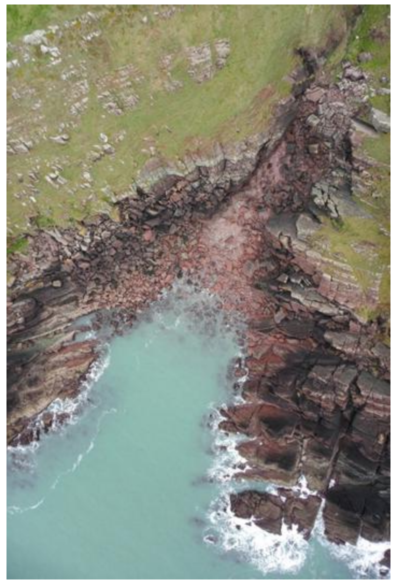
mWave Marine Energy Device and Onshore Infrastructure

ENVIRONMENTAL STATEMENT



June 2019

CHAPTER 8: Fish and Shellfish

Table of Contents

Glossary ii
Acronyms ii
Units ii
8. FISH AND SHELLFISH ECOLOGY 1
8.1 Introduction 1
8.2 Purpose of this chapter 1
8.3 Study area 1
8.4 Policy context 4
8.4.1 National Policy Statements 4
8.5 Consultation 5
8.6 Methodology to inform the baseline 7
8.6.2 Desktop study 7
8.6.3 Surveys 8
8.7 Baseline environment 8
8.7.2 Basking shark (*Cetorhinus maximus*) 8
8.7.3 Regional Fish and Shellfish Assemblage 11
8.7.4 Local Shellfish Assemblage 19
8.7.5 Trends in abundance 21
8.7.6 Designated sites 21
8.7.7 Valued Ecological Receptors 21
8.7.8 Sensitivity to marine energy devices 26
8.7.9 Future baseline scenario 26
8.7.10 Data limitations 26
8.8 Key parameters for assessment 26
8.8.1 Introduction 26
8.8.2 Impacts scoped out of the assessment 26
8.9 Impact assessment methodology 29
8.9.1 Overview 29
8.9.2 Impact assessment criteria 29
8.9.3 Designated sites 30
8.9.4 Measures adopted as part of the mWave Project 30
8.10 Assessment of significance 30
8.10.2 Installation phase 30
8.10.3 Operational and maintenance phase 35
8.10.4 Decommissioning phase 37
8.11 Cumulative Impact Assessment methodology 37
8.11.1 Screening of other projects and plans into the Cumulative Impact Assessment 37
8.12 Cumulative Impact Assessment 41
8.13 Transboundary effects 42
8.14 Inter-related effects 42
8.15 Conclusion and summary 42
8.16 References 44

Table of Tables

Table 8.1: Summary of NPS EN-1 policy relevant to fish and shellfish. 4
Table 8.2: Summary of NPS EN-3 policy relevant to fish and shellfish. 4
Table 8.3: Summary of NPS EN-3 policy on decision making with regards to Fish and Shellfish and consideration of the mWave project assessment. 4
Table 8.4: Summary of key consultation issues raised during consultation relevant to mWave 6
Table 8.5: Summary of key desktop reports. 7
Table 8.6: Summary of survey data used to inform fish and shellfish baseline characterisation. 8
Table 8.7: Summary of spawning and nursery habitat within the fish and shellfish study area from data present in Coull *et al*. (1998) and Ellis *et al*. (2010, 2012) (High intensity habitats that overlap with the wider fish and shellfish study area have been highlighted in grey). 15
Table 8.8: Designated sites and relevant qualifying interest features within the fish and shellfish assessment (light grey indicates species scoped out based on species ecology). 21
Table 8.9: Valued Ecological Receptors Categorisation for fish and shellfish. 22
Table 8.10: Fish ecology VERs in the fish and shellfish study area including justification for those scoped out of further assessment (*italicised*) 23
Table 8.11: Shellfish ecology VERs in the fish and shellfish study area, including those scoped out of further assessment. 25
Table 8.12: Design parameters considered for the assessment of potential impacts on fish and shellfish. 27
Table 8.13: Impacts scoped out of the assessment for fish and shellfish. 28
Table 8.14: Definition of terms relating to the sensitivity of the receptor. 29
Table 8.15: Definition of terms relating to the magnitude of an impact. 29
Table 8.16: Matrix used for the assessment of the significance of the effect. 30
Table 8.17: Designed-in measures adopted as part of the mWave project. 30
Table 8.18: List of other projects and plans considered within the CIA. 38
Table 8.19: Summary of potential environment effects, mitigation and monitoring at the mWave project. 43

Table of Figures

Figure 8.1: The local (META Site 8) and wider fish and shellfish study area, including the location surveys off East Pickard Bay and across the Waterway. 2
Figure 8.2: The mWave study area in relation to designated sites with fish and shellfish notified interest features and across the Waterway. 3
Figure 8.3: UK basking shark distribution based on three methods of (A) 191 tag geolocations collected from eight satellite tagged basking sharks 2001-2003; (B) survey sightings of basking sharks (1994-2003); and (C) 4919 public sightings 1987-2004 (Southall et al., 2005) 9
Figure 8.4 Basking shark siting data West Wales Biodiversity Information Centre and small vessel survey (2005 -2015) 10
Figure 8.5: Spawning grounds within the wider fish and shellfish study area. 17
Figure 8.6: Nursery grounds within the wider fish and shellfish study area. 18
Figure 8.7: Shellfish areas within the wider fish and shellfish study area. Species identified which may be harvested within each Class B Bivalve Mollusc Harvesting Area (orange) are listed under each area identified. The area identified as a Prohibited Bivalve Mollusc Harvesting Area (pink), the species listed within this pink area may not be harvested at any time. 20
Figure 8.6: Total landings of fish and shellfish from the UK fleet landings per year (ICES rectangle 32E4 and 32E5). 21

