships with the aim of preventing and minimising pollution from ships. This will include Shipboard Oil Pollution Emergency Plans (SOPEP). These measures will be secured as part of the CEMP (**Section 20.7**).

255. With embedded mitigation and management measures in place the risk of an accidental spill occurring is very low and should an accidental spill or leak occur, it would be very small in extent and subject to immediate dilution and rapid dispersal within the marine environment. Overall, the likelihood of impact to all fish and shellfish receptors from accidental leaks and spills from vessels and equipment is predicted to be unlikely and therefore the magnitude is **negligible**.

Sensitivity of the Receptor

256. The sensitivity of fish and shellfish to accidental spills is considered to be **high** for larger spills. However, fish are expected to move away from any minor spills prior to the rapid dispersion of these pollutants.

Significance of the Effect

257. All effluent will be discharged in accordance with the applicable MARPOL Annex IV 'Prevention of Pollution from Ships' standards, and therefore the risk of an accidental spill is very low. If a leak did occur, it would be very small in extent and subject to immediate dilution and rapid dispersal within the marine environment. Therefore, the overall effect to fish and shellfish is predicted to be **negligible** and is **Not Significant**.

Underwater Noise and Vibration

All Offshore Infrastructure (OfECC and Array Area)

258. Several activities during the construction phase of the proposed Project will generate underwater noise. Underwater noise can be either impulsive or non-impulsive in nature. Impulsive sounds are those created by high-resolution seabed imaging sources, such as MBES and seismic, impact piling or explosions. Non-impulsive sounds, also known as continuous sound sources, are those created by dredging, drilling type activities and sound created by vessel movements, for example during use of dynamic positioning (DP).

259. Several factors influence the effect of anthropogenic noise on marine receptors, including intensity of the noise source (i.e. amplitude of the sound pressure wave), noise

duration, frequency, the surrounding environment (i.e. water depth, seabed features), and the sensitivity of the receiving fauna.

260. For underwater noise impact appraisals, the metrics used are sound pressure level (SPL) and sound exposure levels (SEL). The SPL is a measure of the amplitude or intensity of a sound and, for impulsive sound sources, is typically measured as a peak or root-mean-square (rms) value. In contrast, the SEL is a time-integrated measurement of the sound energy, which takes account of the level of sound as well as the duration over which the sound is present in the acoustic environment.

261. The noise characteristics of the proposed Project construction activities have been determined using a significant body of knowledge of many common noise generating activities for which there is an extensive range of values in the literature (**Table 20-30**). Where a range of noise source levels was found in the literature a reasonable but realistic worst-case level has been assumed.

262. Some methods of the proposed Project construction phase have not yet been determined. Therefore, all potential methods under consideration have been included in the assessment to determine a worst-case scenario.

Table 20-30. Characteristics of underwater noise sources generated by the construction phase of the proposed Project

Survey or installation activity	Operating Frequency (kHz)	Sound Pressure Level (dB re 1 µPa @ 1 m)	Sound Source Data Reference and Notes
Sub-bottom profiling (SBP)	0.5 – 12	238 SPL_{peak}	Equipment specification sheets (**Appendix 21B: Marine Mammals Noise Modelling**)
Swathe or multi-beam echo sounder (MBES)	170 – 450	221 SPL_{peak}	Genesis Oil and Gas Consultants (2011)
Side scan sonar (SSS) (e.g. EdgeTech 4200 Series)	300 – 600	226 SPL_{peak}	Genesis (2011) and equipment specification sheet
USBL (e.g. Innomar SES-2000)	21 – 31	207 SPL_{peak}	Equipment specification sheets
Cable lay vessel and anchor handling vessel	0.005 – 3.2	180 – 197 SPL_{rms}	Ross (1992) AT&T 2008)
Project support vessels including medium (50 m to 100 m) and small (<50 m) boats	Low to high frequency	160 – 180 SPL_{rms}	Genesis (2011) Richardson *et al*.(1995) OSPAR commission (2009)

Survey or installation activity	Operating Frequency (kHz)	Sound Pressure Level (dB re 1 µPa @ 1 m)	Sound Source Data Reference and Notes
Jet trenching, mechanical trenching	1 – 15	178 SPL_{rms} 181 SPL_{peak} 227 SEL_{cum24}	Nedwell, Langworthy and Howell (2003) Hale (2018)
HDD breakout	n/a	129.5 SPL_{rms}	Nedwell *et al*. (2012)
Rock placement	n/a	172 SPL_{rms}	Orsted (2018) Data from four in-situ measurements of rock placement by vessel Rollingstone
Impact piling, assuming maximum pile diameter of 3 m and a hammer power of 800 kJ, max 4 hours piling per site and max of 3 piles per 24-hour period	n/a	235 SPL_{peak}	Determined from correlation of pile diameter and sound levels reported for a 3 m diameter pile with an 800 kJ hammer strength (**Appendix 21B: Marine Mammals Noise Modelling**)
UXO explosions	n/a	Low order (charge weight 0.1 kg to 2 kg): 266.7 – 276.7 SPL_{peak} High order (charge weight 25 kg to 794 kg): 284.9 – 296.2 SPL_{peak}	Calculations provided within **Appendix 21B: Marine Mammals Noise Modelling**

Hearing and Impacts of Underwater Noise in Fish

263. Fish use sound for communication, prey location and predator avoidance, and thus it is an important environmental cue (Fay and Popper, 2000). Fish ears and the lateral line, also known as the acoustico-lateralis system, perceive underwater sound through sensitivity to vibrations. Swim bladders, which are gas-filled sacs, are also used for sound detection in some teleost or bony fish (Hawkins, 1993). Sensitivity to sound varies between fish species according to the frequency of the sound. Responses in fish to sound also vary depending on the presence and levels of noise within the range of frequencies which fish are sensitive to. For most fish species, any sound occurring above 1 kHz is not audible.

264. Sensitivity to noise, and therefore the potential for impacts to occur in fish are largely determined by fish physiology, and particularly whether a fish has a swim bladder, and uses that swim bladder to improve hearing sensitivity and range (Popper *et al*., 2014). Several categories of fish sensitivity to underwater noise have been developed (based on functional

hearing groups established by Popper and Hawkins (2019) using the presence/absence of morphological features which can be used when assessing impacts. These categories are described below:

- **High hearing sensitivity fish** – this category includes fish which use a swim bladder (or another gas volume) for hearing. These species can detect sound pressure and particle motion and are susceptible to barotrauma. They are sensitive to noise over a wide frequency range (approximately several kHz). Fish species which fall into this category and are present in the Study Area include herring, Allis shad, and twaite shad;
- **Medium hearing sensitivity fish** – this category includes fish which possess a swim bladder but do not use it for hearing. These species can only detect particle motion rather than sound pressure but are still susceptible to barotrauma. They are sensitive to a narrower range of frequencies. Fish species present within the Study Area which fall into this category include Atlantic salmon, sea trout and European eel, Atlantic cod, other Gadidae, and bluefin tuna; and
- **Low hearing sensitivity fish** – this category includes fish which do not possess a swim bladder or other gas chamber. They detect particle motion rather than sound pressure and are less susceptible to barotrauma. Fish species which fall into this category include flatfish, sharks, rays and skates, lamprey as well as some fish species such as sandeel.

265. The Study Area contains fish species which fall into all three of these categories, such as herring, protected migratory fish and elasmobranchs, and including commercially important pelagic fish.

266. Herring is of importance due to it being a high hearing sensitivity fish species (Popper et al., 2014), but also commercially and ecologically. Due to the presence of potential herring spawning grounds within the Study Area, potential effect of underwater noise in spawning herring, and eggs and larvae, are also scoped in for consideration.

267. Fish eggs and larvae are considered separately from adult fish in the threshold tables provided by Popper *et al.* (2014), because of their vulnerability, reduced mobility, and small size. There are though, very few peer-reviewed papers that discuss the responses of eggs and larvae to man-made sound (Popper *et al.,* 2014). Nevertheless, the species that have been studied appeared to have hearing frequency ranges similar to those of adults and similar acoustic startle thresholds (see Popper *et al.,* 2014 and references therein). The development of a swim bladder, or other gas bubbles, during the larval stage may render larvae susceptible to pressure-related injuries.

268. Despite this, effects to eggs and larvae are considered to occur over much shorter distances than effects to adults. Studies of effects from airguns suggest that eggs and larvae only in very close proximity (< 5 m; the most substantial effects occurring within 1.4 m for peak sound pressure levels of 220 to 242 dB re 1 µPa @ 1 m) to the sound source are likely to suffer mortality and tissue damage (Booman *et al.* 1996). Popper (2012) also concluded that damage caused to fish eggs and larvae from geophysical surveys and impact piling is assumed to be limited to the proximity of a sound source.

269. The impacts of underwater noise varies depending on several factors, including the level and character of the noise produced, the distance of the receptor from the source, and environmental features including water depth and seabed features. Potential effects have been summarised below:

- **Physical or physiological effects** – this includes mortality, non-recoverable and recoverable injury. Only in extreme cases, such as where fish are in close proximity to very high sound pressure levels, underwater noise is likely to cause physical injury including barotrauma such as rupturing of the swim bladder and subsequent death. Recoverable injuries such as haematomas, capillary dilation, and loss of sensory hair cells may still lead to death if they decrease fitness, and the animal is subject to predation or disease. Sudden changes in pressure are more likely to result in damage than gradual changes (Popper *et al*., 2014);

- **Auditory damage** – high intensity underwater noise can cause physical damage to the auditory system structures such as the inner ear, sensory hair cells and otoliths (Parvin, *et al.*, 2006). This can be either a temporary threshold shift (TTS) which is a reversible increase in the threshold of audibility at a specified frequency or a portion of an individual's hearing range;
- **Masking** – caused by interference with ecologically significant sounds and relates to behavioural responses. Some fish are known to use auditory cues, such as juvenile fish selecting healthy reef habitats on the basis of their sound signature but the consequences of masking for fish are still not well understood; and
- **Behavioural responses** – includes changes in movements, swimming direction, migration, feeding, breeding and displacement.

270. Underwater noise modelling (**Appendix 21B: Marine Mammals Noise Modelling**) was conducted for the construction activities of the proposed Project. This was calculated for different times of the year (February and August) due to the differences in sea state between these months (e.g. sea temperature, salinity, bathymetry). This allows a worst-case scenario to be assessed.

271. For the purpose of the underwater noise modelling, a threshold level for the onset of low-level behavioural responses in fish was assigned as 150 dB re 1 µPa. This is based on the US Fish and Wildlife Service (USFWS) works and is considered to be highly precautionary. However, this value has been used in the absence of any data in addition to the guidelines provided (Stadler and Woodbury, 2009). The thresholds for recoverable injury and TTS are provided by Popper *et al.* (2014) as SPL_{peak} and unweighted SEL metrics, which vary depending on the type of activity undertaken.

272. For most fish, sensitivity to sound occurs from below 100 Hz to several hundred hertz, or in a very few species, up to several thousand hertz (Mann *et al.,* 2001; Popper *et al.*, 2014). Those species with a swim bladder are sound pressure sensitive at the higher frequencies, and some species of clupeids (but not Atlantic herring) can detect sounds above 20 kHz (ultrasound) (Popper *et al.,* 2014). Therefore, for the purpose of this assessment, only construction activities that generates noise which falls within the hearing frequency for fish have been considered further.

Use of Sub-Bottom Profiling (SBP) During Pre-Construction Surveys

273. SBPs are used to undertake geophysical surveys of the seabed to determine seabed structure, water depth, the presence of any obstructions and to track the location of remotely operated vehicles (ROVs) (other geophysical survey equipment has not been considered as they fall outside the hearing frequency of fish). SBPs typically operate at frequencies <1 kHz and therefore are within the hearing range of fish.

Marine Fish

<u>Sensitivity of the Receptor</u>

274. High sensitivity fish species are present within the Study Area, such as herring, which are known to spawn within the Celtic Sea and within the Milford Haven. Diadromous fish species, such as Atlantic salmon and brown trout, are also present within the Study Area

(which make migrations to nearby rivers) and are predominantly medium sensitivity hearing fish, with the exception of Allis and Twaite shad which are high hearing sensitivity fish. These species are considered to have the following threshold values for continuous noise activities, such as the use of SBP:

- Recoverable injury: 170 dB re 1 µPa rms for 48 hr exposure;
- TTS: 158 dB re 1 µPa rms for 12 hr exposure; and
- Low-level behavioural response: 150 dB re 1 µPa rms.

275. Other species, such as sea and river lamprey, are considered to be low sensitivity fish, meaning they do not possess a swim bladder or other gas chamber and are less susceptible to barotrauma and behavioural disturbance.

276. Overall, the sensitivities considered for this assessment are **low** to **high**.

Magnitude of Impact

277. SBP is considered to have a SPL_{peak} of 238 dB re 1 µPa @ 1 m. The results of the underwater noise modelling (see **Appendix 21B: Marine Mammals Noise Modelling**) for SBP is provided in **Table 20-31**.

Table 20-31. Summary of impact ranges in metres at which SPL has fallen to threshold level for fish species exposed to sub-bottom profiler noise during the months of February and August

Fish Hearing Group	Impact	Threshold	February			August		
			Min	Max	Mean	Min	Max	Mean
Medium	Recoverable Injury	170 dB re 1 µPa rms for 48 hr exposure	78	100	98	78	100	98
High	TTS	158 dB re 1 µPa rms for 12 hr exposure	176	204	198	176	204	198
All Fish	Low Level Behavioural Disturbance	150 dB re 1 mPa rms	286	327	301	300	327	302

278. The maximum distance over which TTS could occur in high hearing sensitivity fish is 204 m in both February and August. This reduces to a maximum distance of 100 m for medium sensitivity fish, which is highly localised. However, **Chapter 21: Marine Mammals** has proposed that the Project geophysical survey will adhere to the appropriate JNCC guidelines (JNCC, 2017) developed for the protection of marine mammals, particularly the 'soft-start', which ensures sound levels only increase gradually allowing individuals to move away. This will mean that injurious impacts to fish will be avoided.

279. The SBP is predicted to result low-level behavioural disturbance within a maximum distance of 327 m for all fish hearing sensitivities. These distances are considered to be small in extent, with species such as diadromous fish able to avoid any area of potential disturbance whilst making their migrations to and from nearby rivers. These distances are not considered to act as a barrier to fish migration, including those species which use the Milford Haven

(which is approximately 3.8 km wide at the mouth of the river), such as Atlantic salmon or for twaite shad which are known to make migrations across the Celtic Sea (twaite shad are a high hearing sensitivity species). Furthermore, the survey will be temporary and variable in location, typically away from the mouth of Milford Haven. Overall, the magnitude of effect is considered to be **low**.

Significance of the Effect

280. Overall, underwater noise effects to fish from the SBP operations will be temporary and highly localised, even for high hearing sensitivity fish species. Effects could comprise limited avoidance behaviour such as moving away from the area of disturbance that would not be significantly different to wide ranging foraging and predator avoidance behaviour nor would this activity prevent fish migration into nearby rivers. Thus, the effect is predicted to be **minor** and **Not Significant**.

Impact Piling During Construction Works

281. Impact piling will be required to anchor the floating WTGs to the seabed, using pin-piles to attach the anchor chains. Impact piling generates underwater noise, which has the potential to result in mortality, injury, or behavioural disturbance to fish.

Marine Fish

Sensitivity of the Receptor

282. High sensitivity fish species are present within the Study Area, such as herring, Allis shad, and twaite shad, as well as medium sensitivity hearing fish, such as the diadromous fish species, Atlantic salmon and brown trout. These species are considered to have the following threshold values for impulsive noise activities, such as the use of SBP:

- Mortality and recoverable injury (low sensitivity fish): 213 dB re 1 µPa peak;
- Mortality and recoverable injury (medium and high sensitivity fish): 207 dB re 1 µPa peak; and
- Low-level behavioural response: 150 dB re 1 µPa rms.