Glossary

Term	Definition
Acoustic Doppler Current Profiler	An acoustic doppler current profiler (ADCP) is a hydroacoustic current meter similar to sonar, used to measure waves and water current velocities over a range of depth.
Bathymetry	The measurement of water depth in oceans, seas and lakes.
Crustacea	Arthropod of the large, mainly aquatic group Crustacea, such as a crab, lobster, shrimp, or barnacle.
Demersal	Relating to the seabed and area close to it. Demersal spawning species are those which deposit eggs onto the seabed.
Epibenthic	Organisms living on the surface of the seabed.
Epifauna	Animals living on the surface of the seabed.
Intertidal	An area of a seashore that is covered at high tide and uncovered at low tide.
META Project	The META project, located in Pembrokeshire, consists of eight test sites where a range of marine energy testing activities will be permitted over a 15 year period. The licensing and consenting of the mWave project was originally intended to be undertaken within the consenting and licensing of the META project, with mWave being deployed within META Site 8.
Mollusc	Invertebrate animal belonging to the phylum mollusca that includes snails, clams, chitons, tooth shells, and cephalopods (e.g. octopus, squid and cuttlefish).
Nursery habitat	Habitats where high numbers of juveniles of a species occur, having a greater level of productivity per unit area than other juvenile habitats.
Pelagic	Any part of the water column (i.e. the sea from surface to bottom sediments) that is not close to the seabed. Pelagic spawning species release their eggs into the upper layers of the sea.
Planktivorous	Feeding on plankton
Plankton	Small and microscopic organisms drifting or floating in the sea or fresh water, consisting chiefly of diatoms, protozoans, small crustaceans, and the eggs and larval stages of larger animals.
Recoverable injury	Relating to underwater noise impacts, recoverable injury includes hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.
Spawning	The release or deposition of eggs and sperm, usually into water, by aquatic animals.
Subsea Umbilical Termination Unit	Underwater connection box approx 1.5m^2. mWave umbilical and ADCP will connect into unit.
Zooplankton	Plankton consisting of animals (e.g. small crustaceans or immature stages of larger animals)

Acronyms

Acronym	Description
ADCP	Acoustic Doppler Current Profiler
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
META	Marine Energy Test Area
MEW	Marine Energy Wales
ADCP	Acoustic Doppler Current Profiler
MPCP	Marine Pollution Contingency Plan
DDV	Drop Down Video
OSPAR	Oslo-Paris Convention
SUTU	Subsea Umbilical Termination Unit

Units

Unit	Description
dB	Decibel
kW	Kilowatt (power)
km	Kilometre
m	Metre
mg/l	Milligram per litre
mm	Millimetre
MW	Megawatt (power)
m^2	Metres squared
m^3	Metres cubed
NM	Nautical mile
μPa	Micropascal

8. FISH AND SHELLFISH ECOLOGY

8.1 Introduction

8.1.1.1 This chapter of the Environmental Statement presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of the mWave project on fish including basking shark (*Cetorhinus maximus*) and shellfish. Specifically, this chapter considers the potential impact of the offshore component of the mWave project during its three phases, namely, namely installation, operation and maintenance, and decommissioning.

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

- Chapter 5: Coastal Processes;
- Chapter 7: Benthic Subtidal and Intertidal Ecology; and
- Chapter 11: Commercial Fisheries.

8.2 Purpose of this chapter

8.2.1.1 The primary purpose of the Environmental Statement is to support the marine licence application for the mWave project, including the WEC, marine communications cable up to MHWS, Acoustic Doppler Current Profiler (ADCP), Subsea Umbilical Termination Unit (SUTU) and navigational markers (if needed), as outlined in Chapter 1: Introduction. A separate planning application will be submitted to Pembrokeshire Coast National Park Authority (PCNPA) for the onshore control station and the communication cable down to Mean Low Water (MLW).

8.2.1.2 This Environmental Statement chapter:

- Presents the existing environmental baseline established from desk studies, site specific and wider surveys, and consultation;
- Presents the potential environmental effects on fish and shellfish arising from the mWave project, based on the information gathered and the analysis and assessments undertaken;
- Identify any assumptions and limitations encountered in compiling the environmental information;
- Highlights any mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process; and
- Highlights any monitoring deemed appropriate in order to validate the findings of this assessment.

8.3 Study area

8.3.1.1 As discussed in Chapter 1 Introduction, the licensing and consenting of the mWave project was originally intended to be undertaken within the consenting and licensing of the Marine Energy Wales META project with mWave being deployed at the eastern end of META Site 8 (East Pickard Bay). Whilst the mWave device is short term and of limited extent compared to the META project, the baseline information for the META Site 8 has been used in the following assessment to ensure consistency of information across the two projects which are likely to be in the consenting process at the same time.

8.3.1.2 Fish and shellfish are spatially and temporally variable, therefore for the mWave project the fish and shellfish ecology assessment has identified an appropriate study area. The local fish and shellfish study area is defined as the seabed encompassing the META Site 8 (Figure 8.1), with the mWave device being located in its south eastern area. The local study area also includes the marine cable route search area (up to Mean High Water Spring (MHWS)) which landfalls at East Pickard Bay, and the intertidal area in the immediate vicinity. A wider fish and shellfish study area is also considered which extends from the mouth of Milford Haven waterway to its upper reaches (subsequently referred to as 'the Waterway'). The wider study area extends from the mouth of Milford Haven, between St Govan's Head to Skomer Island, out to 12 NM (insert within Figure 8.1).

8.3.1.3 For basking shark, the local study area is as described above. In addition to this a regional study area has been identified as a 100km buffer from the centre of the Waterway. This is the same study area as used for marine mammals and is shown in Figure 9.2 of Chapter 9. The regional study area provides a wider geographic context for comparison with the local study area in terms of the basking shark present and their relative abundance. It should be noted that the regional study area does not delineate populations of basking sharks but does provide a sufficiently large area within which ecological patterns of the key species can be understood.