Magnitude of Impact

283. Impact piling will consist of pin piling. The underwater noise modelling is based on each pin pile installation to last for four hours as a worst case and there will be eight anchors per WTG, with a total of ten WTG. Impact piling is considered to have a SPL_{peak} of 235 dB re 1 µPa @ 1 m.

284. The results of the underwater noise modelling (see **Appendix 21B: Marine Mammals Noise Modelling**) for the effects from impact piling is provided in **Table 20-32**. As fish are highly mobile species and are likely to swim away from the noise, the assessment for moving receptors was based on typical swim speeds for representative species for each sensitivity category, which are as follows (further detail regarding the representative speeds used within the model are provided within **Table 21B-7**, **Appendix 21B: Marine Mammals Noise Modelling**):

- Low hearing sensitivity fish: 1.10 m/s;
- Medium hearing sensitivity fish: 0.97 m/s; and
- High hearing sensitivity fish: 0.11 m/s.

285. It should be noted that fleeing speeds are likely to be greater than typical swimming speeds. However, data on fleeing speeds for fish are limited. Additional parameters used as part of the underwater modelling for impact piling are as follows:

- A generic protocol for a soft start procedure was used in the absence of a specific procedure for the project:
  - i.e. an initial source level of 13 dB lower that the maximum level, increasing in discrete steps of approximately 3.5 dB every 5 minutes to the maximum level after a 20-minute period (adapted from the nearby Erebus project).
- A minimum and maximum hammer energy of 50 kJ and 800 kJ;
- Piling in one location at a time;
- A maximum of four hours to drive one pile to the design depth; and
- One piling operation undertaken over a 24-hr period.

Table 20-32. Summary of impact ranges in metres at which SPL has fallen to threshold level for fish species exposed to impact piling noise during the months of February and August

Fish Hearing Group	Impact	Threshold	February			August		
			Min	Max	Mean	Min	Max	Mean
Low	Mortality / Recoverable Injury	213 dB re 1 mPa peak	0	0	0	0	0	0
Medium / High	Mortality / Recoverable Injury	207 dB re 1 mPa peak	0	0	0	0	0	0
All Fish	Low Level Behavioural Disturbance	150 dB re 1 mPa rms	23,547	30,672	26,050	19,273	27,257	22,749

286. The results of the underwater sound modelling show that the threshold for mortality and recoverable injury for all fish species, is only predicted to occur within 0 m from the sound source, with limited potential for effect. Additionally, the injury risk to fish and shellfish would be further reduced with the implementation of standard JNCC mitigation measures for piling (JNCC, 2010a) which have been proposed as part of **Chapter 21: Marine Mammals**.

287. Behavioural disturbance, such as avoidance behaviour could occur for all hearing sensitivity fish species within a maximum distance of 30.7 km and 27.3 km, for February and August, respectively. Based on these distances, there is potential for disturbance to occur within approximately 10 km of the mouth of Milford Haven and across part of the Celtic Sea, near the mouth of the Bristol Channel. The area of disturbance in not considered to overlap with important herring spawning grounds (a high hearing sensitivity fish), as identified by Coull *et al.* (1998), although there might be some minor overlap (2-5 km) with the area of BGS sediment identified as marginal potential herring spawning habitat.

288. Despite the parameters of the modelling estimated disturbance to occur over 80 days, in reality the duration of the piling works is expected to be much shorter in total. It is estimated that the maximum number of days when piling may occur during construction would be 45 days with a minimum of 20 piling days over the construction period. This assumes

up to six piles can be installed in one day. No more than one pile will be installed concurrently. The anticipated piling duration per day would range between 90 minutes and 180 minutes per pile and piles of this nature would require a maximum hammer energy of 800 kJ. Up to three driven piles will be used per WTG for the proposed Project, with a diameter of up to 3 m and penetration depth of up to 55 m.

289. Although fish may be disturbed for longer periods during the day, the overall duration of the works will be temporary and short term in duration (maximum of 45 days). Furthermore, these distances are based on low-level disturbance, for a threshold of 150 dB re 1 mPa rms which is overly precautionary. A high relative risk of behavioural disturbance to high hearing sensitivity fish species, was determined by Popper *et al.* (2014), to occur at intermediate distances (i.e. within hundreds of metres or <1 km), rather than thousands of metres. For medium and low hearing sensitivity fish, this is reduced to near distances (i.e. tens of metres).

Significance of the Effect

290. Fish in the Study Area are unlikely to experience mortality or injury from underwater noise produced by impact piling, particularly as there will be a soft-start procedure in place and fish are highly mobile and can move away from the noise source as it commences. Although there will be avoidance behaviour to the impact piling area of disturbance, this will be approximately 10 km away from the closest river mouth, the Milford Haven. Furthermore, impact piling will be short term and temporary, lasting a maximum of 45 days. Once the impact piling has stopped, fish are expected to return to the area (Popper and Hawkins, 2019). Overall, the effect is predicted to be **minor** and therefore **Not Significant**.

Unexploded Ordnance (UXO)

291. There is the potential for unexploded ordnance (UXO) to be identified within the Offshore Development Area and require detonation to be rendered harmless. Should UXO detonation be required there is the potential for the underwater sound to cause injury and disturbance to fish and shellfish.

292. Prior to construction there will be a full geophysical survey to determine presence of UXO and the need for any explosive objects to be cleared. An application for a separate Marine Licence in respect of UXO clearance will be made post submission, when the exact number and type of detonations have been established. However, an initial impact assessment of the effect of UXO detonation is included here, so that regulator opinion can received prior to the application submission. Once the size and number of UXO within the Offshore Development Area have been determined an updated risk assessment will be provided to support the Marine Licence and EPS licence applications.

Marine Fish

Sensitivity of the Receptor

293. There are some protected species known to be potentially present in the Study Area and there is potential for mortality and significant injury in fish from UXO detonation. These include Allis and twaite shad which are high hearing sensitivity fish species, with twaite shad known to make extensive migrations across the Celtic Sea to the Severn Estuary. Other high hearing sensitivity fish species present within the Study Area, include herring, which are known to spawn within the Celtic Sea and within the Milford Haven.

294. Injury and mortality to fish can occur in the immediate vicinity of the explosion from the compressive forces of the shock wave and also at more distant regions where negative

pressure and the reflection of the shock wave from the water surface can cause cavitation and negative pressures low enough to cause harmful expansion of swim bladders and other barotraumas, which may result in immediate or delayed mortality (Popper *et al.,* 2014). Fish without swim bladders are thought to be less likely to be affected unless in very close range of the detonation.

295. Popper *et al.* (2014) defines the threshold values for impulsive explosive noise for fish functional hearing groups as the following:

- Mortality and potential mortal injury (low to high sensitivity fish): 229 – 234 dB re 1 µPa SPL_{peak};
- Mortality and potential mortal injury (fish eggs and larvae): >13 mm/sec peak velocity.

296. Overall, the sensitivity of fish and shellfish to UXO detonation is considered to be **high**.

Magnitude of Impact

297. The results of the underwater noise modelling (see **Appendix 21B: Marine Mammals Noise Modelling**) for the potential effects to fish and shellfish from detonation of UXO has used the assumed range of charge weights (25 to 794 kg) provided as part of the nearby Erebus OWF (~20 km to the northwest of the Llŷr Project Area). Given the geographical proximity of the two developments, it is deemed appropriate therefore to work with the same charge weights that were agreed for the Erebus Project in the analysis undertaken for the Llŷr Project. It is important to consider a range of charge weights as different weights could conceivably yield different blasts on detonation, due to different degradation rates and burial in sediment.

298. A number of detonation techniques are now available, including both low-order and high-order clearance techniques. This assessment of clearance follows the Marine environment: unexploded ordnance clearance joint interim position statement (BEIS, 2022). Therefore, the potential impacts for both the unrealistic worst-case (high-order) and the realistic worst-case (low-order) have been presented.

299. The results of the underwater noise modelling (see Appendix 21B: Marine Mammals Noise Modelling) for the effects from UXO detonation is provided in Table 20-33.

Table 20-33. Summary of the impact distances based on the unweighted SPLpeak explosive noise criteria given by Popper et al. (2014)

Fish Hearing Group	Impact (dB re 1 mPa peak)	Detonation Charge Size					
		25 kg	55 kg	120 kg	240 kg	525 kg	794 kg
All groups	Mortality and potential mortal injury 234 dB	188	244	317	400	519	596
All groups	Mortality and potential mortal injury 229 dB	322	418	543	684	888	1,019

300. Using the worst-case scenario, i.e. based on the lower threshold value for risk of morality or potential mortal injury (229 dB re 1µPa SPL_{peak}) and the varying charge weights assessed from 25 kg to 794 kg. Mortality or injury could occur within 322 m to 1,019 m for all hearing sensitivity fish species. This is considered to be localised and very short in duration. At the point of UXO detonation the sound generated is a single short pulse, with a duration in

the order of milliseconds. The intensity of the sound is determined by the size and nature of the UXO, rather than the duration.

301. As part of **Chapter 21: Marine Mammals**, JNCC guidelines (JNCC, 2010b) will be adopted during UXO clearance activities to further minimise the potential risk of injury to marine mammals. These measures will also potentially reduce the risk to fish and shellfish species. Low order detonation techniques will also be adopted where possible and where multiple explosive charges are present, wherever possible, the smaller charges shall be detonated first to maximise the 'soft-start' effect.

302. Although no thresholds for behavioural disturbance have been provided, Popper *et al.* (2014) does provide broad distances over which TTS could occur from the detonation of explosives. Although onset TTS is not a behavioural disturbance metric, the use of the onset TTS is considered appropriate for UXO clearance disturbance assessments because the noise resulting from a clearance event is short lived in the environment (in the order of seconds) (Robinson *et al.*, 2022). Popper *et al.* (2014) reports that there is a high probability of TTS occurring at intermediate distances (i.e. hundreds of metres) for high hearing sensitivity fish and near distances (i.e. tens of metres) for all other hearing sensitivity fish species. Therefore, any behavioural disturbance will also be highly localised and very short in duration and fish can return to the area following detonation. If behavioural disturbance is greater than 1 km (i.e. above 3.8 km which is the distance to the mouth of the Milford Haven), then any effects will be momentary and therefore obstruction to migratory routes will negligible.

303. Overall, the magnitude of effect is considered to be **medium**.

Significance of the Effect

304. Given the mitigation measures and the short and intermittent nature of this activity (limited to instances when detonation of UXO is required) and that effects are most likely to be limited to the vicinity of the area where the detonation takes place, injury and behavioural disturbance is likely to affect fish at the individual level rather than whole populations. Thus, with the measures identified above the effect is predicted to be **minor** and therefore **Not Significant**.

Underwater Noise and Vibration Effects to Shellfish

Shellfish

Sensitivity of the Receptor

305. The impact of underwater noise on marine invertebrates including shellfish is relatively unknown, however it is thought that they are more sensitive to the particle motion rather than the sound pressure (Popper and Hawkins, 2019). At present there are no published sensitivity thresholds for this receptor group. However, many invertebrate species do have tactile hairs or mechano-sensory systems that are thought to respond to the particle displacement components of an impinging sound field and not to the pressure component (Popper *et al.*, 2001; Lovell *et al*., 2005; Spiga, *et al*., 2012).

306. Crustaceans, for example, are thought to detect the particle motion component of sound (Lovell, *et al*., 2005) and the prevalence of noise from aquatic crustaceans suggests it is important for communication between individuals (Spiga *et al*., 2012). Whilst there are a small number of studies indicating there is some potential for injury in adult or developmental stages of individual invertebrates this has only been demonstrated for animals in very close proximity (a few metres) to high intensity noise such as that from seismic airguns.

307. Several species of shellfish are considered to be present in the Study Area, including Nephrops, but most are considered to be present in small numbers. Noise from proposed Project construction activities is therefore unlikely to cause significant disturbance to shellfish species such as *Nephrops*. For example, the impact of sound on a shrimp fishery in Brazil indicated that shrimp stocks were resilient to the disturbance by seismic airguns (Andriguetto-Filho *et al.,* 2005) and as a burrowing species Nephrops has the ability to seek refuge from any disturbance should it occur by retreating back into their burrow system. All currently available evidence suggests that other shellfish species known to be present in the Study Area such as crabs, lobsters and scallops, have a similarly low sensitivity to underwater noise sources, particularly of the type generated by the cable construction activities (Wale, *et al.*, 2013; Spiga *et al*., 2012). Sensitivity of shellfish to underwater noise is therefore considered to be **low**.

Magnitude of Impact

308. Effects from underwater noise to shellfish as a result of the proposed Project are considered to be limited spatially and temporary in nature. This includes activities with the highest SPL values, such as sub-bottom profiling, impact piling, and UXO detonation. Overall, the magnitude of effect to shellfish is considered to be **negligible**.

Significance of the Effect

309. Considering the limited spatial and temporal extent of underwater sound from cable construction activities, combined with available evidence suggesting that shellfish have a low sensitivity to underwater sound, the impact is predicted to be **negligible** and therefore **Not Significant**.

20.8.2. Operational Impacts

Permanent Direct Loss And Physical Disturbance To Fish And Shellfish Habitats

310. The placement of hard substrates on the seafloor, including cable and scour protection, can result in the permanent loss of fish and shellfish habitats and species. The functional groups which have been considered as part of this impact pathway and a summary of their sensitivities are listed in **Table 20-28**.

311. Migratory fish (e.g. salmon, sea trout, sea and river lamprey and European eel) are not considered to have functional associations with seabed habitats due to their life history strategies and transient presence within the Study Area. Therefore, potential effects of permanent habitat disturbance and/or loss are not considered for this receptor group. This is also true of pelagic fish species and spawners, for which no distinguishable change from baseline conditions is expected, and they have been scoped out in relation to this effect.

312. There are several demersal species which are known to be present within the Study Area (e.g., cod, whiting, dover sole, plaice and sandeel). However, most of these demersal species are highly mobile, with wide distributions and broad habitat requirements meaning they have the capacity to exhibit avoidance behaviour and move into alternative available habitats nearby. Thus, although this receptor group is still considered for this impact pathway, this group are considered to have low sensitivity to permanent physical disturbance and/or loss of habitat due to placement of hard substrates on the seabed and have not been considered further.

313. Shellfish species, such as scallops are most likely to be present and susceptible to permanent loss of habitat and disturbance, and have been considered further within this assessment. Nephrops are also considered unlikely to be present, due to the lack of sandy mud and finer sediments identified within OfECC and Array Area.

314. The fish species which are deemed to be highly sensitive to permanent habitat loss are herring and sandeel as these are demersal spawners and exhibit specific habitat requirements for spawning (i.e., gravelly sediments for herring and sandy sediments for sandeel). Adult sandeel is also sensitive owing to the co-location of spawning and adult habitats and sediment requirements for burrowing.

All Offshore Infrastructure (OfECC and Array Area)

OfECC

315. Cable and scour protection, in the form of rock berms, grout bags or concrete mattresses are likely to be needed at some locations where the minimum cable burial depth of 0.8 m cannot be achieved. Introduction of hard substrate would replace the existing seabed, leading to the permanent loss of fish and shellfish habitats and species.

316. Until construction has commenced, it is not yet known specifically where cable protection and/or scour protection will be required along the OfECC. However, based on currently available data it has been estimated that a total distance of 1,600 m of each of the offshore export cables will require cable protection. Assuming a berm width of 5 m this will cover an area of 16,000 m^2 for both offshore export cables, with the majority of the cable protection predicted to be required in the nearshore area (**Figure 20-14**[12]).