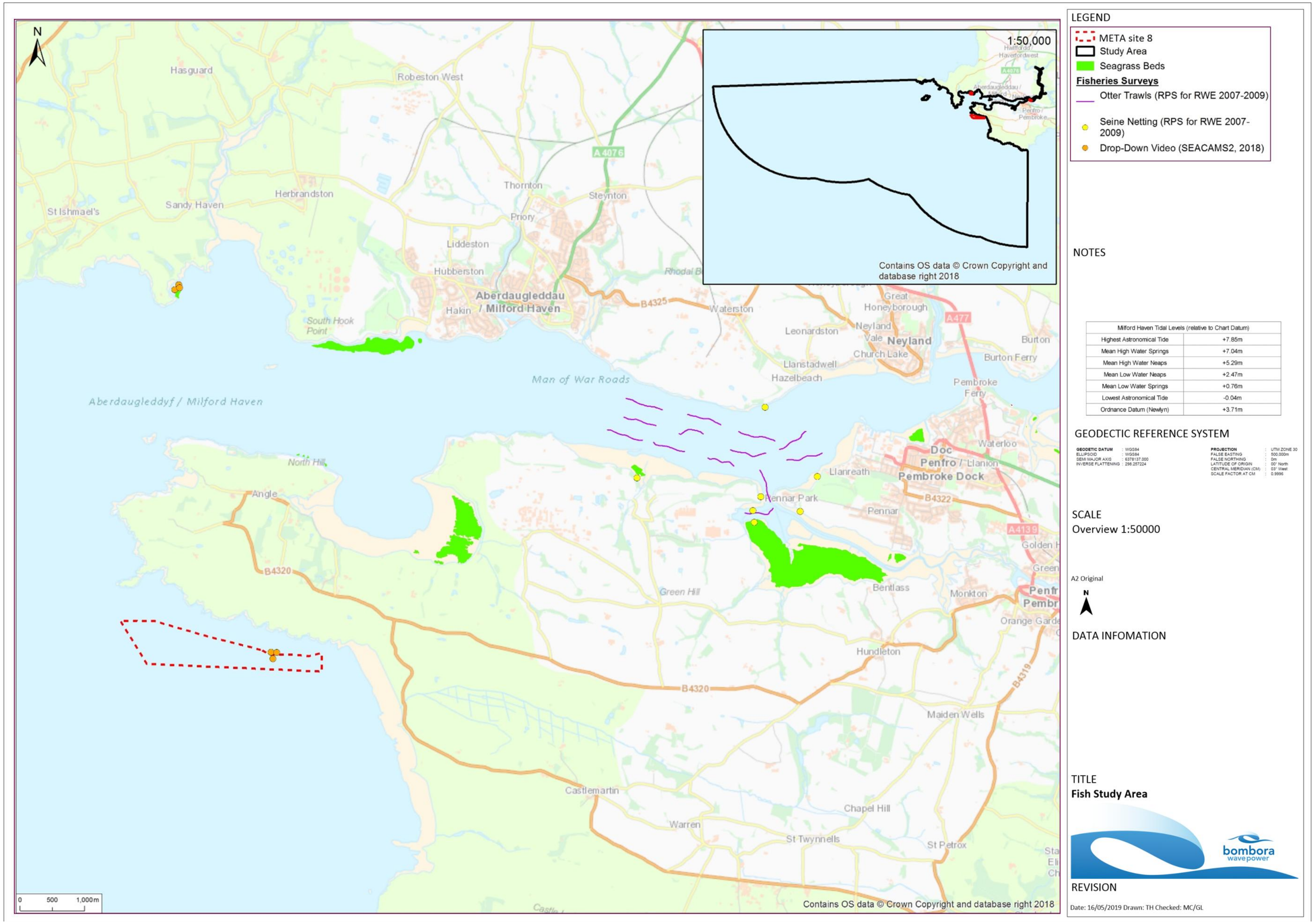


Figure 8.1: The local (META Site 8) and wider fish and shellfish study area, including the location surveys off East Pickard Bay and across the Waterway.

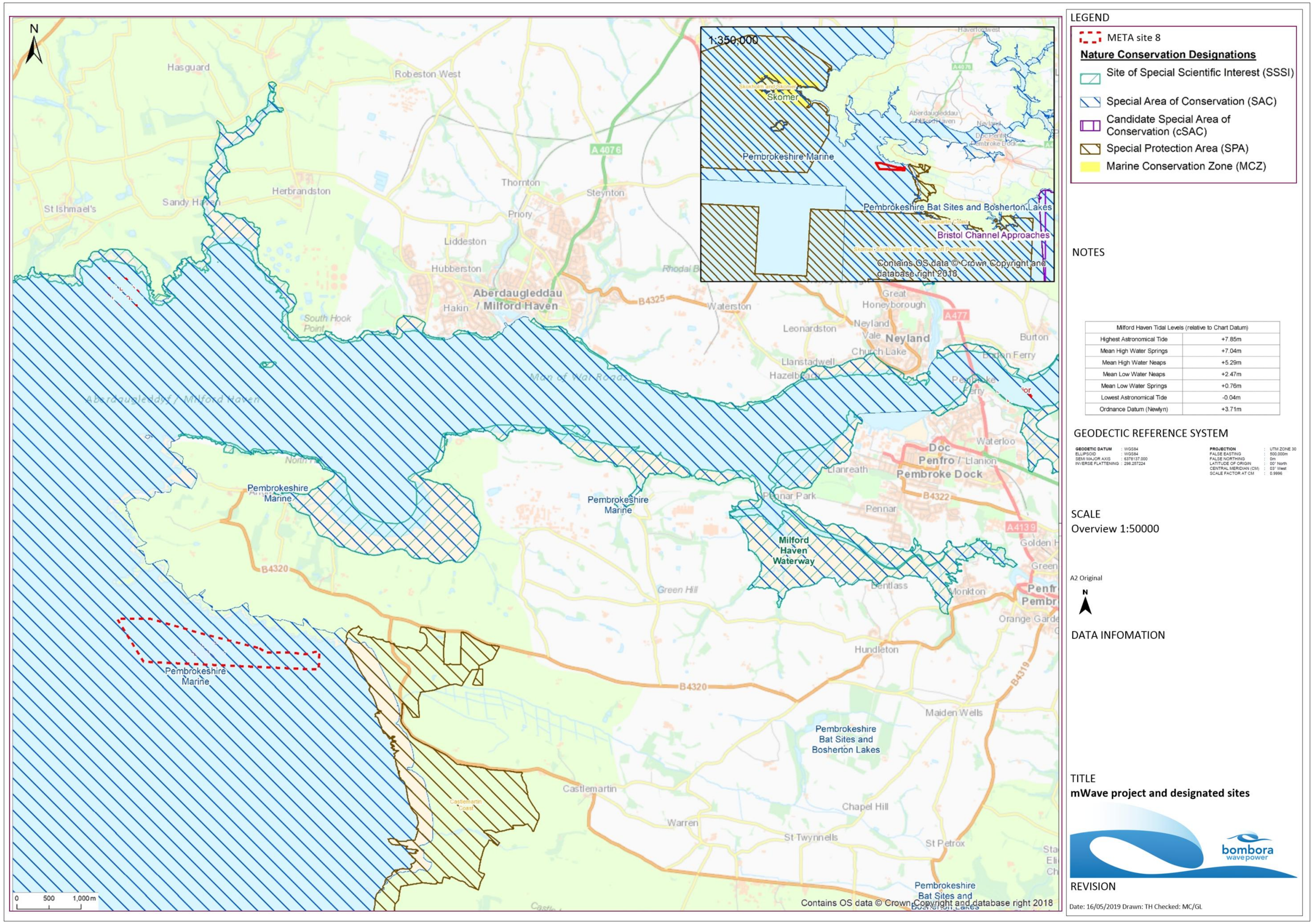


Figure 8.2: The mWave study area in relation to designated sites with fish and shellfish notified interest features and across the Wate rway.