317. Iron encased articulated pipe protection will be used to protect the cables in areas of constrained routeing options within the OfECC, such as but not limited to the 11 km of offshore export cables nearest to shore (between KP 48 and KP 38). The cable at this location will be routed so that it avoids surrounding Annex I reef through a point where a ‘gap’ has been identified. For both cables, the articulated piping will represent a total area on the seabed of 11,000 m^2.

318. There will also be protection requirements at the HDD punch-out point, estimated to be 100 m^2 and concrete mattressing has been assumed for the four known cable crossings (**Chapter 04: Description of the Proposed Project**) covering a 8,000 m^2 area.

319. Total habitat loss in the OfECC has been estimated to be 35,100 m^2.

Array Area

320. Sources of permanent habitat loss in the Array Area consist of:

- Placement of cable and scour protection;
- Clump weights are required for the mooring lines – it has been estimated that 25 weights will be required per mooring line, for eight mooring lines at each of the 10 WTGs;
- Anchoring will be provided by drag embedment anchors, which are buried below the seabed surface and do not result in permanent loss of habitat, but may require scour protection;
- Drilled pile anchors or drag embedment anchors – a worst-case scenario is 8 anchors per WTG; and
- Subsea connector – will be located on the seabed connecting the first and last turbine.

[12] Cable protection and sand wave levelling will be confirmed as part of the Cabal Burial Risk Assessment (CBRA) which will inform the Cable Specification and Installation Plan (CSIP). These will be completed post-consent and approved by NRW prior to any works commencing.

321. Thus, the total footprint of habitat loss within the Array Area is estimated to be 56,084 m^2. The Array Area is dominated by sandy substrate with varying compositions of gravel and small contributions of mud.

Overall

322. The total area of predicted permanent physical disturbance to habitats across the OfECC and Array Area has been calculated as 0.091 km^2 (91,184 m^2).

Herring

Magnitude of Impact

323. The proposed cable and scour protection for the proposed Project, overlaps an area identified as important herring spawning grounds by Coull *et al.* (1998) towards the mouth of the Milford Haven (as part of the OfECC – from KP 37 to KP 48). This area was recorded as marginal potential herring spawning habitat, according to BGS sediment data (from KP 31 to KP 49). Despite this, herring spawning has been identified as occurring further upstream in the Milford Haven rather than at the mouth of the estuary where there is potential for disturbance (Davies *et al.,* 2020a).

324. Cable and scour protection overlapping this marginal habitat (including the HDD exit points), across the OfECC (there is no permanent loss of potential herring habitat as part of the Array Area), represents an area of 16,070 m^2 (or 0.016 km^2). This includes protection required at the HDD punch-out point. No cable crossings have been identified as overlapping potential herring spawning habitat at this location. The spatial extent of permanent habitat loss of herring grounds is considered low in the context of alternative available habitat surrounding the OfECC. This includes a large area of nearby habitat to the northwest of the cable corridor, which was identified as preferred habitat for herring spawning. There is no loss of herring spawning habitat associated with the Array Area. Overall, the magnitude of effect to herring spawning grounds is considered to be **low**.

Sensitivity of Receptor

325. Herring are considered to be of medium value, representing an important food source for seabirds and marine mammals. Furthermore, herring spawning grounds are considered to have a high sensitivity to permanent direct loss and physical disturbance; however, herring lack site specific fidelity to spawning sites at a local scale, meaning they can move to alternative nearby suitable habitat. Therefore, the sensitivity of spawning herring and their eggs is considered to be **high**.

Significance of the Effect

326. The permanent placement of cable and scour protection on the seabed leading to the loss of potential herring spawning habitat is predicted to be low in spatial extent in the context of more suitable spawning habitat to the northwest of the OfECC and known grounds within Milford Haven. Overall, the effect is predicted to be **minor** and therefore **Not Significant**.

Sandeel

Magnitude of impact

327. The OfECC and Array Area passes through high intensity spawning grounds for sandeel, as designated by Ellis *et al.* (2012), with much of the offshore infrastructure passing through preferred habitat for sandeel (sand, gravelly sand, and slightly gravelly sand – as identified by BGS Sediment Data).

328. The areas of the OfECC that fall within this area of suitable sandeel spawning habitat which require cable and scour protection, as well as concrete mattress protection for four cable crossings, represents an area of 34,570 m^2 (0.035 km^2). There is an additional permanent loss of habitat of 56,084 m^2 associated with the Array Area. In total, there is predicted to be a loss of 90,654 m^2 (or 0.091 km^2) of potential preferred sandeel spawning habitat.

329. Although the OfECC and Array Area overlaps with preferred habitat for sandeel, this habitat is widespread and found throughout the Celtic Sea. Hotspot maps for the presence of juvenile and adult sandeel within the Study Area were found to be more concentrated further towards the Bristol Channel and along the Cornwall coastline and less so in the location of the OfECC and Array Area (Campanella and van der Kooij, 2021). Overall, the magnitude is considered to be **low** in the context of the wider availability of habitat.

Sensitivity of Receptor

330. Sandeel are considered to be of high value, representing an important food source for seabirds and marine mammals. Furthermore, sandeel are partly benthic species, spending much of their life histories buried in the seabed, particularly in Autumn where they remain buried in the seabed, only briefly emerging to spawn between November and February. During spring and summer, when sandeel are actively feeding, they tend to remain within 10 km of their grounds (Wright *et al.,* 2019). Due to their association with the seabed, including the deposition of their egg matts, sandeel are considered to have a high sensitivity to permanent physical loss and disturbance of habitat. The high site fidelity exhibited by sandeel also increases this species potential sensitivity to benthic habitat loss at sub-population levels (Jensen *et al.,* 2011). Therefore, the sensitivity of sandeel spawning grounds is considered to be **High.**

Significance of the Effect

331. Given the wider availability of potential sandeel spawning habitat within the Study Area, the placement of hard substrates on the seabed for the proposed cable and scour protection is considered to be highly localised. The effect is predicted to be **minor** and therefore **Not Significant**.

Shellfish

Magnitude of Impact

332. The OfECC and Array Area overlaps with sediment comprised of predominantly sand and gravelly sand and therefore shellfish species such as scallops are most likely to be present and susceptible to permanent loss of habitat and disturbance. Despite this, sand is widespread within the Study Area, meaning that there is a wide availability of alternative habitat for shellfish species.

333. The OfECC and Array Area does not overlap with any identified rocky habitat, which would be suitable for species such as crabs and European lobster. The OfECC has been updated since the benthic surveys in 2022 / 2023 (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**), to avoid Turbot Bank, and additional surveys were undertaken in 2024 (**Appendix 19D: Drop down video survey 2024**) to define an offshore export cable route that avoids the designating features of the Pembroke Marine SAC (by determine the presence of Annex I reef and sandbanks). This DDV survey identified a potential 'gap' through Annex I reef between KP 48 and KP 41.8, so that the cable would be laid so that it avoids these designated features.

334. Nephrops are also considered unlikely to be present, due to the lack of sandy mud and finer sediments identified within OfECC and Array Area.

335. Although a small proportion of shellfish habitat would be lost under the footprint of the permanent cable protection, there would be no overlap with known or designated shellfish beds and therefore the impact of cable protection on associated shellfish populations would be of **negligible** magnitude.

Sensitivity of Receptor

336. Commercially important shellfish such as brown crab and scallop are considered to be moderately sensitive to permanent habitat loss (Neal and Wilson, 2008; Marshall, 2008). Some crustaceans (e.g. crabs and European lobster) may benefit from the addition of artificial hard substrates (in the form of cable and scour protection), providing additional refuge and new potential sources of food (Taormina *et al.,* 2020). Thus, the overall sensitivity of shellfish of commercial and/or conservation importance is considered to be **low**.

Significance of the Effect

337. There would be no overlap of cable and scour protection with known or designated shellfish beds and any permanent loss of habitat would be highly localised compared to the wider availability of habitat and for some receptors would provide refuge and additional sources of food. Therefore, the effect of permanent loss of habitat is predicted to be **negligible** and **Not Significant**.

Other Marine Fish

Magnitude of Impact

338. The placement of hard substrates on the seafloor in the OfECC and Array Area will result in the permanent loss of habitat for other fish and shellfish habitats and species. For example, flatfish such as plaice and sole exhibit a preference for sandy substrates, which is a sediment recorded across much of the Offshore Development Area. Other fish species, such as the elasmobranch angelshark, are known to be associated with soft sandy sediment, sometimes burrowing within the sediment. However, the extent and scale of the impact is considered to be small when considering the wider availability of suitable habitats within the Study Area, including sandy substrates which are widespread. Thus, the permanent placement of hard substrates on the seabed leading to effects to flatfish and other marine fish, is predicted to be of **negligible** magnitude.

Sensitivity of Receptor

339. All remaining fish receptors are considered to have a **low** to **high** value and **low** to **medium** sensitivity to permanent loss of habitat.

340. For other fish species which occupy or utilise rocky habitats, studies have shown that these species may benefit from the additional of artificial substrates, most likely due to the increase in habitat complexity (i.e., refuge) and increased epifaunal communities which provide food resource (Wilhelmsson *et al.,* 2006a and 2006b; Taormina *et al.,* 2020). This is particularly relevant to the proposed Project, given that the majority of rock placement will occur in sandy habitats. These fish species are therefore considered to have low sensitivity to habitat loss associated with the placement of rock or concrete mattresses as subsequent habitat and food resource may be available on the structures themselves.

Significance of the Effect

341. The extent of the impact is local in comparison to the wide distribution and availability of suitable foraging grounds for fish. Therefore, the effect of permanent habitat loss on this receptor is assessed as **negligible** and **Not Significant**.

Increase in Thermal Emissions from Cable Operation

All Offshore Infrastructure (OfECC and Array Area)

342. Submarine power cables are known to produce heat during operation which when buried in the seabed, can increase the temperature of surrounding sediment (Emeana *et al*., 2016). This increase in temperature in substratum temperature can affect fish and shellfish receptors, particularly those which are sediment swelling and demersal (Taormina *et al*, 2018). The full effects of temperature changes on sediment composition and biogeochemical cycles are unknown, but there have been preliminary studies which have suggested that such increases in temperature may have an impact on temperature responsive bacteria (NRW, 2020), including changes to bacterial community composition and nitrogen cycling (Hicks *et al*., 2018).

343. Sediment particle size composition has been identified as an influence on heat transfer in sediments (Emeana *et al*., 2016). Coarse silts were found to experience the greatest temperature change but only to a short distance from the heat source. This compares to fine and coarse sands which experienced a lower temperature change but at a greater distance from the heat source. The OfECC and Array Area predominantly consist of sandy habitat with varying percentages of gravel and mud, and therefore the influence of thermal emissions is expected to vary but be limited overall.

344. The proposed Project consists of up to two electricity export cables transmitting electricity from the WTGs to the shore over a distance of 55 km. The offshore export cables will be buried within separate trenches 10 m apart, with a target depth of 1.2 m (but a minimum burial depth of 0.8 m). In addition, there will be inter-array cables linking the WTGs with a total length of 17.10 km, although some of the cables will be dynamic within the water column.

345. The temperature associated with buried cables decreases with distance from the cable, decreasing rapidly with distance. Therefore, if a target burial of 1.2 m is reached, any increase at the sediment surface or in shallow sediment depths at which infaunal species are typically found is expected to be small and likely to be only a few degrees higher than ambient temperature (compared to approximately 50°C at the direct vicinity of the cable). For example, in a modelling study of a 525 kV HVDC cable (a much higher power output than those to be used for the proposed Project), buried to a target depth of 1.2 m, the maximum temperature increase at a sediment depth of 30 cm was predicted to be 1.68°C (Stammen, 2020). If the burial depth is decreased to 0.8 m, then any further changes to temperature are considered to be negligible. Sea water temperature in the Celtic Sea varies seasonally and therefore small variations due to thermal emissions from the cable can be accommodated by fish and shellfish receptors, which are likely to only occur at the very surface of the sediment.

346. Only species which have life history stages associated with the benthos are considered further in this assessment (such as herring and sandeel spawning grounds, and shellfish). Therefore, the focus of the assessment is on demersal spawners, such as herring and sandeel, as well as shellfish species as these are considered to be the receptors which have the highest potential to be affected by the effect of thermal emissions.

Herring and Sandeel Spawning Grounds

Magnitude of Impact

347. Both herring and sandeel lay eggs on top of the seabed rather than within the sediment and therefore are not considered to be at risk of thermal heating of sediment. In the top layers of the sediment, significant sediment heating is expected to be minimal, and is unlikely to result in effects to herring or sandeel individuals or eggs laid in the OfECC or Array Area. As a result, thermal impacts on spawning grounds are considered to be of **negligible** magnitude.

Sensitivity of the Receptor

348. Herring do not spend large proportions of time on the seabed, rather they lay demersal eggs (predominantly gravelly sediments). Whereas sandeel spend a large proportion of their time burrowed in sediments (Van der Kooij *et al.*, 2008). In comparison to herring, sandeel have a preference for habitat with a high percentage of medium to coarse sand (particle size of 0.25 mm to 2 mm) and a mud content of less than 10% (particles <63 µm) (see **Spawning and Nursery Grounds**). They are typically associated with sandbanks (MarineSpace Ltd, 2013) and due to their habitat preferences, their distribution is often patchy. Due to their association with the seabed, both herring and sandeel are considered to have a **medium** sensitivity to thermal increases.

Significance of the Effect

349. Thermal heating is expected to be minimal in upper sediment depths greater than 30 cm, where sandeel are expected to be buried (or herring egg mats on the surface). Overall, the effect is considered to be **negligible** and **Not Significant.**

Shellfish

Magnitude of Impact

350. The Study Area is important for a number of commercial species including scallops, although this species is not known to burrow in sediment. Nephrops create extensive but shallow systems of branching unlined burrows to a depth of around 20 cm and therefore is considered to represent a worst-case scenario of the increase in thermal emissions on shellfish. There is little potential for increase in sediment temperature from thermal emissions to impact individuals, based on estimates of thermal heat changes in the upper 30 cm of sediment. Furthermore, the benthic survey did not identify *Nephrops* in the Study Area (**Appendix 19A: Nearshore 2023 Benthic Survey Report** and **Appendix 19B: Offshore 2023 Benthic Survey Report**), and only 0.74 tonnes of *Nephrops* were landed in 2022 in the ICES rectangles in which the Study Area is located (MMO, 2023.

351. Therefore, the magnitude of the impact is considered to be **negligible**.

Sensitivity of the Receptor

352. Due to the shallow depths at which shellfish species such as nephrops are expected to burrow within the Study Area, the sensitivity of shellfish is assessed as **low**.

Significance of the Effect

353. Any thermal effects to the sediment as a result of the cables, will be limited to depths very close to the cable (target burial depth of 1.2 m and minimum burial depth of 0.8 m) and will be contained to the location of the cable route only. Thus, for all shellfish species, the effect of thermal emissions is considered to be **negligible** and therefore **Not Significant**.

Effects of EMF Emissions

All Offshore Infrastructure (OfECC and Array Area)

354. Subsea cables associated with the proposed Project, including both the inter-array cables and export cables, are known to produce EMF emissions (Hutchison *et al*., 2020) and have the potential to affect the foraging and migratory success and behaviour of electro-receptive species (such as elasmobranchs), migratory fish (such as salmon), and shellfish. When assessing the effect of EMF, several factors should be considered, including the design of the cable, the surrounding environmental conditions including water movement, and species sensitivities (Gill *et al*., 2023).

355. The design of the proposed Project includes up to two electricity export cables transmitting electricity from the WTGs to the shore over a distance of 55 km. The export cables will be within separate trenches 50 m apart with a target burial depth of 1.2 m, and a minimum burial depth of 0.8 m. However, this could increase to a maximum burial depth of 3 m where required. Where it is not possible to bury the cable, and cables will be surface laid, cable protection will be used. In addition, there will be IACs with a total combined length of 17.10 km (which will be a combination of buried and dynamic in the water column), with a worst-case scenario of 20% cable protection required.

356. EMF emissions will occur for the operational lifetime of the proposed Project from the export cables and inter-array cables. The findings from the project-specific EMF Assessment (see **Appendix 19C**: **EMF Assessment Report**) demonstrate that for an export cable buried 0.5 m below the seabed, the EMF emissions impacting on a receptor on the seabed are predicted to have a magnetic field density of 50.5 µT (microtesla). The magnetic field density decreases to 4.3 µT for a receptor located 1 m above the seabed, and 0.1 µT for a receptor which is 2 m from the seabed.

357. As cable burial depth increases to 1.25 m, EMF emissions decrease (noting for the Project the target burial depth is 1.2 m, with a minimum burial depth of 0.8 m). When a cable is buried 1.25 m below the seabed, the maximum magnetic field density acting upon a receptor at the seabed surface is predicted to be 2.6 µT. This decreases to 0.8 µT when a receptor is 1 m above the seabed, and 0.05 µT when 2 m above the seabed. Given the low level of EMF emissions predicted, if the burial depth is reduced to 0.8 m, any changes in EMF emissions are considered to be negligible and similar in effect to that provided in the modelling.

358. The highest EMF emissions are expected to occur where cable crossings are located. However, elevated EMF emissions at cable crossings are expected to be highly localised, and cable protection can assist in mitigating against considerable adverse effects.

359. When cables are exposed in the water column, for example dynamic cables between the seabed and the floating platforms, the magnetic field density at the cable surface is predicted to be ~5.2 mT (millitesla). The induced electric field from the surface of exposed cables is predicted to be ~5.4 mV/m, which is considered to be the worst-case scenario. At 0.44 m from the centre of the cable, the induced electrical field strength will be approximately equal to the earth's magnetic field (approximately 51.5 µV/m). At a distance of 2 m from any of the cables required for the proposed Project, EMF effects are reduced to negligible.

360. Water depths in the Array Area range between 85 m – 65 m below LAT, and 65 m – 0 m below LAT along the OfECC (see **Chapter 18: Physical Processes**). Water becomes shallower towards the landfall at Freshwater West. Therefore, for the majority of the OfECC, species occupying the upper layers of the water column are not considered to be at risk of exposure

to EMF emissions above background levels. In addition, only marginally elevated field strengths are expected to be present in shallow waters less than 2 m deep.

361. Exposure to EMF emissions which have been artificially created have been observed to cause several impacts, including reduced swimming speeds in migrating European eel (Westerberg and Lagenfelt, 2008), attraction to magnetic fields in free swimming trout larvae (Formicki *et al*., 2004), and reduced swimming speeds and attraction to the cables in several species of elasmobranch (Gill *et al*., 2009). Species which use electromagnetic perception for prey detection, including elasmobranchs, may also suffer from reduced foraging success due to EMF exposure.

362. A review of other offshore wind developments around the UK with export and inter-array cables of similar or high voltage to the proposed Project, has concluded that effects of EMF emissions from offshore wind farms are limited. For example, initial EMF modelling conducted for the Pentland floating OWF, located off the coast of Dounreay in Caithness, concluded that both buried and protected cables, and in-water dynamic cables would produce EMF effects below the natural variation of the earth's magnetic field (Peterson, 2022). With a proposed burial depth of 0.6 m (less than the minimum burial depth for the Project) and a 66-kV cable, an EMF level of 0.73 µT was predicted at 1 m from the buried cables, which reduces to 0 µT at 5 m from the buried cables (Peterson, 2022). The modelling for the Pentland floating OWF determined that benthic receptors, such as demersal fish species, were unlikely to detect any notable change due to EMF emissions, even without burial of the cable.

363. The Awel y Môr Offshore Wind Farm on the coast of North Wales, UK, used an export cable with a maximum system voltage of 400 kV, and concluded that any EMF would rapidly attenuate away from the cable and would be at strengths which are unlikely to result in impacts to fish and shellfish (RWE Renewables UK, 2022). The Coastal Virginia Offshore Wind Commercial Project on the eastern Atlantic coast of the United States assessed the impacts of nine 230 kV export cables and 66kV inter-array cables, and determined that any EMF emissions would be below thresholds of detection in electrosensitive and magnetosensitive receptors and impacts would be negligible (Bureau of Ocean Energy Management Office of Renewable Energy Programs, 2023).

364. Ecological impacts caused by EMF from subsea power cables are thought to be very limited or absent (Sinclair *et al*., 2023). However, sensitivity to EMF emissions differs between species and groups of fish and shellfish, and therefore the effect of EMF emissions created by the proposed Project is assessed by receptor group below. The functional groups which have been considered as part of this impact pathway and a summary of their sensitivities are listed in **Table 20-28**.

Diadromous Species

<u>*Magnitude of Impact*</u>

365. The increase in background EMF as a result of the proposed Project is considered to be restricted to a small area around the cables. Migratory species spend a large amount of time in the upper reaches of the water column away from the seabed and given the majority of the proposed Project is in deep water up to 85 m, it is expected that any changes in EMF will be avoided by migratory fish species. Freshwater West (where water depths are shallower) is a bay and therefore is thought to be outside of the typical migratory paths for fish. However, even in very shallow water, marginally elevated field strengths are only expected to be present in waters less than 2 m deep. As such, the area where EMF emissions from the cables have the potential to affect diadromous fish is extremely limited. Thus, the impact of EMF exposure is considered to have a **negligible** magnitude overall.

<u>*Sensitivity of the Receptor*</u>

366. The proposed Project is in the vicinity of several estuaries and rivers which are important habitats for migratory fish species in the Study Area (see **Section 20.5.7**). There is some evidence to suggest that diadromous fish species change their direction and sometimes geographic position to avoid features which fall in the main magnetic field of cables (Klimney *et al*., 2021).

367. Although disturbance to migratory fish is not well understood, a review of literature suggests that significant responses are expected to be limited, and any reactions are only anticipated in the immediate area of the proposed Project. Diadromous fish have shown distinct directional and behavioural reactions to magnetic fields, such as reduced swimming speed in European eels (Westerberg and Begout-Anras, 2000; Öhman *et al*., 2007; Westerberg and Lagenfelt, 2008).

368. Conversely, studies of juvenile salmon which had to cross a cable emitting EMF have shown no significant differences in behavioural reactions and migration success (Wyman *et al*., 2018). In addition, biotelemetry studies of migrating European eels showed that the location of a subsea cable did not create a strong barrier to migration movements, with only brief changes in direction shown in small numbers of fish (Westerberg and Begout-Anras, 2000).

369. On this basis, it is concluded that diadromous fish have a **low** sensitivity to EMF.

<u>*Significance of the Effect*</u>

370. Considering the shallow depths in which significant changes in EMF are likely to occur, migratory fish are unlikely to demonstrate behavioural changes to EMF, particularly for those species which migrate in the upper water column. In conclusion, the effect of EMF emissions on diadromous species is considered to be **negligible** and therefore **Not Significant**.

Pelagic Species

<u>*Magnitude of Impact*</u>

371. The Study Area consists of several commercially important pelagic species including herring, sprat, and bluefin tuna. As these species are pelagic, their association with the seafloor is limited and therefore they are unlikely to come into contact with any increase in EMF emissions beyond background levels that may occur in a small area around the proposed Project. Therefore, the magnitude of EMF emissions on pelagic fish is considered to be **negligible**.

<u>*Sensitivity of the Receptor*</u>

372. The pelagic nature of these species indicates they are unlikely to come into contact with, or are able to easily avoid, any increase in EMF in a small area around the cable. Even for benthic feeding pelagic fish the zone of influence for EMF is restricted to a distance of a few tens of metres and is unlikely to limit access to prey as foraging grounds are widespread and readily available. Additionally, pelagic fish are known to swim continually, often covering several kilometres daily and so the time spent in the vicinity of the cables will be limited. Pelagic species are thought to have low sensitivity to EMF and there was no evidence found to suggest that clupeids or scombrids are able to detect EMF or are affected by it in anyway (Snyder *et al.*, 2019). Thus, the sensitivity of pelagic fish to EMF is considered to be **low**.

Significance of the Effect

373. The pelagic nature of these species indicates they are unlikely to come into contact with, or are able to easily avoid, any increase in EMF in a small area around the cable. Therefore, the effect on pelagic species is considered **negligible** and **Not Significant**.

Demersal Species

Magnitude of Impact

374. The maximum EMF produced by the proposed Project is not expected to cause major behavioural responses in demersal fish. Magnetic fields are expected to rapidly reduce as distance increased from the cable (Sinclair *et al*., 2023). Therefore, any behavioural responses which do occur are expected to be minor with very localised avoidance of the immediate area of the proposed Project (within 2 m of proposed Project cables). EMF emissions are anticipated to have little influence on demersal teleost species and therefore, the magnitude of the effect is considered to be **negligible.**

Sensitivity of the Receptor

375. Several teleost demersal species (excluding elasmobranchs) are present in the Study Area, including sandeel, hake, haddock, plaice and sole (see **Other Demersal Species**). Such species spend a large amount of time on or above the seabed, potentially exposing them to increased EMF generated by the proposed Project cables (Hutchison *et al*., 2018).

376. There is a knowledge gap on how sensitive demersal species are to increased EMF emissions. However, some species are known to benefit from magnetic fields. For example, plaice use magnetic fields as navigational cues (Metcalfe *et al*., 1993). Field data from surveys investigating the effect of an offshore windfarm in the Kattegat area of the Baltic Sea, concluded that EMF was unlikely to alter cod behaviour. This was based on observations of fish aggregating within the vicinity of cables during both active and inactive electricity transmission over several years in comparison to reference areas (Bergström *et al.*, 2013; Hammar *et al.*, 2014).

377. On balance the evidence indicates that some individual fish may avoid the area of EMF around the cable, but this will be limited. Therefore, a **low to medium** sensitivity has been assigned on a precautionary basis.

Significance of the Effect

378. EMF emissions will be highly localised in nature and may result in very limited avoidance of the area of effect by demersal fish species. However, there are some knowledge gaps and the sensitivity of demersal species to EMF emissions is unclear. Overall, it is considered that EMF generated by electricity transmission will have a **negligible** effect on demersal teleost fish populations and is therefore **Not Significant**.

Elasmobranchs

Magnitude of Impact

379. Behavioural responses are only expected to occur over a small area within 2 m of the OfECC and therefore will be highly localised and the magnitude of impact is considered to be **low**. Any effects which do occur will be highly localised (within 2 m) and will not interfere with any key functional activities, with only mild behavioural responses anticipated.

Sensitivity of the Receptor

380. The Study Area includes habitat which supports angelshark and basking shark. Blue shark and several other shark and ray species including lesser spotted dogfish, thornback ray

and common stingray have also been observed in the Study Area. Elasmobranchs are considered to be particularly sensitive to EMF due to their use of an electrosensory system and naso-olfactory apparatus for prey detection, predator avoidance and locating mates, for which magnetic fields are used (Hutchison *et al*., 2018).

381. Laboratory experiments to determine the effect of exposure to EMF on the lesser spotted dogfish reported that individuals were attracted to EMF field strengths that corresponded to prey items but were repelled by the fields mimicking the full strength of a cable in operation (Gill & Taylor, 2001; Gill, *et al*., 2009). Mesocosm experiments using a cable with a conductor cross section of 16 mm^2, the ability to carry 600 V to 1000 V and rated from 25 A to 730 A to assess influences on lesser spotted dogfish and thornback ray found that dogfish dispersed around the enclosure before and after the cable was active and aggregated within two meters of the sunken cable when it was active indicating an attraction (Gill, *et al*., 2009). However, the study found no significant difference in the distribution of thornback rays between the active and inactive periods of cable operation, suggesting different behavioural response between elasmobranch species (Gill, *et al*., 2009). Behavioural conditioning studies have shown that the lesser spotted dogfish cannot discriminate between artificial and natural DC electric fields. If this behavioural response is common among elasmobranchs, then it might explain why some sharks and rays are known to bite submarine cables (Newton, Gill, & Kajiura, 2019).

382. There is little evidence of the effect of EMF emissions on angelshark. As angelshark are known to burrow in sediment, there is a higher risk of exposure to increased emissions of EMF. Angelshark prefer sandy habitats, which covers a wide area of seabed in the Study Area (see **Chapter 19: Benthic Ecology**). However, angelshark are found over a depth range up to 150 m (OSPAR, 2010), which is beyond the depth range of the proposed Project. Furthermore, the area potentially affected by EMF emissions is considered to only cover a very small proportion (i.e. within 2 m of the OfECC and IACs) of the wider available suitable habitat for angelshark in the Study Area.

383. Basking shark, and other elasmobranchs which are pelagic species, are considered to have a lower risk of exposure to EMF as they will spend a large proportion of time in the upper reaches of the water column rather than near the seabed. Such species may experience some EMF effect in shallow water, but they are expected to exhibit avoidance behaviour and use other surrounding suitable habitat nearby.

384. Benthic elasmobranchs such as skates and rays have a higher risk of encountering effects of EMF. For example, studies have assessed the response of little skate *Leucoraja erinacea* to EMF at different background levels from the Cross Sound subsea cable (Hutchison *et al*., 2018). Response to EMF varied with little skate traveling between 20% and 90% further from the cable compared to individuals in control conditions, depending on the level of EMF being emitted. Other observed responses included slower swimming speeds, more time spent closer to the seabed and a higher proportion of large turns. However, this was determined as typical exploratory behaviour and it was concluded that the cable did not act as a barrier to skate movement.

385. In conclusion, elasmobranch species have a medium to high value and a **medium** sensitivity to EMF.

Significance of the Effect

386. Behavioural responses are only expected to occur over a small area within 2 m of the OfECC and therefore will be highly localised. However, Elasmobranchs are considered to be

particularly sensitive to EMF and therefore the effect is considered to be **minor** overall and is **Not Significant**.

Spawning, Eggs, Larvae and Juvenile Fish

387. The proposed Project is located in spawning grounds for sandeel and herring. Any EMF disturbance from the cable has the potential to disrupt fish behaviour such as spawning and could have a direct impact on the eggs, larvae and juveniles of these species.

Magnitude of Impact

388. Due to the limited effects of EMF emissions expected in the direct vicinity of Project cables, rapid dissipation of EMF from the cables, the wide area considered suitable for sandeel habitat and smaller areas suitable for herring spawning within the Study Area and Celtic Sea (see **Figure 20-9 and Figure 20-11**), any effects to herring and sandeel spawning, eggs and larvae are expected to be highly localised and only applicable to larvae within 2 m of the Project cables. Therefore, the magnitude is assessed as **negligible**.

Sensitivity of the Receptor

389. Laboratory studies to investigate the effect of exposure to EMF on eggs, larvae and juveniles have been carried out on a number of fish species. Bochert and Zettler (2004) reported no impact on survival in juvenile flounder exposed to magnetic fields with a strength of 3,700µT for a period of four weeks and Woodruff *et al.* (2012) reported no significant effect on survival for Atlantic halibut larvae exposed to EMF with a strength of 3,000 µT for a period of 27 days. Rainbow trout eggs and larvae exposed to EMF with a strength of 10,000 µT for a period of 36 days did not show any significant effects on mortality, growth or development (Fey *et al.,* 2019).