8.4 Policy context

8.4.1 National Policy Statements

8.4.1.1 While it is recognised that the mWave project does not constitute a Nationally Significant Infrastructure project (NSIP), the National Policy Statements (NPS) available to support NSIPs are considered to provide useful context to the production of fish and shellfish environmental assessments. In addition, the UK Marine Policy Statement and the Draft Welsh National Marine Plan have been considered in Chapter 3: Needs and Alternatives and not reiterated here.

8.4.1.2 Planning policy on renewable energy infrastructure, specifically in relation to fish and shellfish, is contained in the overarching National Policy Statement (NPS) for Energy (EN-1; DECC, 2011a) and the NPS for Renewable Energy Infrastructure (EN-3; DECC, 2011b).

8.4.1.3 NPS EN-1 and NPS EN-3 include guidance on what matters should be considered in a fish and shellfish environmental impact assessment. These are summarised in Table 8.1 and Table 8.2, respectively.

8.4.1.4 NPS EN-3 also highlights several factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 8.3.

Table 8.1: Summary of NPS EN-1 policy relevant to fish and shellfish.

Summary of relevant policy framework	How and where considered in the Environmental Statement
Biodiversity	
Where the development is subject to EIA the applicant should ensure that the Environmental Statement clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. (paragraph 5.3.3 in NPS EN-1).	Effects on Fish and Shellfish, including species of conservation importance, including those listed as features of designated sites, are fully considered in sections 8.10.2 (installation phase),8.10.3 (operation and maintenance phase) and 8.10.4 (decommissioning phase). Baseline information on these receptors is presented in section 8.7, with an evaluation of these receptors in the context of their conservation importance considered in section 8.7.7.
The most important sites for biodiversity are those identified through international conventions and European Directives. The Habitats Regulations provide statutory protection for these sites (paragraph 5.3.9 in NPS EN-1).	Effects of fish and shellfish features have been assessed within the report to inform the Habitats Regulation Assessment for Natura 2000 sites.
Marine Conservation Zones (MCZs) introduced under the Marine and Coastal Access Act (MCAA) 2009 are areas that have been designated for the purpose of conserving marine flora and fauna, marine habitat or features of geological or geomorphological interest (paragraph 5.3.12 in NPS EN-1).	Skomer MCZ is the only MCZ in Wales (insert within) and can be found at the northern extent of the wider fish and shellfish study area (see section 8.7.6)
Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in England and Wales and thereby requiring conservation action (paragraph 5.3.17 in NPS EN-1).	All species receptors, including those of principal importance for the conservation of biodiversity in Wales are summarised in section 8.7, with evaluation of these receptors in the context of their conservation importance considered in section 8.7.7.
The applicant should include appropriate mitigation measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During installation, they will seek to ensure that activities will be confined to the minimum areas required for the works; and • During installation and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements.	Mitigation measures which have been designed into the mWave project are presented in Table 8.17.

Table 8.2: Summary of NPS EN-3 policy relevant to fish and shellfish.

Summary of relevant policy framework	How and where considered in the Environmental Statement
Biodiversity	
Applicants should assess the effects on the offshore ecology and biodiversity for all stages of the lifespan of the proposed project (paragraph 2.6.64 of NPS EN-3).	Installation, operation and maintenance, and decommissioning phases of the mWave project have been assessed (see section 8.10).
Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate (paragraph 2.6.65 of NPS EN-3).	Consultation with relevant statutory and non-statutory stakeholders has been carried out from the early stages of mWave (see section 8.5).
Applicants should assess the potential for the scheme to have both positive and negative effects on marine ecology and biodiversity (paragraph 2.6.67 of NPS EN-3).	Both the potential positive and negative effects of the mWave project have been assessed (see section 8.10).
Fish and shellfish ecology	
Impacts arising from installation and decommissioning at the seabed with consequential effects on fish communities, migration routes, spawning activities and nursery areas for particular species (paragraph 2.6.73 of NPS EN-3).	The mWave project assessment has considered all phases of the mWave project development on fish and shellfish species with key life stages in the vicinity of the development (see section 8.10).
In addition, there are potential noise impacts, which could affect fish during construction and decommissioning and to a lesser extent during operation (paragraph 2.6.73 of NPS EN-3).	The mWave assessment has considered noise effects on fish and shellfish species arising from installation and decommissioning (vessel and cable laying noise, there will be no site preparation works, no piling; see Table 8.13)
The applicant should identify fish species that are the most likely receptors of impacts with respect to feeding areas; spawning grounds; nursery grounds; and migration routes (paragraph 2.6.74 of NPS EN-3).	Focus has been given to potential impacts on fish (and shellfish) species at key life stages, such as during spawning or on known nursery habitats (see section 8.7 *et seq.*).

Table 8.3: Summary of NPS EN-3 policy on decision making with regards to Fish and Shellfish and consideration of the mWave project assessment.

Summary of relevant policy framework	How and where considered in the Environmental Statement
Biodiversity	
The local planning authority should consider the effects of a proposal on marine ecology and biodiversity taking into account all relevant information made available to it (paragraph 2.6.68 of NPS EN-3).	This fish and shellfish impact assessment (section 8.10) considers the effects of the mWave project on fish and shellfish ecology.
The designation of an area as a European site does not necessarily restrict the construction or operation of a project in or near that area (paragraph 2.6.69 of NPS EN-3).	European sites have been considered during the assessment (see section 8.7.6) and in the NSER.

8.5 Consultation

8.5.1.1 As identified previously, the mWave project was originally intended to be consented within META Site 8 (East Pickard Bay). As such, consultation on META Site 8 also included the mWave communication cable and mWave device. A summary of the key issues raised during consultation specific to fish and shellfish at Site 8 and the mWave project, is outlined in Table 8.4, together with how these issues have been considered in the production of this Environmental Statement chapter.

Table 8.4: Summary of key consultation issues raised during consultation relevant to mWave

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
09 November 2018	Wales Marine Fisheries Advisory group and Wales Fishing Association – fisheries engagement	Loss of fishing opportunity is the greatest concern	There is no restriction to fish or shellfish from entering the consented zone, therefore, no decrease in fish and shellfish abundance (see section 8.9.4).
20 November 2018	Welsh Federation of Sea Anglers - meeting	No issues raised	No response made.
28 March 2018	NRW Scoping Opinion (ABPmer advice to NRW	According to the fish and shellfish ecology section of the Scoping Report, potential effects of marine noise on fish and shellfish are proposed to be scoped out of the EIA on the basis that the installation, operation, maintenance and decommissioning of marine renewable devices will result in noise levels lower than ambient noise levels experienced within study area. This does not correspond with the underwater noise section of the Scoping Report which presents a proposed approach to assessing the effects of the installation and operation of devices on fish and benthic ecology.	Information on noise levels likely to be generated during installation, operation and decommissioning from the mWave project is provided in Chapter 6, Underwater Noise. The levels produced have been used to identify an area of potential injury or disturbance for fish. Due to the limited area of potential effect from noise and the coastal position of the deployment site the effects have been scoped out of the assessment. See Table 8.13 Impacts scoped out where justification is provided for scoping this impact out.
		The underwater noise assessment should also include a desk-based review of the latest available scientific evidence of the observed responses of marine fauna (namely fish, marine mammals and benthic invertebrates) to different types of underwater sounds for context. Although scientific research on the potential effects of underwater noise on invertebrates is relatively underdeveloped, there is increasing evidence to suggest that invertebrates are sensitive to noise, in particular particle motion.	Information on noise levels likely to be generated during installation, operation and decommissioning from the mWave project is provided in Chapter 6, Underwater Noise. The levels produced have been used to identify an area of potential injury or disturbance. Due to the limited area of potential effect from noise, and the coastal position of the deployment site, the effects have been scoped out of the assessment. See Table 8.13 Impacts scoped out, where justification is provided for scoping this impact out.
		The section on shellfish is not entirely accurate. There are no current permits for carpet clams, razor or native oyster fisheries. Oysters were historically widespread in the Haven but are now depleted and there is no current oyster dredge fishery in the Haven. There are however still important oyster bed habitats within the Haven which have high sensitivity to certain benthic impacts such as disturbance and habitat loss.	Baseline section 8.7 has been updated to reflect NRW comments.
		The same impacts identified within the benthic section (Table 6-4) must be assessed in the EIA/ES for shellfish.	Where appropriate, similar impacts have been assessed for benthic interests as for fish and shellfish. These include for installation; 'Temporary changes to fish and shellfish habitat' (section 8.10.2.1), 'Temporary increases in suspended sediments' (section 8.10.2.18) and 'Accidental Pollution' (section 8.10.2.35). For operational impacts; 'Medium term habitat loss' (section 8.10.3.13) has been included.
28 Mar 2019	NRW/MMO – Scoping Opinion	Injury and mortality impacts from wave devices must be considered in the EIA/ES. It is acknowledged that the majority of wave devices present little concern for impacts on fish, however, some devices have the potential for fish ingress within the device. Other unforeseen impacts may also occur. A review of existing wave devices would help to identify potential other impacts which may be relevant to the EIA.	mWave is a WEC device which sits on the seabed. It generates energy through the displacement of air from membrane covered cells which are present on the top of the device. The displaced air is passed through a generator. By its very nature it has to be contained to prevent air escaping, as such there are no areas, which contain moving parts, which fish could ingress into.
		Basking sharks have been included in the marine mammals chapter of the scoping report rather than fish ecology. Basking sharks should be considered in the fish ecology chapter of the EIA/ES.	The assessment of effects on basking sharks has been included in this chapter. Reference is made to Chapter 9 in terms of regional study area.

8.6 Methodology to inform the baseline

8.6.1.1 The mWave project is located off the south coast of the Angle Peninsula to the south of Milford Haven Waterway. There is extensive data and knowledge regarding fish and shellfish ecology available and this has been acquired through:

- Publicly available journals;
- University studies;
- Commissioned reports by local interest groups;
- SEACAMS East Pickard Bay baited drop down video surveys; and
- Historical characterisation surveys undertaken by RPS for projects within the Waterway.

8.6.1.2 Due to the availability of suitable data, new data or modelling studies have not been required to characterise the fish and shellfish baseline for the mWave project EIA (see Chapter 4: Environmental Assessment Methodology). UK nature conservation designations occurring within the fish and shellfish study area have also been used to inform the fish and shellfish baseline.

8.6.2 Desktop study

8.6.2.1 Information on fish and shellfish within the fish and shellfish study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 8.5 below. Where reports and data date back to the 1990s, up-to-date data and information have been used to ensure these sources are still valid.

Table 8.5: Summary of key desktop reports.

Title	Source	Year	Author
International Bottom Trawl Surveys	ICES; http://datras.ices.dk/home/descriptions.aspx	2017	ICES
International Herring Larvae Survey (IHLS)	ICES; http://www.ices.dk/marine-data/data-portals/Pages/Eggs-and-larvae.aspx	2015	ICES
Crab and lobster stock assessments	Cefas	2017	Cefas
Spawning and nursery grounds of selected fish species in UK waters	Cefas Scientific Series Technical Report	2012	Ellis *et al.*
Fisheries Sensitivity Maps in British Waters	Cefas Scientific Series Technical Report	1998	Coull *et al.*
Long-term satellite tracking reveals variable seasonal migration strategies of basking sharks in the north-east Atlantic	Scientific Reports	2017	Doherty *et al.*
Basking shark population assessment. Final project report.	Global Wildlife Division, Department for Environment	2005	Sims *et al.*
Spatial distribution patterns of basking sharks on the European shelf: preliminary comparison of satellite-tag geolocation, survey and public sightings data.	Journal of the Marine Biological Association of the United Kingdom	2005	Southall *et al.*
Seasonal movements and behaviour of basking sharks from archival tagging: no evidence of winter hibernation	Marine Ecology Progress Series	2003	Sims *et al.*
Wales Marine Planning Portal	Welsh Government	Compiles a series of relevant data sources	n/a
The Marine Conservation Society Basking Shark Watch 20 Year Report (1987 – 2006).	Marine Conservation Society	2006	Bloomfield and Solandt
National Biodiversity Network (NBN) Gateway	NBN Atlas	Compiles a series of relevant data sources	n/a