390. The magnetic field strengths tested in these laboratory experiments are considerably higher (by two to three orders of magnitude) than those likely to be encountered by eggs and larvae even in the immediate vicinity of the cable. This is consistent with the findings of a recent review of available literature on the effects of marine renewable energy on marine animals (Copping *et al.,* 2020). The study reports that the evidence to date suggests that the levels are unlikely to keep animals away from their preferred habitats or to affect migration and there are no reports of significant effects in eggs, larvae or juvenile fish.

391. More recent studies into the effect of magnetic fields generated by the cables of offshore wind farms on lesser sandeel larvae identified that larvae exposed to magnetic fields of up to 150 µT has been shown to not affect spatial distribution of the larvae or result in behavioural changes to swimming speed or movement (Cresci *et al*., 2022). The magnetic field used in this study is also much higher than the modelled maximum magnetic field expected to be generated from proposed Project cables (70 µT). Therefore, sensitivity of spawning, eggs, larvae and juvenile fish from EMF exposure is assessed as **low**.

Significance of the Effect

392. Any effects to herring and sandeel spawning, eggs and larvae from EMF are expected to be highly localised and only applicable to larvae within 2 m of the Project cables. Overall, the effect is considered to be **negligible** and is therefore considered to be **Not Significant**.

Shellfish

Magnitude of Impact

393. Any effects to shellfish on the seabed are expected to be highly localised, limited to the immediate vicinity around the proposed Project cable route (i.e. less than 2 m). The

numbers of shellfish in the Study Area which could come into contact with elevated EMF emissions is, therefore, considered to be small. Due to the limited area of seabed likely to be affected compared to the overall available habitat in the surrounding wider marine environment, the magnitude is assessed as **negligible**.

Sensitivity of the Receptor

394. Several commercially important shellfish species are considered to be present in the Study Area and within the footprint of the proposed Project, including Nephrops, European lobster, crab species, common whelk and scallops.

395. There was no evidence of negative EMF impacts to bivalve molluscs (whelk and scallops) found in the literature. Research on nudibranch molluscs has shown they are able to detect changes in geomagnetic fields, but it is not understood if or how this is interpreted outside of prey detection (Wang *et al.*, 2004). Further research on nudibranch molluscs shows that exposure between 100 µT and 500 µT EMF improved immune response with no negative impact on physiology or behaviour (Zhang *et al.,* 2020). However, despite being in the same phylum, the physiology of nudibranchs is dissimilar to that of bivalves. Nudibranchs possess some adaptations bivalves do not and have evolved relative sensitivity for active foraging or hunting, as opposed to sessile filter feeding. Following a review of available literature, there is also little evidence of significant concerns in relation to EMF effects on molluscs.

396. Several experiments have tested the effect of EMF exposure on edible crab in terms of stress and behavioural responses. EMF strengths of 250 µT were found to cause limited physiological and behavioural responses, whereas higher EMF strengths of 500 µT and 1000 µT detected small stress responses in histological indicators (Scott *et al*., 2021). The maximum EMF exposure resulting from the proposed Project is expected to be much smaller than these values, with the worst-case increase predicted to be 70 µT (where a cable is not buried). Crabs have been shown to have a clear level of attraction to elevated EMF levels (Scott *et al*., 2021), but this has not been shown to impact overall crab movements (Love *et al*., 2017). Such attraction has also been observed in European lobster (Scott, 2019; cited in Harsanyi *et al*., 2022).

397. The impact of EMF exposure to both edible crab and European lobster during embryonic development has been studied (Harsanyi *et al*., 2022). During incubation of eggs, female edible crabs will exhibit very little movement and lower feeding rates. Both species are also considered to inhabit scour protection zones around cables due to their ability to act as an artificial reef (Langhamer and Wilhelmsson, 2009; Hunter and Sayer, 2009). Given their attraction to artificial EMF, there is concern over the impact elevated EMF levels could have on eggs during the development stage (Harsanyi *et al*., 2022). Exposure to 2.8 mT EMF levels throughout the embryonic development stage resulted in decreased carapace height, decreased total length and decreased maximum eye diameter for larvae of both edible crab and European lobster. Lobster larvae also experienced reduced swimming test success and an increased occurrence of larval deformity. However, there were no significant differences in development time from 50% developed to hatching between control conditions and exposure to EMF (Harsanyi *et al*., 2022). It should be noted that the field strength used in this study was orders of magnitude higher than those expected to occur during the proposed Project for buried cables, and EMF effects for exposed cables are predicted to be negligible within 2 m of the cable.

398. The overall sensitivity of this receptor is assessed as **low**.

Significance of the Effect

399. Any effects from changes in EMF to shellfish would be localised and therefore all impacts in the ZoI are considered to be highly localised. Overall, the effect is considered to be **negligible** and **Not Significant**.

Disturbance Effects to Fish (Such as Barrier Effects, Collision and Entanglement) from the Presence of Floating Offshore Structures and Associated Tethering Systems

Array Area

Magnitude of Impact

400. The floating platforms and associated infrastructure on the seabed in the Array Area, including chains and anchor points may act as aggregation devices for fish and shellfish, particularly in the colonisation of infrastructure by bivalve shellfish present in the Study Area, such as blue mussels. There are some patches of blue mussel beds located in Milford Haven Waterway and in the nearshore are of Freshwater West (**Chapter 19: Benthic Ecology**).

401. The anchor chains which secure the WTGs to the seafloor may also provide a risk for collision and entanglement of several important fish species, including basking shark and bluefin tuna. The collision risk is considered to be highest during periods of high flow, as the platforms will create an area of lower water velocity behind them, which may attract fish seeking refuge from the higher flows (MarineSpace Ltd, 2019; Blue Gem Wind, 2021). Any infrastructure on the seabed, such as cables, are considered to provide a negligible risk of collision and entanglement as they will be buried, or protected with cable protection measures, and stationary.

402. In terms of collision and entanglement risk, there will be a maximum of eight mooring lines per WTG, for which there will be 10 WTGs (total of 80 mooring lines). The exact dimensions of mooring lines have not yet been determined; however, the diameter will be thin and therefore they are unlikely to act as a barrier to fish species. For example, the diameter for inter-array lines used in the Pentland Floating Offshore Wind Farm are 300 mm (Petersen, 2022). The additional mooring lines are also considered to be very small in number are not considered to greatly increase the risk of collision. In addition, the mooring chains will be taught or semi-taut in the water column to maintain the position of the floating platform and is not considered to be capable of forming loops.

403. The area of the Array Area is also very small and unlikely to act as a barrier to migrating fish species in the Celtic Sea, which is expansive.

404. There is the potential for entanglement of species such a basking shark within ghost (discarded) fishing gear and debris which could become caught on the mooring systems. Entanglement in ghost gear is considered to be a large global threat to basking shark with the potential for mortal injury (Wilson and Wilding, 2017). It is acknowledged in available literature that fishing gear can become caught on mooring systems for floating offshore renewable energy technologies and result in entanglement of marine species such as basking shark (e.g. Harnois *et al.*, 2015; Garavelli *et al.*, 2020). However, regular cable inspections will be carried out as part of the mitigation measures provided for marine mammals (**Chapter 21: Marine Mammals**) to ensure that any ghost fishing gear caught on the mooring systems is identified and removed. With this in place, the risk of entanglement of basking sharks in ghost fishing gear attached to the mooring lines is considered to be low.

405. As a result, the magnitude of impact resulting from entanglement and collision with proposed Project infrastructure is considered to be **low**.

Sensitivity of the Receptor

406. Colonisation of offshore infrastructure such as offshore wind farms by blue mussel is common (Zupan *et al*., 2023), as the hard surface of the WTGs and associated infrastructure provides an 'artificial reef'. However, the faecal pellets and other organic matter produced by the biofouling organisms can build up around the footprint of the WTGs and result in changes to the biochemistry and ecosystems in the surrounding areas, for example by altering Total Organic Carbon concentrations (Ivanov *et al*., 2021). It can also result in an increase in detritovore biomass, which can increase the number of apex predators in the Study Area (Raoux *et al*., 2017; cited in MarineSpace Ltd, 2019). However, the available surface area for colonisation on floating platforms is considered to be lower than that for fixed foundation WTGs and so any colonisation is considered to be limited.

407. Basking shark are considered to be more vulnerable to entanglement in mooring systems associated with offshore renewable energy developments due to their large size and foraging habits (Garavelli *et al.,* 2020), as they forage with their mouths open when swimming and therefore are susceptible to entanglement across the mouth (Knowlton and Kraus, 2001; Johnson *et al*., 2005; both cited in Benjamins *et al*., 2014; Blue Gem Wind, 2021). However, basking shark are a very mobile species and therefore are considered able to avoid entanglement of mooring systems.

408. Therefore, fish receptors are considered to be of **low** sensitivity to this impact pathway.

Significance of the Effect

409. The risk of entanglement is considered small, given the small number of mooring chains required for the Array Area and the small area over which this is located. The impact to fish receptors is considered to be **negligible** and therefore **Not Significant**.

Underwater noise and vibration

410. During operation of the proposed Project, underwater noise can be produced from both the WTGs (non-impulsive), and from cables that may 'snap' as cable tension is released in the mooring system (impulsive).

411. The noise characteristics of the proposed Project operational activities have been determined using a significant body of knowledge of many common sound generating activities for which there is an extensive range of values in the literature (**Table 20-34**). Where a range of noise source levels was found in the literature a reasonable but realistic worst-case level has been assumed.

Table 20-34. Characteristics of underwater noise sources generated by the operation phase of the proposed Project

Survey or construction activity	Operating Frequency (kHz)	Sound Pressure Level (dB re 1 µPa @ 1 m)	Sound Source Data Reference and Notes
Vibration from the rotating machinery in the WTGs, transmitted into the water column	<1 kHz	118 dB SPL_{rms} at 150 m from the largest turbine	Barham and Mason (2021)

Survey or construction activity	Operating Frequency (kHz)	Sound Pressure Level (dB re 1 µPa @ 1 m)	Sound Source Data Reference and Notes
Mooring equipment noise including 'bangs, creaks and rattles' and snapping noise	Up to 20 kHz	167.2 SPL_{peak}	Based on predominant windspeed of 20 knots at Llŷr Array Area (~10 m/s) and 7^{5t}h percentile from Burns *et al.* (2022)
Metal cable snapping		SEL_{cum} of 157 dB re 1 µPa^2s over 24 hours at 150 m	Xodus (2015) (Referred to in Erebus Supplementary Environmental Information Addendum Report)

412. Noise generated by mooring equipment is considered to fall outside of the hearing range of fish based on their operating frequencies and noise source levels and therefore are not considered to pose any risk to injury or disturbance. Therefore, they have been scoped out.

413. Vibration from the rotating machinery in the WTGs and metal cable snapping are considered to occur within the hearing range of fish and therefore are considered further in this assessment.

414. The hearing and impacts of underwater noise in fish have been described in Hearing and Impacts of Underwater Noise in Fish.

Vibration from the rotating Machinery in the Turbines, Transmitted into the Water Column

Marine Fish

Sensitivity of the Receptor

415. High sensitivity fish species are present within the Study Area, such as herring, Allis shad, and twaite shad, as well as medium sensitivity hearing fish, such as the diadromous fish species, Atlantic salmon and brown trout. Overall, the sensitivity of fish and shellfish to underwater vibration from rotating machinery is **low to high**.

Magnitude of Impact

416. During the operational phase of the proposed Project, vibrations generated from the running of the WTGs can propagate into the surrounding water column. As floating WTGs are anchored to the floor, they have a reduced radiating area compared to monopiles and fixed foundations (MarineSpace Ltd, 2019). This is due to the smaller weighted and buoyant section resting beneath the sea surface (Barham and Mason, 2021).

417. Tougaard *et al.* (2020) report that noise at windfarms in Denmark and Sweden was only measurable above ambient background noise at frequencies below 500 Hz. More recent measurements by Tougaard *et al.* (2020) indicate that acoustic source levels are at least 10-20 dB lower than ship noise in the same low frequency range. The underwater noise assessment conducted by Erebus (Barham and Mason, 2021) also concluded that sound and vibration measurements relating to the WTG operating would be dominated by background sound from shipping lanes.

418. Modelling of the impact of underwater noise as a result of WTG operation, including vibration from rotating machinery in the WTGs, concluded that any sound produced is expected to be very low and would not be above the threshold for disturbance in fish (**Appendix 21B: Marine Mammals Noise Modelling**).

419. Overall, the noise produced by the vibration from the rotating machinery in the WTGs, is not expected to be above ambient or above that produced by shipping vessel noise and would not elicit any behavioural responses from fish. The magnitude of effect is considered to be **negligible**.

Significance of the Effect

420. Overall, the effect of underwater noise produced by the vibration from rotating machinery in the WTGs is expected to be highly localised and is not expected to be above ambient noise levels and therefore is expected to be **negligible** and **Not Significant**.

Metal Cable Snapping

Marine Fish

Sensitivity of the Receptor

421. High sensitivity fish species are present within the Study Area, such as herring, Allis shad, and twaite shad, as well as medium sensitivity hearing fish, such as the diadromous fish species, Atlantic salmon and brown trout. Overall, the sensitivity of fish and shellfish to underwater noise is **low to high**.

Magnitude of Impact

422. Cable snapping can occur when tension which has built up in the mooring lines of the floating WTGs is released. This can also generate particle motion, which is known to be a key acoustic stimulus in fish, including larvae and juveniles (Popper *et al*., 2014).

423. Cable snapping was not assessed in the modelling of impacts from underwater noise (**Appendix 21B: Marine Mammals Noise Modelling**) as there was no spectral data available for this feature and hence it was not possible to include. However, the noise produced is considered to result in SEL_{cum} of 157 dB re 1 µPa2s over 24 hours. This is considered to be below the threshold for any effects to fish and shellfish species.

424. This is supported by MarineSpace Ltd (2019), which also found noise produced by cable snapping to be below the threshold for PTS or injury to fish, based on assessments conducted by the Hywind Scotland Pilot Park Project (Xodus, 2015). Overall, the magnitude is considered to be **negligible**.

Significance of the Effect

425. Overall, the underwater noise effects of metal cable snapping are not considered to be above the threshold for effects to fish and shellfish. Therefore, the impact is considered to be **negligible** and **Not Significant**.

Effects to Fish and Shellfish from Maintenance Activities

All Offshore Infrastructure (OfECC and Array Area)

426. Maintenance activities and cable repair where required, will be carried out using the same or similar methods as cable construction, and therefore the potential pathways for impact to fish and shellfish ecology would be the same as those identified for the construction phase of the proposed Project.

Marine Fish

427. Repair works are likely to be highly localised to the area of concern and therefore the spatial extent of any impacts would be small in extent. Furthermore, any maintenance or repairs works would be of a significantly shorter duration. A WCS is for up to five cable repairs assumed to be required over the lifetime of the proposed Project.

428. The only exception is where cable protection would be required (where rock had not been placed previously) as part of maintenance and cable repair works to achieve cable retrenching and reburial. In this event, further permanent physical disturbance to and/or loss of fish and shellfish would arise.

429. The OfECC will be routed to achieve the precautionary target depth of lowering as much as possible and a detailed review of rock placement requirements has already been undertaken. Maintenance and unforeseen cable repair (although unlikely) are routine, and the procedures and processes are well defined and is common in the industry. Impacts of maintenance and cable repair works would be of smaller magnitude than cable construction and likely small in extent and highly localised, only likely to be required for very small areas.

430. There will also be regular maintenance within the Array Area, including the WTGs. Although this will consist of an increase in vessels, these will be limited and would not represent a significant change from baseline, with lots of vessels already transiting this area.

Sensitivity of the Receptor

431. The sensitivity of fish and shellfish to maintenance activities is considered to be the same as for cable installation (**Section 20.8.1**) and therefore is stated to be **low to high**.

Significance of the Effect

432. Due to smaller magnitude during maintenance activities compared to cable installation, the effect is predicted to be **minor** and therefore **Not Significant**.

20.8.3. Decommissioning Impacts

433. At the end of the operational life of the proposed Project, the options for decommissioning will be evaluated.

434. Other project constraints will also be taken into consideration (e.g. safety and liability), with the least environmentally damaging option chosen wherever possible.

435. The proposed Project has an anticipated lifetime of up to 30 years from full commissioning, and therefore advances may be made in the approach to decommissioning, or changes may be made to legislative requirements for decommissioning at this time. Details of the proposed decommissioning strategy will be agreed towards the end of the 30 years operational life of the proposed Project, in line with the applicable legislation and taking into account guidelines at that time. This will include the decommissioning programme, activities involved and the arrangements for post-decommissioning monitoring, maintenance, and management of the proposed Project. Engagement with regulators and stakeholders will also be undertaken prior to decommissioning. The decommissioning phase of the proposed Project is expected to be complete within 12 months, between 2052 and 2054.

436. However, the decommissioning phase is expected to largely mirror the construction phase over a time period of 12 months (see **Chapter 04: Description of the Proposed Project**). This will include the removal of infrastructure, such as:

- WTGs will be de-energised and IAC cables disconnected and recovered or laid down for later recovery.

- Floating platforms will be disconnected from their moorings and the platform and WTG will be towed to local ports for disassembly.
- Anchors and moorings will be dismantled and recovered to shore for onshore disposal. However, if piles have been used as the anchor solution these will be cut off below the seabed level and the remaining structure recovered to the surface for onshore disposal; The decision to leave piles in situ would be agreed with the Regulator and relevant consultees to ensure this represented the most suitable approach.
- Both IAC and offshore export cables will be lifted from the water column or seabed using a grapnel and/or ROV and cables will be recovered to a vessel for onshore disposal. The recovery vessel will either spool the recovered cable into a carousel or will cut the cable into lengths as it is bought aboard, before being transported to shore.
- In the case of dynamic cables, buoyancy modules will also be removed and recovered to the vessel.
- Cable or scour protection will be recovered using a grab vessel and suitable barge for transport to shore.
- Once onshore project components will be processed and disposed of in accordance with relevant regulations at the time of disposal.

437. Based on these activities, the following impact pathways have been scoped in for further assessment:

- Temporary direct loss and physical disturbance to fish habitats;
- Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition;
- Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils; and
- Underwater noise and vibration.

Temporary Direct Loss and Physical Disturbance to Fish Habitats

Magnitude of Impact

438. The removal of the: WTG mooring / anchor systems; cable protection; and the possible removal of the Array Area and OfECC cables from the seabed, would result in temporary direct loss and physical disturbance to fish and shellfish habitats and species. It is likely that the equipment used to remove any cables would be similar to that used during the construction phase and could be used to reverse the burial process and expose cable. However, pre-clearance activities such a pre-grapnel run and boulder clearance would be required, nor would further sandwave levelling. As such, the area of seabed disturbed would be smaller than the area impacted during the construction phase and would be highly localised to infrastructure itself. The magnitude is considered to be **negligible** to **low**.

Sensitivity of the Receptor

439. The receptors assessed for this impact pathway for the construction phase would not change and therefore their sensitivities are also considered to be the same for the decommissioning phase. Herring and sandeel and their spawning habitat are considered to have a **high** sensitivity to temporary physical disturbance.

Significance of the Effect

440. Overall, any temporary physical disturbance to fish and shellfish habitats and species, would be smaller in extent than during the construction phase and therefore the effect is considered to be **negligible** to **minor** and **Not Significant**.

Temporary Physical Disturbance to Fish and Shellfish Habitats and Species from Increased Suspended Sediment Concentrations (SSC) and Sediment Deposition

Magnitude of Impact

441. The removal of any infrastructure during the decommissioning phase would result in increased SSC and sediment deposition and subsequent temporary disturbance to fish and shellfish habitats and species. It is likely that the equipment used to remove any cables would be similar to that used during the construction phase and as such, increased SSC is considered to be similar to that during the construction phase, with the majority of sediment expected to have deposited in tens of centimetres thickness on the seabed between 50 – 500 m away of the source of disturbance. The magnitude is considered to be **negligible** to **low**.

Sensitivity of the Receptor

442. The receptors assessed for this impact pathway for the construction phase would not change and therefore their sensitivities are also considered to be the same for the decommissioning phase. Herring and sandeel and their spawning habitat are considered to have a **high** sensitivity to temporary physical disturbance from increased SSC and sediment deposition.

Significance of the Effect

443. Overall, any temporary physical disturbance to fish and shellfish habitats and species as a result of increased SSC and sediment deposition, would be similar or smaller in extent than during the construction phase and therefore the effect is considered to be **negligible** to **minor** and **Not Significant**.

Changes to Marine Water Quality as a Result of Accidental Leaks and Spills from Vessels, Including Loss of Fuel Oils

Magnitude of Impact

444. Vessels will be required for the removal of any infrastructure as part of the decommissioning phase and any potential surveys requires. The management plans in place during decommissioning will be similar to the construction phase and will include the following: vessels will be required to comply with the International Regulations for Preventing Collisions at Sea (1972); regulations relating to International Convention for the Prevention of Pollution from Ships (MARPOL Convention 73/78) specifically including compliance with Annex IV on pollution by sewage and prevention of air pollution by ships; and Annex V on pollution by garbage from ships with the aim of preventing and minimising pollution from ships. This will include Shipboard Oil Pollution Emergency Plans (SOPEP).

445. With embedded mitigation and management measures in place the risk of an accidental spill occurring will be very low and should an accidental spill or leak occur, it would be very small in extent and subject to immediate dilution and rapid dispersal within the marine environment. Overall, the likelihood of impact to all fish and shellfish receptors from accidental leaks and spills from vessels and equipment is predicted to be unlikely and therefore the magnitude is **negligible**.

Sensitivity of the Receptor

446. The receptors assessed for this impact pathway for the construction phase would not change and therefore their sensitivities are also considered to be the same for the decommissioning phase. Fish and shellfish are considered to have a **high** sensitivity to this impact pathway.

Significance of the Effect

447. Overall, any changes to marine water quality as a result of accidental leaks and spills from vessels, would be similar or smaller in extent than during the construction phase (particularly as fewer vessels are likely to be required) and therefore the effect is considered to be **negligible** to **minor** and **Not Significant**.

Underwater Noise and Vibration

Magnitude of Impact

448. There is not considered to be a requirement for further UXO detonation or any impact piling (as the any piles used as the anchor solution will be cut off below the seabed level and the remaining structure recovered to the surface for onshore disposal). However, there is the potential that further geophysical surveys may be required to assess the condition and location of the cable (including its current burial depth) and any cable and scour protection as well as other physical environment information. If SBP is used then it has the potential to effect fish and shellfish, as it typically operates at frequencies <1 kHz and therefore are within the hearing range of fish.

449. The duration of the geophysical survey will be similar to the construction phase and will likely operate the SBP at the same sound intensity (SPLpeak of 238 dB re 1 µPa @ 1 m). As with underwater noise effects during construction, effects to fish from the SBP operations will be temporary and highly localised, even for high hearing sensitivity fish species. Effects could comprise limited avoidance behaviour such as moving away from the area of disturbance that would not be significantly different to wide ranging foraging and predator avoidance behaviour nor would this activity prevent fish migration into nearby rivers. Overall, the magnitude is considered to be **low**.

Sensitivity of the Receptor

450. The receptors assessed for this impact pathway for the construction phase would not change and therefore their sensitivities are also considered to be the same for the decommissioning phase. Fish and shellfish are considered to have a **low** to **high** sensitivity to this impact pathway.

Significance of the Effect

451. Overall, any changes to underwater noise as a result of geophysical survey required for the decommissioning phase, would be similar in extent than during the construction phase and therefore the effect is considered to be **minor** and **Not Significant**.

20.8.4. Summary of Residual Environmental Effects

452. This chapter of the ES has assessed the potential environmental effects on fish and shellfish from the construction, operation and maintenance and decommissioning phases of the proposed Project. Where significant effects have been identified, additional mitigation has been considered and incorporated into the assessment.

453. **Table 20-35** summarises the impact assessment undertaken and confirms the significance of any residual effects, following the application of additional mitigation.

20.9 Summary of Additional Mitigation Measures

454. Aside from the embedded mitigation and best practice measures provided **Section 20.7**, no additional mitigation measures or monitoring have been recommended as a result of the impact assessment undertaken.

20.10 Summary of Effects and Conclusions

455. This section summarises the residual significant effects of the proposed Project on fish and shellfish following the implementation of mitigation.

456. There were no significant effects to fish and shellfish ecology identified as a result of the proposed Project and no requirement for additional mitigation. Therefore, the residual effects to fish and shellfish remain **Not Significant**.

Table 20-35. Summary of assessment of environmental effects

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of impact	Significance of effect	Additional Mitigation	Residual Significance of Effect
Construction						
Temporary direct loss and physical disturbance to fish habitats	Herring	High	Low	Minor	None required	Minor **Not Significant**
	Sandeel	High	Low	Minor	None required	Minor **Not Significant**
	Shellfish	Medium to high	Low	Negligible	None required	Negligible **Not Significant**
	Other marine fish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition	Herring	High	Low	Minor	None required	Minor **Not Significant**
	Sandeel	Medium	Low	Minor	None required	Minor **Not Significant**
	Diadromous fish	Medium	Negligible	Negligible	None required	Negligible **Not Significant**
	Shellfish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
	Other marine fish	Low	Negligible	Negligible	None required	Negligible **Not Significant**

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of impact	Significance of effect	Additional Mitigation	Residual Significance of Effect
Changes to marine water quality from the mobilisation of contaminants	Fish and shellfish receptors	Low	Negligible	Negligible	None required	Negligible **Not Significant**
Changes to marine water quality from the use of drilling fluids at HDD break-out points	Fish and shellfish receptors	Medium	Negligible	Negligible	None required	Negligible **Not Significant**
Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils	Fish and shellfish receptors	High	Negligible	Negligible	None required	Negligible **Not Significant**
Underwater noise and vibration effects	Marine fish	Low to high	Low to medium	Minor	None required	Minor **Not Significant**
	Fish and shellfish receptors	Low	Negligible	Negligible	None required	Negligible **Not Significant**
Operation and Maintenance						
Permanent direct loss and physical disturbance to fish and shellfish habitats	Herring	High	Low	Minor	None required	Minor **Not Significant**
	Sandeel	High	Low	Minor	None required	Minor **Not Significant**
	Shellfish	Low	Negligible	Negligible	None required	Negligible **Not Significant**

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of impact	Significance of effect	Additional Mitigation	Residual Significance of Effect
	Other Marine Fish	Low to medium	Negligible	Negligible	None required	Negligible **Not Significant**
Increase in thermal emissions from cable operation	Herring and sandeel spawning grounds	Medium	Negligible	Negligible	None required	Negligible **Not Significant**
	Shellfish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
Effects of electromagnetic field (EMF) emissions	Diadromous fish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
	Pelagic fish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
	Demersal fish	Low to medium	Negligible	Negligible	None required	Negligible **Not Significant**
	Elasmobranchs	Medium	Low	Minor	None required	Minor **Not Significant**
	Spawning, eggs, larvae and juvenile fish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
	Shellfish	Low	Negligible	Negligible	None required	Negligible **Not Significant**
Aggregation of fish and associated effects such as	Fish and shellfish	Low	Low	Negligible	None required	Negligible **Not Significant**

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of impact	Significance of effect	Additional Mitigation	Residual Significance of Effect
barrier effects, collision and entanglement from the presence of floating offshore structures and associated tethering systems						
Underwater noise and vibration - Vibration from the rotating machinery in the WTGs, transmitted into the water column	Fish and shellfish	Low to high	Negligible	Negligible	None required	Negligible **Not Significant**
Underwater noise and vibration - Metal cable snapping	Fish and shellfish	Low to high	Negligible	Negligible	None required	Negligible **Not Significant**
Effects to fish and shellfish from maintenance activities	Marine fish	Low to high	Negligible to Low	Minor	None required	Minor **Not Significant**
Decommissioning						
- Temporary direct loss and physical disturbance to fish habitats; - Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition;	Fish and shellfish	Low to High	Negligible to Low	Negligible to Minor	None required	Negligible to Minor **Not Significant**

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of impact	Significance of effect	Additional Mitigation	Residual Significance of Effect
- Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils; and - Underwater noise and vibration.						

20.11 Cumulative Effects of the proposed Project

20.11.1. Introduction

457. Cumulative effects are those effects upon receptors arising from the proposed Project alongside all existing, and/ or reasonably foreseeable projects, plans and activities that result in cumulative effects with any element of the proposed Project. Existing Projects are generally considered as part of the baseline and as such are considered within the impact assessment presented in **Section 20.8** above.

458. This section assesses potential cumulative effects on fish and shellfish ecology from identified projects, plans and activities that have the potential to act cumulatively with the proposed Project.

459. PINS Advice 17: Cumulative Effects Assessment (2019) suggests that CEA follows a four-stage process. The aim of this approach is to accurately determine relevant projects and associated relationships with scoped in receptors identified in the ES, to be included within the interproject CEA.

460. The approach to the assessment of cumulative effects is detailed in Appendix 5B: Approach to Cumulative Effects Assessment, and is also summarised in Table 20-36 below.

Table 20-36. PINS Advice 17 Stages of the CEA Process

CEA Stage	Activity
Stage 1	Determine a zone of influence (ZoI) via desk study for each topic receptor scoped into the ES. This will establish a *long list* of projects within each ZoI that will be shortlisted in Stage 2. This list of plans and projects/activities is drawn up through a desk study of planning applications, development plan documents, relevant development frameworks and any other available sources to identify ‘other development’ within the ZoI. Information on each project (location, development type, status, etc.) is documented, along with the certainty or tier assigned to the ‘other development’ (i.e. confidence it will take place in the current form and when it will take place in relation to the project). PINS notes that the project should then consult with the relevant planning authority/ authorities and statutory consultees regarding the long list.
Stage 2	Screening of the long list identified in Stage 1, to establish a short list for the CEA. Screening is based on the criteria presented in the scoping report and subsequent comments by the regulator and statutory consultees. PINS has provided inclusions/ exclusion threshold criteria, against which the potential for ‘other development to give rise to significant cumulative effects by virtue of overlaps in temporal scope, the scale and nature of the ‘other developments’ and /or receiving environment, or any other relevant factors is assessed. From this assessment, a shortlist of ‘other developments’ to be included in the CEA is produced. It is noted that documented information on each of the ‘other developments’ is likely to be high level at this stage, outlining the key issues to take forward.
Stage 3	Gathering of all information available on short listed projects generated in Stage 2. At this stage all available data and information about the shortlisted projects that will be included in the CEA is collected to inform the assessment. This should utilise the most current information for each project in the public domain, and

CEA Stage	Activity
	assess the assumptions and limitations of the information collected on each shortlisted project.
Stage 4	Each of the shortlisted projects are reviewed in turn by the different topics to assess whether cumulative effects may arise and the nature of those effects (i.e. beneficial or adverse). The significance of the effects on environmental receptors is established within each ES technical chapters. Where significant adverse cumulative effects are identified, mitigation measures are also considered within the CEA alongside the mechanism to secure that mitigation, e.g. consent condition requirements.

461.

462. PINS Advice Note 17 provides criteria that may be used to indicate the certainty that can be applied to other plans and projects to be considered in the CEA. The criteria are assigned in tiers which descend from Tier 1 (most certain) to Tier 3 (least certain) and reflect a diminishing degree of certainty which can be assigned to each development.