Identification of designated sites

8.6.2.2 All designated sites within the fish and shellfish study area that could be affected by the installation, operation and maintenance, and decommissioning of the mWave project, were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the fish and shellfish study area were identified using a number of sources. These included international, national and local designations including SACs, SPAs, NNRs, SSSIs and LNRs identified by examining the JNCC's website, the European Site European Nature Information System (EUNIS) database, the Department for Environment, Food and Rural Affairs (Defra), MAGIC interactive map applications (http://magic.defra.gov.uk/), and the Wales Marine Planning Portal interactive map application (http://lle.gov.wales/apps/marineportal).
- Step 2: Information was compiled on the relevant qualifying fish and shellfish interest features for each of these sites:
  - The known occurrence of species within the mWave project was based on the relevant desktop information on the fish communities of the fish and shellfish study area.
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the mWave project, including the cable route search area (up to MHWS);
  - Sites and associated features were located within the potential Zone of Impact (ZoI) for impacts associated with the mWave project (e.g. habitat loss/disturbance, increase in suspended sediments and deposition);
  - Notified interest species features of a designated site were either recorded as present during historic surveys within the mWave project area, or identified during the desktop study as having the potential to occur within the mWave project area;
  - Where national and locally designated sites (i.e. SSSIs, rMCZs, NNRs and LNRs) fall within the boundaries of an internationally designated site (e.g. SAC), only the international site has been considered, as potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken). In some cases, however, where a national site forms a component of an international site, but the latter designation does not list a qualifying interest feature that is present on the SSSI citation, the individual SSSI will be taken forward for further assessment for that particular feature or the species;

- Where a national site falls outside of an international site, but within the fish and shellfish study area, the national site will be taken forward for further assessment for a particular feature; and
- Skomer MCZ is the only MCZ designated in Wales and as such is the only one considered for assessment.

8.6.3 Surveys

8.6.3.1 A summary of surveys used to inform the fish and shellfish EIA is outlined in Table 8.6 below.

Table 8.6: Summary of survey data used to inform fish and shellfish baseline characterisation.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
SEACAMS camera drop down video (DDV) survey	DDV survey commissioned within the vicinity of the mWave deployment site off East Pickard Bay.	DDV surveys were used to identify fish species present off East Pickard Bay. DDV surveys were left in position for 1 hour with bait (mackerel) to attract fish species at varying depths (6 – 18 m). Both benthic and demersal species were attracted.	SEACAMS Ltd.	2018	Appendix 8.1
Otter Trawls	Thirteen otter trawl surveys were carried out in the vicinity of the Pembroke Power station.	Otter trawl surveys were used to determine the fish community present within the Waterway.	RPS	2007-2009	RPS, 2007
Seine Netting	Severn seine nets were deployed in the vicinity of the Pembroke Power station.	Seine nets were deployed to determine the fish community present within the Waterway.	RPS	2007-2009	RPS, 2007

8.7 Baseline environment

8.7.1.1 This section characterises the existing environment within the wider fish, including basking sharks, and shellfish study area as illustrated in Figure 8.1 and outlined in section 8.2.1.1.

8.7.2 Basking shark (*Cetorhinus maximus*)

8.7.2.1 The basking shark has a circumglobal distribution and can undertake extensive trans-ocean basin migrations (Witt *et al.,* 2012). Data (sightings, geotag and survey data) suggest a restricted range for basking sharks around Britain, with the majority of sightings falling between the Hebrides and the north coast of Brittany, with relatively few occurrences on the west coast of Ireland and east coast of the UK (see Figure 8.3 for UK-wide distribution map of basking sharks). This suggests the western region of the European shelf is a particularly important habitat for basking sharks within the north-east Atlantic (Southall *et al.,* 2005). Highest densities of basking sharks are recorded along western facing shores. High density hotspots (through sightings data) appear to be western Scotland, the Isle of Man and south west England, with lower concentrations off the coast of Pembrokeshire and western Ireland, where they can be observed surface-feeding on dense zooplankton patches (Miller *et al.,* 2015). Basking sharks generally live in open waters but migrate towards the shore in summer, when they can be seen 'basking', i.e., swimming slowly at the surface with the mouth wide open with the snout and dorsal fin visible above water.

8.7.2.2 Basking sharks are thought to pair in early summer and are likely to be ovoviviparous. Estimates for gestation period are 12 – 36 months, and there is an estimated 24 months between litters. Basking sharks are often associated with surface aggregations of zooplankton, particularly along tidal and shelf-break fronts where they feed on small fish, fish eggs and zooplankton (Fowler, 2009).

8.7.2.3 Although spatio-temporal data is still limited, in UK waters, basking sharks are known to exhibit distinct seasonality, with peak sighting periods between June and September each year (Witt *et al.,* 2012).

8.7.2.4 Basking sharks have been documented feeding in the Celtic Deep (a candidate MCZ), whose northern tip is approximately 84km from the Pembrokeshire (https://www.mcsuk.org/mpa/show-1481456). Tag geolocations suggest individual basking sharks spend considerable time in the Celtic Sea undertaking persistent ranging movements near the Celtic Sea front (Southall *et al,* 2005) (Figure 8.3). Sightings of basking sharks and tagged basking sharks show that individuals use the waters off the Pembrokeshire coast, within the regional study area (Miller *et al.,* 2015, Witt *et al.,* 2012), supported by sightings data provided by the WWBIC (WWBIC, 2019). The WWBIC have three records of basking shark from 6th June 1960 (Appendix 8.2). The three sitings were made from the St Ann's Head between Wattick Bay and Dale, mostly likely of the same animal moving around the coast (Figure 8.4). There is another record from May 2014 which was recorded approximately 25km offshore of St Anns Head during small boat surveys from Neyland to Celtic Deep between 2005 and 2015. The Population size and structure estimates for the basking shark in the north-east Atlantic however are currently unknown.