463. Tier 1

- Under construction;
- Permitted application(s), whether under the PA2008 or other regimes, but not yet implemented; and
- Submitted application(s) whether under the PA2008 or other regimes but not yet determined.

464. Tier 2

- Projects on the Planning Inspectorate's Programme of Projects where a scoping report has been submitted.

465. Tier 3

- Projects on the Planning Inspectorate's Programme of Projects where a scoping report has not been submitted;
- Identified in the relevant Development Plan (and emerging Development Plans – with appropriate weight being given as they move closer to adoption) recognising that there will be limited information available on the relevant proposals; and
- Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.

20.11.2. Scope of Cumulative Effects Assessment for Fish and Shellfish Ecology.

466. An initial long list of projects, which have the potential for a cumulative effect with the proposed Project, has been produced and is presented in **Appendix 5A: Approach to Cumulative Effects Assessment.** The assessment has considered projects and information available up to January 2024.

467. The maximum predicted ZoI for the Project is 30.7 km, based on potential low-level behavioural response to underwater noise effects. This distance was calculated as part of the Project specific underwater sound modelling for impact piling (**Appendix 21B: Marine Mammals Noise Modelling**). On a precautionary basis other projects have been scoped in that are 62 km away from the project.

468. However, a regional approach has been considered for the CEA (see **Section 20.4.3** for further detail on what is a regional approach), meaning that other projects that have effects which overlap with migratory routes of certain fish species have been considered further. Projects scoped in for further assessment using this approach, include the Hinkley C DCO variation and the Cardiff Bay Tidal Lagoon projects, which are located 139 km and 141 km from the proposed Project, respectively.

469. For other impact pathways, CEA projects have been considered further where they fall within the mean tidal ellipse for the Study Area, which is 14 km and describes the theoretical maximum distance for the transport of very fine particulate matter and other changes in water quality.

470. The short list of projects identified and included within the CEA for fish and shellfish ecology is provided in **Table 20-37** and presented in **Figure 20-15**.

Table 20-37. List of projects considered for fish and shellfish ecology cumulative effects assessment

Project Name/Developer	Project Type	Tier and Status	Approx. distance from the proposed Project (km)
Llŷr 2 Floating Offshore Wind Project *[project not displayed on **Figure 20-15**]*	*Offshore Wind Farm*	*Tier 2 - Scoping submitted*	*0*
Valorous (Blue Gem Wind) *[project not displayed on **Figure 20-15**]*	*Offshore Wind Farm*	*Tier 3 - Concept/In-Planning*	*0*
Erebus (Blue Gem Wind)	*Offshore Wind Farm*	*Tier 1 - Consented*	*5*
Dragon Energy Project	*Inshore Energy*	*Tier 3 - Concept/In-Planning*	*7*
South Pembrokeshire Demonstration Zone	*Wave Energy*	*Tier 3 - Concept/In-Planning*	*8*
*Trivane Demonstrator **	*Offshore Wind Farm*	*Tier 3 - In-Planning*	*15*
*Crown Estate Leasing Round 5 - Includes the projects Llywellyn and Gwynt Glas **	*Offshore Wind Farm*	*Tier 3 - In planning*	*15-29*
*White Cross **	*Offshore Wind Farm*	*Tier 1 - Application submitted*	*17*
*Telecommunication Cable - FR 0000084477 00001 ** *[project displayed on **Figure 20-15** as blue telecommunications cable]*	*Telecommunications Cable*	*Tier 1 - Consented*	*23*
*NOBEL Banks **	*Minerals Aggregates Site*	*Tier 3 – No information Available*	*33*
*Celtic Deep Phase 1 and 2**	*Offshore Wind Farm*	*Tier 3 - In planning*	*34*
*Telecommunication Cable - FR 0000266176 00003 ** *[project displayed on **Figure 20-15** as blue telecommunications cable]*	*Telecommunications Cable*	*Tier 1 - Consented*	*37*
*Petroc**	*Offshore Wind Farm*	*Tier 3 - In planning*	*39*

Project Name/Developer	Project Type	Tier and Status	Approx. distance from the proposed Project (km)
*Celtic Sea RWE Renewables **	*Offshore Wind Farm*	*Tier 3 - In planning*	*39*
*Celtic Sea Ocean Winds**	*Offshore Wind Farm*	*Tier 3 - In planning*	*45*
*Morwind **	*Offshore Wind Farm*	*Tier 3 - In planning*	*61*
*Hinckley C DCO variation **	*Nuclear Power*	*Tier 3 – In planning*	*138*
*Cardiff Bay Tidal Lagoon **	*Tidal Energy*	*Tier 3 – In planning*	*141*

** Projects considered for underwater noise effects only.*

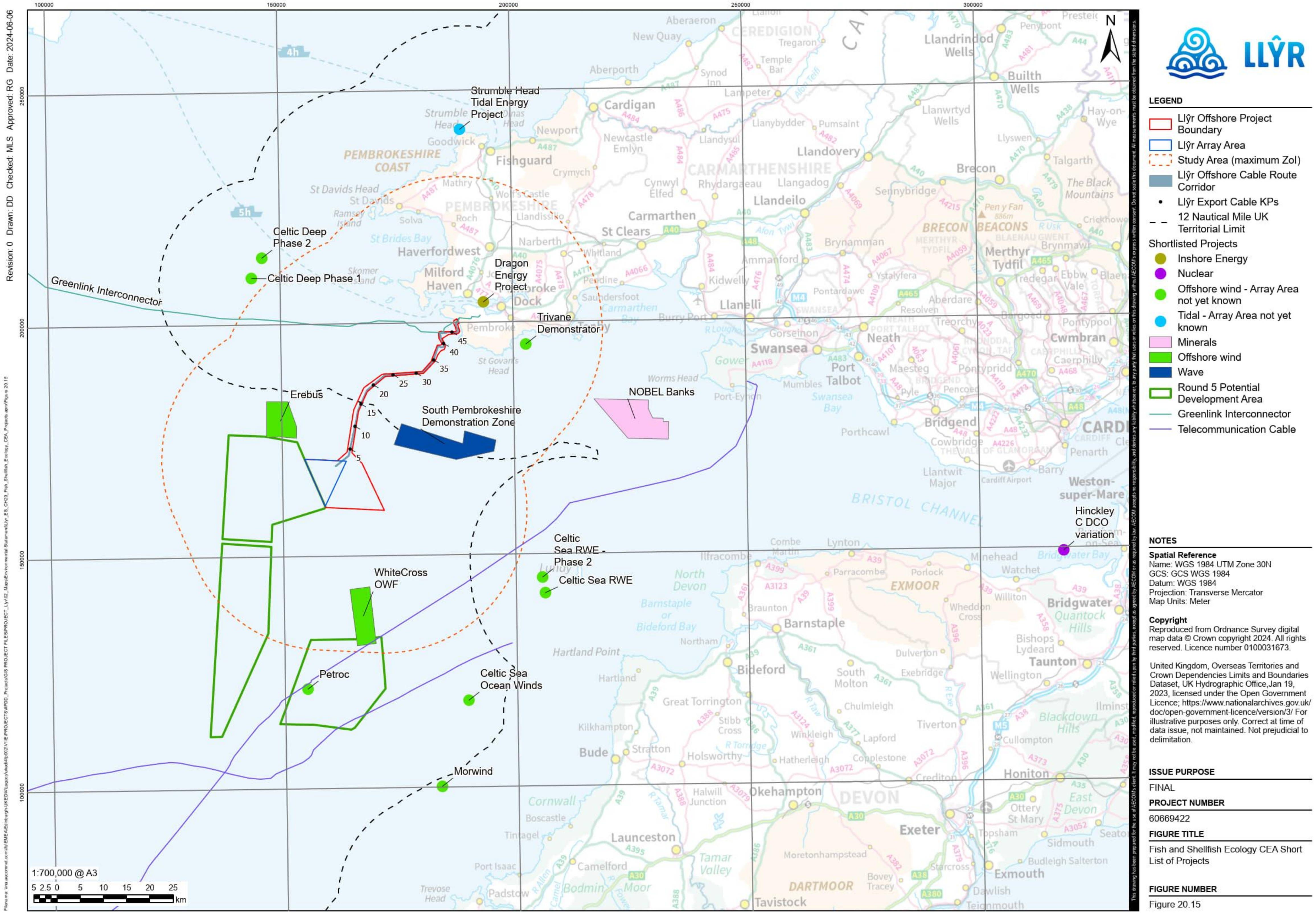

*Figure 20-15. Short-list of projects, plans and activities considered within the fish and shellfish ecology CEA**

The Greenlink Interconnector has been included for reference. However, this project has not been considered in the CEA and is instead discussed in the future baseline section (Section 20.5.11**).*

471. Several of the potential impact pathways identified are avoided or reduced to negligible (Not Significant) through the use of embedded mitigation, management plans and best practice. Other impact pathways have been scoped out on the basis that they don't represent a significant change beyond ambient. Further justification has been provided in **Table 20-38** on the impact pathways which have been scoped out.

Table 20-38. List of impact pathways scoped out for fish and shellfish ecology cumulative effects assessment

Impact Pathway	Justification for Scoping Out
Construction	
Changes to marine water quality from the mobilisation of contaminants	There were limited contaminants identified within sediment in the Study Area. If sediment is disturbed, then contaminants would be rapidly diluted and are not expected to be above ambient. This is also considered to be the case for other nearby project and therefore this impact assessment has been scoped out from the CEA.
Changes to marine water quality as a result of accidental leaks and spills from vessels, including loss of fuel oils	Vessels used as part of the proposed Project will comply with the International Regulations for Preventing Collisions at Sea (IMO, 1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (MARPOL Convention 73/78). Other projects would also adhere to these regulations and therefore has been scoped out from the CEA.
Operation	
Disturbance effects to fish (such as barrier effects, collision and entanglement) from the presence of floating offshore structures and associated tethering systems	There will be regular cable inspections, to ensure that any ghost fishing gear caught on the mooring systems of the proposed Project is identified and removed. Furthermore, the risk of entanglement from fish species is small given the spacing between mooring lines and the small Array Area as a whole. Therefore, this impact pathway has been scoped out from the CEA.
Underwater noise and vibration - Vibration from the rotating machinery in WTGs, transmitted into the water column	The effect of underwater noise produced by the vibration from rotating machinery in the WTGs is expected to be highly localised and is not expected to be above ambient noise levels (such as from other vessels). Therefore, this impact pathway has been scoped out from the CEA.
Underwater noise and vibration - Metal cable snapping	The underwater noise effects of metal cable snapping are not considered to be above the threshold for effects to fish and shellfish and therefore has been scoped out from the CEA.
Effects to fish and shellfish from maintenance activities	Maintenance activities as part of the proposed Project will be highly localised, short in duration, and will not represent a significant increase in vessel use compared to baseline. If maintenance activities were to occur concurrently with another project, this is not expected to result in a change from baseline. Therefore, this impact pathway has been scoped out from the CEA.

472. The impact pathways that have been considered as part of this CEA are provided below.

Construction

- Temporary direct loss and physical disturbance to fish habitats;
- Temporary physical disturbance to fish and shellfish habitats and species from increased suspended sediment concentrations (SSC) and sediment deposition; and
- Changes to marine water quality from the use of drilling fluids at HDD break-out points; and
- Underwater noise and vibration effects to fish and shellfish.

Operation and Maintenance

- Permanent direct loss and physical disturbance to fish and shellfish habitats;
- Increase in thermal emissions from cable operation; and
- Effects of EMF emissions.

Decommissioning

473. The methods for the decommissioning of the proposed Project, and a list of other potential and proposed project, are unknown at the time of writing. However, complete removal of all infrastructure from the seabed would involve similar activities that can be considered to fall within the assessment envelope for the construction phase.

20.11.3. *Cumulative Effect Assessment*

Construction

Temporary Direct Loss and Physical Disturbance to Fish Habitats

474. There are a number of construction activities that may cause temporary loss and/or physical disturbance to seabed habitats that could be important for fish and shellfish species (e.g. herring and sandeel). The maximum distance over which such physical temporary disturbance occurs for the proposed Project is estimated to be 50 m. This is based on a disturbance swathe for cable clearance activities of 25 m per cable, including pre-grapnel run and boulder clearance. Therefore, the projects scoped into this assessment are those within the offshore development area, which comprises Llŷr 2 and Valorous (Blue Gem Wind).

475. Llŷr 2 is being developed by the Applicant and has undertaken scoping, but on the basis of existing proposed Project survey data, the habitats in the Llŷr 2 area will not require sandwave levelling and so temporary disturbance will be restricted to WTG, mooring line, anchor and cable installation activities which are limited in extent and do not overlap with proposed Project. There is the potential for simultaneous construction between the proposed Project and other developments, particularly with Llŷr 2 Floating Offshore Wind Project and Valorous (Blue Gem Wind), which both have construction planned for 2027/2028 and 2028/2029, respectively[13]. However, temporary physical disturbance from both projects is expected to be limited, as the areas affected are small, and the seabed identified in both the proposed Project array and OfECC areas are comprised of sand (which has the potential for sandeel spawning). Therefore, it is not anticipated that there will be any spatial overlap in the areas of disturbance with the proposed Project.

[13] It should be noted, that the Valorous project has been delayed by the Crown Estate Round 5 (The Crown Estate, 2024) seabed leasing process and therefore the construction timelines are expected to be several years later than this.

476. The other short-listed projects (Erebus (Blue Gem Wind), Dragon Energy Project, and South Pembrokeshire Demonstration Zone) are beyond the distance at which cumulative interactions are likely to occur, and equally construction periods are not planned to overlap.

477. Disturbance effects from the CEA projects considered will be temporary in nature and be relatively small in spatial extent compared to the wider availability of habitat. The habitats disturbed will have the ability to recover, as sediments will redistribute and recolonise over time. Sands and gravels (which are found throughout the Study Area) are regularly exposed to disturbance from wave action and currents, particularly in shallower water. Therefore, the habitat and associated fish and shellfish species are considered to have some habituation to disturbance, with fish species (such as herring and sandeel) able to return once the habitat has recovered. This will be consistent across all projects in the Offshore Development Area. Cumulatively, the effect of temporary disturbance on benthic ecology is therefore considered **minor**, and **Not Significant**.

Temporary Physical Disturbance to Fish and Shellfish Habitats and Species from Increased Suspended Sediment Concentrations (SSC) and Sediment Deposition

478. Construction activities, such as ploughing and jet trenching, associated with the proposed Project, and likely those projects listed in the short list (**Table 20-37**) have the potential to temporarily increase SSC and sediment deposition. This can affect fish and shellfish, through clogging of gills, smothering, and the potential obstruction of migration routes.

479. The projects listed on the short list which fall within 14 km of the proposed Project, have the potential for any plumes to be transported over the mean tidal excursion, and thus overlap with the proposed Project. However, this would only be the case if activities were conducted for the proposed Project and the shortlisted projects simultaneously, which at present only includes Llŷr 2 Floating Offshore Wind Project and Valorous (Blue Gem Wind), where both have construction planned for 2027/2028 and 2028/2029, respectively. It should be noted, that although the Valorous scoping report noted this construction timeline, the project has been delayed by the Crown Estate Round 5 (The Crown Estate, 2024) seabed leasing process and therefore the construction timelines are expected to be several years later than this.

480. It should be considered that SSC and depositional loads will vary between the projects shortlisted, depending upon the local environmental conditions at the site of their activities. Furthermore, a cumulative effect would only apply to the finer fragments of the particulate matter, as the largest sediment plumes and highest levels of increased SSC are associated with the disturbance of sediments which have a high proportion of fine particulate matter, such as muds and clays. These fine sediments remain in suspension for longer and therefore travel the furthest distance from the source of disturbance, settling to the seabed more slowly.

481. Considering most of the sediment in the OfECC and the Array Area is dominated by sand and gravel particles, which are expected to have deposited in tens of centimetres thickness on the seabed between 50 m – 500 m away from the source of disturbance, the likelihood of plumes overlapping is therefore reduced significantly. Thus, should the works be temporally separated between projects, it is considered there will be sufficient time to allow any localised increases in SSC to disperse and dilute.

482. The majority of the sediment disturbed by the proposed Project will be deposited within 50 m and therefore effects are considered to be highly localised. Burrowing species, such as sandeel, are expected to have some habituation to increased SSC and smothering.

Sediment that is deposited is expected to be redistributed over short timescale, given that there is an absence of fine sediment in the Study Area.

483. Overall, the potential for cumulative effects of SSC is considered to be **minor** and **Not Significant.**

Impact from Changes to Marine Water Quality from the Use of Drilling Fluids at HDD Break-Out Points

484. Release of drilling fluids, used for HDD operations, and unintended releases before the planned breakout (as experienced during construction of Greenlink), in the intertidal zone of Freshwater West could result in decreased water quality that can have effects on the health of fish and shellfish populations.

485. In the case of the Valorous (Blue Gem Wind) project, it is not anticipated that the construction period will overlap with the proposed Project, as the construction dates declared are expected to be delayed as a result of the Crown Estate Round 5 seabed leasing process.

486. It is expected that projects requiring HDD will use drill fluids selected from the OSPAR List of Substances/Preparations Used and Discharged Offshore (2021); considered to 'Pose Little or No Risk to the Environment' (PLONOR).

487. Constituents of the drilling fluids, including silt-clay sized particles such as bentonite have a maximum theoretical range of approximately 14 km, which is the tidal excursion on a mean tide in the nearshore area around the landfall and outside Milford Haven. However, discharged drilling fluid is expected to be subject to immediate dilution processes and rapid dispersal over this distance which will result in no detectable change from the baseline beyond 500 m (see **Chapter 18: Physical Environment**, see **Section 18.9.1** for further detail). Any drilled solids released are also predicted to settle rapidly in the vicinity of the breakout and therefore, any effects are expected to be localised.

488. Therefore, based on the low likelihood of different projects undertaking HDD at the same time, and the very localised effects from HDD fluid release (which will be PLONAR) the overall effect is considered **negligible** and therefore **Not Significant**.

Underwater Noise and Vibration

489. During the construction phase of the proposed Project, there is potential for underwater noise associated with project activities to disturb fish and shellfish. The largest distance over which effects were predicted to occur to this receptor, was from impact piling activities, for which low-level behavioural disturbance was calculated to occur over 30.7 km.

490. However, this was based on a threshold of 150 dB re 1 mPa rms which is overly precautionary. A high relative risk of behavioural disturbance to high hearing sensitivity fish species from impact piling, was determined by Popper *et al*. (2014), to occur at intermediate distances (i.e. within hundreds of metres or <1 km), rather than thousands of metres. Other activities which produced underwater sound, include potential UXO detonation and the use of SBP for geophysical surveys. These were predicted to have disturbance effects to fish and shellfish, at maximum distances of 1,019 m (for a maximum charge weight of 794 kg) and 327 m, respectively.

491. Taking this into consideration, cumulative effects to fish and shellfish are considered to occur within a maximum distance of 5 km of the proposed Project. Therefore, only the projects Erebus, Valorous, and Llŷr 2, have been considered further. It was also concluded as part of this ES chapter, that underwater noise from the proposed Project would not act as a barrier to fish migration and therefore cumulative effects are not considered to occur with

other projects along the Severn Estuary, such as the Hinkley C DCO Variation and the Cardiff Bay Tidal Lagoon.

492. Erebus has reported that effects from underwater noise to fish and shellfish, could occur from the use of impact piling and UXO detonation. For impact piling, recoverable injury and mortality and potential mortal injury would be limited to <100 m from the pile driving. For UXO, mortality and potential injury to fish with a swim bladder involved in hearing was predicted to occur at distances of up to 810 m following the deflagration of a UXO device using a 525 kg charge. This project has stated that a 'soft-start' would be used as part of these activities, to reduce the potential for injury or mortality. Erebus has not provided distances over which behavioural disturbance could occur.

493. For cumulative disturbance effects to occur for underwater sound, these activities would need to be conducted simultaneously, which at present only includes the Llŷr 2 Floating Offshore Wind Project, which has construction planned for 2027/2028 and Valorous, with construction planned for 2028/2029. The Llŷr 2 Floating Offshore Wind Project and Valorous are assumed to have similar effects as that of the proposed Project, assuming that similar methods will be used.

494. If these activities occurred concurrently, they will be short-term and temporary. For example, impact piling is predicted to occur for a maximum number of 45 days with a minimum of 20 piling days over the construction period. Similarly, detonation of UXO would also be very intermittent and short-term. If disturbance effects were to occur between the proposed Project and the Llŷr 2 Floating Offshore Wind Project, then a maximum disturbance distance of 2 km is predicted from each Array Area. However, as these sites are further offshore, this distance would not be large enough to result in a barrier to fish migration and individuals would be able to return once the temporary activities were completed.

495. Cumulatively, the effect of underwater noise on fish and shellfish is therefore considered **minor**, and **Not Significant**.

Operation and Maintenance

Permanent Direct Loss and Physical Disturbance to Fish and Shellfish Habitats

496. The placement of hard substrates on the seafloor, including cable and scour protection, can result in the permanent loss of fish and shellfish habitats and species. Projects in close proximity to the proposed Project and therefore considered for this impact pathway include Llŷr 2 Floating Offshore Wind Project, Valorous, and Erebus. It is not anticipated there will be any overlap of operations and maintenance activities between these projects in terms of the placement of hard substrates on the seafloor.

497. For the proposed Project, the majority of the cable protection for the OfECC is predicted to be required in the sand and gravel sediment habitats of the nearshore area. There will also be cable protection at the HDD punch-out point, and concrete mattressing has been assumed for the four known cable crossings (**Chapter 04: Proposed Project Description**).

498. In the offshore development area, permanent habitat loss will occur for IAC and scour protection, placement of clump weights for mooring lines, anchoring and subsea connectors. Whilst the amount of each will vary between the projects (the proposed Project, Llŷr 2 Floating Offshore Wind Project, Valorous, and Erebus), it is anticipated that all will have similar required pathways for this impact.

499. The proposed Project is considered to result in the permanent loss of habitat of 91,184 m^2, which includes habitat identified as potentially suitable to both herring and sandeel. The

Erebus project will result in the permanent loss of habitat of 163,001 m^2, and includes the placement of hard substrate on suitable habitat for both herring and sandeel spawning.

500. The habitats which could be lost from the infrastructure detailed above are relatively homogenous, with sediments dominated by sand with varying compositions of gravel, considered to be suitable for either herring or sandeel spawning. However, compared to the extent of this habitat in the wider Study Area and Celtic Sea, the loss of habitat is still considered to be very small. Furthermore, the placement of the hard substrates for each project will be in discrete locations and will not overlap.

501. Cumulatively, the effect of direct permanent habitat loss on fish and shellfish ecology is therefore considered **minor** and **Not Significant**.

Increase in Thermal Emissions from Cable Operation

502. The operation of electricity cables generates heat due to resistance in the conductor components, which can warm the cable surface and adjacent sediments. Thermal emissions from the operation of the proposed Project have been appraised as resulting in no significant effects to fish and shellfish ecology, with temperatures expected to be reduced to negligible at the surface of the sediment. At crossings with other power cables, the potential increase in temperature within the sediments is higher.

503. Sediment particle size composition has been found to influence heat transfer, with coarse silts experiencing the greatest temperature change, but to a shorter distance from the source, while fine and coarse sands had a lower temperature change but a greater affected distance. The sediments in the vicinity of the proposed Project predominantly consist of sand with varying percentages of mud and gravels, and therefore, the effect of temperature change is only expected to vary slightly.

504. The Erebus project reported that heat emissions have the potential to increase sediment temperatures to no more than 5.5°C within a few centimetres of the cable when buried to a depth of a metre, with negligible effects to fish and shellfish (particularly at the surface of the sediment). This is also considered to be the case for the Valorous projects. Although these projects overlap with the proposed Project, there is not considered to be a cumulative effect from thermal emissions due to low increases in temperature, meaning any effects will be highly localised to the cables themselves.

505. Overall, it is considered that there is no potential for this effect to accumulate sufficiently to result in a significant cumulative effect. Sea water temperature in the Celtic Sea varies seasonally and therefore it is anticipated that small variations due to thermal emissions from the cables can be accommodated by fish and shellfish receptors. Therefore, the effect of thermal emissions from the proposed Project in combination with those projects on the short-list, on all fish and shellfish ecology, is assessed as **negligible** and therefore **Not Significant**.

Effects of Electromagnetic Field (EMF) Emissions

506. EMF will be emitted for the duration of operational life of the proposed Project, and other windfarm projects on the short-list (Llŷr 2 Floating Offshore Wind Project, Erebus and Valorous), from both their export and the inter-array cables. The effects of EMF reduce with distance from the cables, and the modelling for the proposed Project shows negligible emissions beyond 2 m if cables are buried at a depth of 1.2 m. Given the low level of EMF emissions predicted, if the burial depth is reduced to 0.8 m, any changes in EMF emissions are considered negligible and similar in effect to that provided in the modelling.

507. Whilst it is acknowledged that at crossings with other power cables, the potential increase in EMF is higher, the area where cables cross and interact is very small and as EMF reduces with distance any increase is also expected to be highly localised.

508. Erebus has reported that EMF produced by this project will be reduced to background levels within 4 m of the cable. EMF emissions for the proposed Project alone, was assessed as resulting in no significant effects (See **Section 20.8.3**).

509. Given the above and the highly localised effect of EMF to fish and shellfish from each project, it is considered that there is no potential for this effect to accumulate sufficiently to result in a significant cumulative effect. Cumulatively, the effect of EMF is therefore considered **minor** and **Not Significant**.

Decommissioning

510. For the purposes of the EIA and to provide a worst-case assessment, it has been assumed that all infrastructure from the proposed Project will be removed during decommissioning. It is probable that equipment similar to that used to install the infrastructure could be used to reverse the installation process during decommissioning.

511. While there is potential for cumulative effects to occur in relation to temporary physical disturbance to fish and shellfish habitats and species, disturbance from increased SSC and deposition of sediment, changes to water quality, and effects from underwater noise and vibration, the impacts of decommissioning activities are expected to be no greater than that associated with construction for the proposed Project.

512. Decommissioning activities for the proposed Project will take place after 30 years and therefore may overlap with the operational period of the closest project outside of the offshore development area (Erebus project) when there would be limited scope for adverse impacts. However, there may also be potential for overlap with decommissioning of the other identified cumulative schemes although full details of the decommissioning timescales are unclear.

513. Aside from Erebus, Valorous, and Llŷr 2, the other short-listed projects outside of the offshore development area are more than 5 km away from the proposed Project, and as such it is assumed less likely for cumulative effects to take place due to distance and the nature of the projects. For example, underwater noise effects from the proposed Project, may occur as a result of geophysical surveys. However, effects to fish and shellfish will be highly localised and limited to disturbance effects within 500 m of the survey activities. This is also true of temporary disturbance effects, with the area effected being much smaller than during construction (due to pre-clearance activities and sand wave levelling not being required).

514. Erebus has also reported a reduction in effects from decommissioning compared to construction activities. Given that decommissioning activities will be short-term, highly localised, and unlikely to occur concurrently with other nearby decommissioning activities from other projects, the cumulative effect on fish and shellfish ecology is considered to be **minor** and therefore **Not Significant**.

20.12 Inter-related Effects of the proposed Project

515. The term 'Inter-related' takes into account the environmental interactions ('inter-relationships') with other receptors within the proposed Project. These are referred to in the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 and further described in **Chapter 31 – Inter-related Effect Assessment**.

516. As set out in PINS Advice Note 17 (PINS), 2019, inter-related -project effects, or 'interrelationships between topics', derive from combinations of different project specific impacts which, when acting together on the same receptor, could result in a new or different effect, or an effect of greater significance than the project effects, when considered in isolation.

517. Inter-related effects comprise the following:

- *Project lifetime effects*: effects that have the potential to occur during more than one phase of the proposed Project (i.e. construction, operation and maintenance and decommissioning) and also to interact in a way that could potentially create a more significant effect than if it was assessed in isolation.
- *Receptor-led effects*: effects that have the potential to interact, spatially and temporally, to create inter-related effects on a receptor.

518. **Chapter 31 - Inter-related Effects Assessment** details the approach to the inter-related effects assessment and includes a description of the likely inter-related effects that may occur as a result of the proposed Project on fish and shellfish ecology.

20.12.1. Inter-related Project Lifetime Effects

Table 20-39. Inter-related Project lifetime effects

Development Phase	Nature of inter-related effect	ES Reference	Inter-related effects assessment
Construction, operation, and decommissioning	Indirect effects on prey resources	**ES Chapter 19: Benthic Ecology** **ES Chapter 21: Marine Mammals** **ES Chapter 22: Ornithology**	The impact assessment on benthic ecology has concluded that the proposed Project would not have a significant effect on this receptor, including permanent or temporary disturbance effects. Therefore, there is not considered to be indirect impacts such as a loss of prey items on fish and shellfish. Overall, the extent of the impact is local and minor in comparison to the wide distribution and availability of suitable foraging grounds for fish. Similarly, the impact assessment for fish and shellfish, also concluded that there would not be a significant effect. Any effects would not have indirect effects to ornithology and marine mammals which rely on fish and shellfish as a prey item. There would not be population level effects to fish and shellfish and any changes would be highly localised and temporary. As a result, it is not expected that these impacts will result in inter-related effects of greater significance, through combined project phases, than those assessed in isolation.

Development Phase	Nature of inter-related effect	ES Reference	Inter-related effects assessment
	Changes in water quality	**ES Chapter 18: Marine Water and Sediment Quality**	Due to the very localised nature of the works which would occur predominantly in sand and gravel habitats, any physical disturbance to fish and shellfish habitats and species and local increases in SSC and sediment deposition will be short-term. Changes in water quality could occur during any development phase due to pollution events, but these would be unplanned and standard control measures will be adhered to, to minimise risk. As a result, it is not expected that these impacts will result in inter-related effects of greater significance to water quality as a whole, through combined project phases, than those assessed in isolation.

20.12.2. Inter-related Receptor-Led Effects

519. It is considered possible for spatial and temporal interactions to occur between the impacts identified for fish and shellfish. However, although these potential combined effects may arise (e.g. contaminants released in the same location as a pollution event occurring, or disturbance of seabed habitats where cables from two projects cross), it is predicted that this will not be more significant than the assessment of individual impacts when considered in isolation. This is due to the localised nature of the impacts, the combined area of habitat potentially affected would be very limited, and the scale and recoverability of the receptors (i.e. recovery of potential herring and sandeel spawning habitat following disturbance).

20.13 Transboundary Effects

520. A transboundary effect refers to the impacts or effects of a project that extend beyond the boundaries of the United Kingdom and have the potential to affect the environment of other countries within the European Economic Area (EEA). These effects can occur either from the proposed Project on its own or when combined with the effects of other projects or activities in the wider geographical area.

521. In terms of the impacts on fish and shellfish receptors, impacts will be localised to the extent of the fish and shellfish Study Area. Given the intervening distance to neighbouring European Economic Area (EEA) states, there is no potential for transboundary impacts and resultant effects to occur.

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