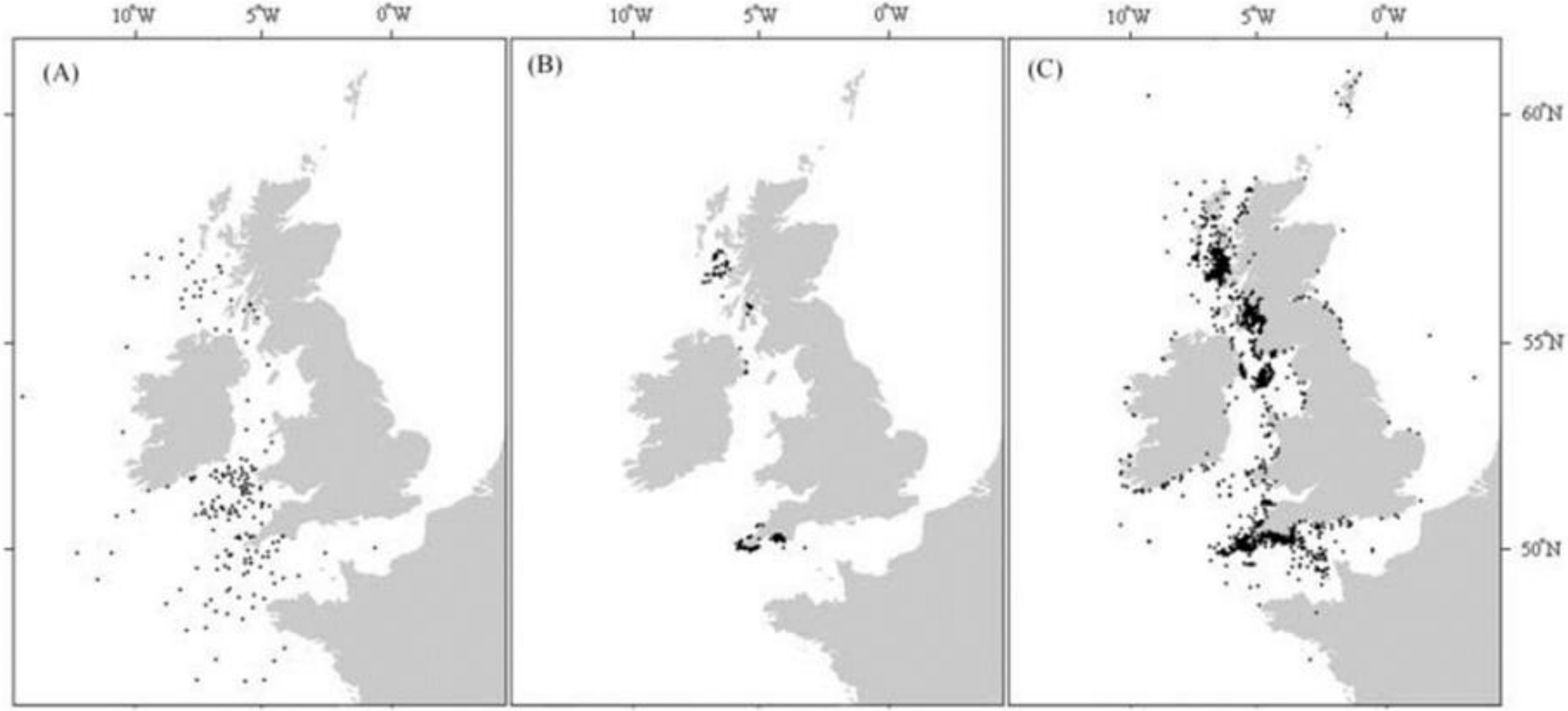


Figure 8.3: UK basking shark distribution based on three methods of (A) 191 tag geolocations collected from eight satellite tag ged basking sharks 2001-2003; (B) survey sightings of basking sharks (1994-2003); and (C) 4919 public sightings 1987-2004 (Southall et al., 2005)

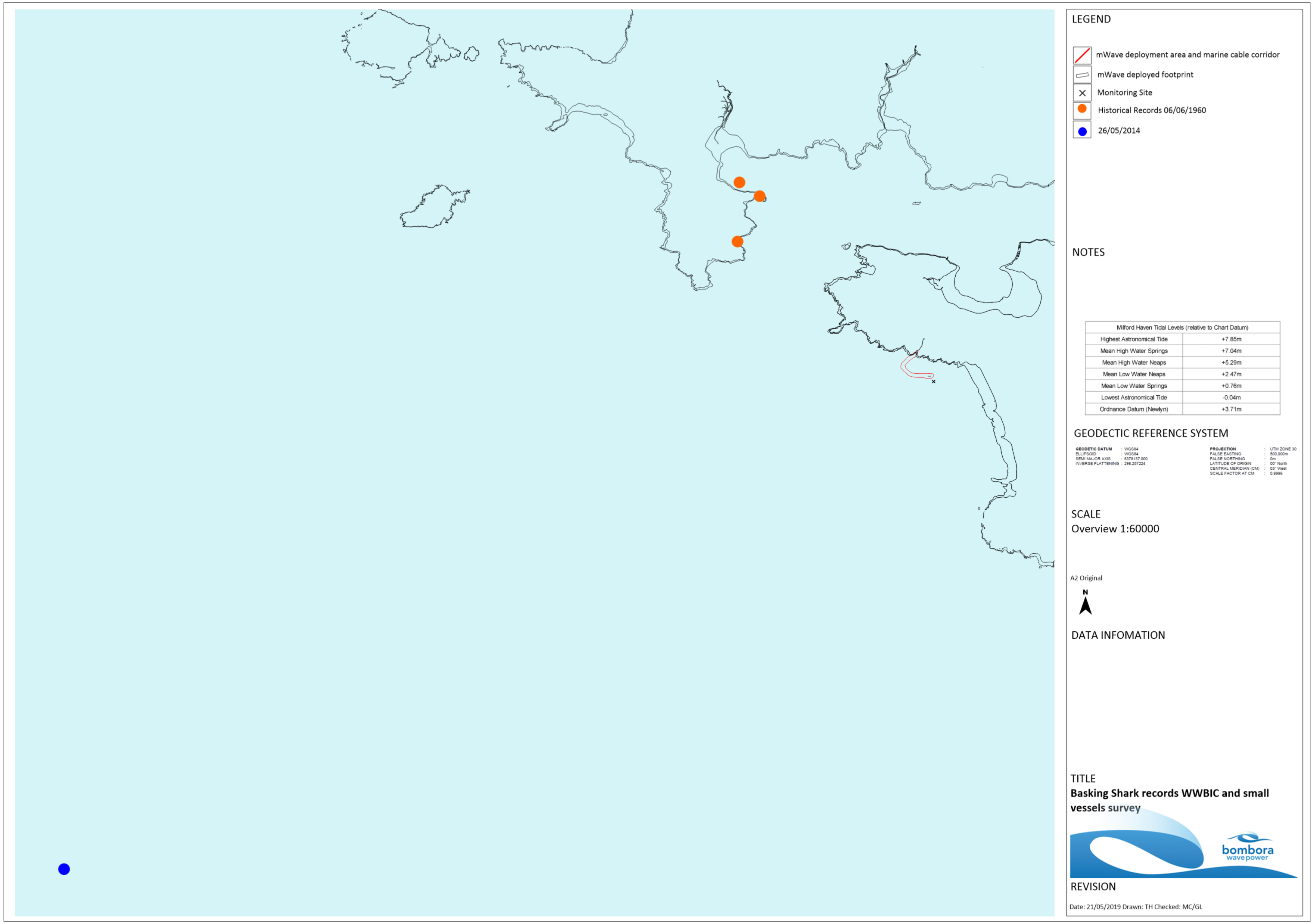


Figure 8.4 Basking shark siting data West Wales Biodiversity Information Centre and small vessel survey (2005 -2015)

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8.7.3 Regional Fish and Shellfish Assemblage

8.7.3.1 The inshore waters of Pembrokeshire consist of a wide range of demersal, bentho-pelagic and pelagic fish species, such as European plaice *Plueronectes platessa*, herring *Clupea harrengus* and cod *Gadus morhua*. Mobile and sessile shellfish inhabit both the intertidal and subtidal regions of the area, and elasmobranchs, such as sharks, skates and rays, can be found foraging for prey. The area is home to species of both commercial and conservation importance. For instance, the Waterway has been designated for its migratory fish species and acts as a spawning and nursery ground for a number of species.

8.7.3.2 Within the Waterway, the fish communities showed a significant variation in assemblages due to the salinity gradient from the mouth of the Waterway (full salinity) through to the Cleddau rivers (fresh water). The Waterway provides a diverse habitat of hard and soft substrates to support a wide variety of fish species, which is further enhanced by the presence of artificial/biological structures such as jetty piles, docks and localised beds of *Zostera* spp. and other macrophytes. Species found are described to be typical of species expected for an estuary of this type.

8.7.3.3 Seasonal otter trawl and seine netting surveys for the proposed Pembroke Power station, were undertaken in 2006 and 2007. These were carried out approximately mid-way in the Waterway (RPS, 2007; Figure 8.1). Assemblages recorded were gobies *Pomatoschistus* spp, sand smelt *Atherina presbyter* and sea bass *Dicentrarchus labrax*, clupeids including sprat *Sprattus spattus* and herring, pollack *Pollachius pollachius,* plaice, three species of mullet; thick lipped *Chelon labrosus*, thin lipped *Liza ramada* and golden grey *Liza aurata* and Atlantic salmon *Salmo salar*. Of these species the most abundant fish species sampled were gobies. with 400 individuals recorded in one trawl, associated with seagrass (*Zostera* spp.) and muddy seabed found within the trawl area (Figure 8.1). Elasmobranch species recorded were thornback ray *Raja clavate* and small-spotted catshark.

8.7.3.4 In addition to the surveys described above, other elasmobranchs species identified include other species of ray and tope *Galeorhinus galeus*, some of which have commercial importance. Low intensity nursery areas for these species occur in the area (see section 8.7.3.24 *et seq.*, for information on spawning and nursery habitats). Tope is listed as vulnerable on the IUCN Red List of Threatened Species.

8.7.3.5 Within the wider fish and shellfish study area, East Pickard Bay is located on the south side of the Angle Peninsula, which is the southern arm of the Waterway, where the tidal range can be found to remain consistent with minimal seasonal variation (PCNPA, 2013c). The geology of the area can be found to be predominately hard, red calcareous marls with sporadic red and green sandstones and very fine to coarse-grained sediments. The resulting geology and coastal processes have resulted in a range of biogenic and geogenic reef structures providing suitable habitat for migratory, demersal, benthic and pelagic fish species, as well as allowing shellfish to settle. Further information on coastal processes and the benthos can be found in Chapter 5: Coastal Processes and chapter 7: Benthic Subtidal and Intertidal Ecology, respectively.

8.7.3.6 Drop down video (DDV) surveys were undertaken off East Pickard Bay, near the mWave deployment in June 2018. Using bait to attract marine life, the surveys recorded assemblages of primarily dermersal fish species of *Triglidae* (includes sea robins and gurnards, bottom-feeding fish), common dab *Limanda limanda,* European plaice and Pleuronectidaem (includes flounders). The elasmobranch *Scyliorhinidae* (family of catsharks) and small-spotted catshark *Scyliohinus canicular* were also recorded.

8.7.3.7 The fish and shellfish study area provide a suitable spawning habitat for cod, sandeel *Ammodytes americanus*, plaice, sole *Solea vulgaris*, herring and sprat (Ellis *et al.,* 2012). The sheltered estuarine conditions also provide a safe environment for juvenile fish and other smaller species of fish, such as seahorses. The fish and shellfish study area can be considered as an important nursery area for sandeel, plaice, sole, whiting *Merlangius merlangus*, herring, mackerel, spotted ray *Raja montagui*, thornback ray and tope (Ellis *et al*., 2012) (see section 8.7.3.24 *et seq*, for information on spawning and nursery habitats).

8.7.3.8 The long snouted seahorse *Hippocampus guttulatus* are commonly associated with shallow beds of seagrass and seaweeds, swimming upright with their long tails wrapped around the plant stems, which helps them to avoid being swept away by currents[1]. The substrate in the coastal area off East Pickard Bay is exposed rocky shores, which is not appropriate habitat for seahorse. There are no records of the species on NBN Atlas in this area and, as such, seahorse are not included further within the assessment.

Migratory Fish Species

8.7.3.9 A number of migratory fish species have been designated as primary features of both the Milford Haven/ Sir Benfro Forol and the Cleddau River/Afnydd Cleddau SACs (see section 8.7.6). They have the potential to occur in the fish and shellfish study area, migrating to and from the Cleddau rivers which these species use either for spawning habitat or as a nursery area for growth and development into the adult stage (JNCC, 2017). Migratory fish species are of conservation importance as Annex II species protected under European legislation or as Welsh BAP priority species (see Table 8.10).

8.7.3.10 Four diadromous migratory fish are qualifying interest features of the Pembrokeshire Marine SAC: sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, allis shad *Alosa alosa* and twaite shad *Alosa fallax*. River and sea lamprey are also qualifying interest features of the Cleddau Rivers SAC (Table 8.8). Atlantic salmon, sea trout *Salmo trutta* and European eel *Anguilla anguilla* are all listed as OSPAR threatened/declining species and are listed as Welsh BAP priority species and have been found transiting the Waterway, however they are not features of either SAC.

[1] http://jncc.defra.gov.uk/page-5658

Sea Lamprey

8.7.3.11 The sea lamprey is distributed throughout the UK and can be found from the most southern regions of England up to the most northern parts of its ecological range in Scotland. Spawning occurs in lower reaches of the Cleddau Rivers in freshwater gravel beds. Upon hatching, juvenile lamprey will often burry themselves in gravel, silt or sand, to prevent predation. After five years in fresh water the lamprey progressively makes their way to the open sea to mature.

8.7.3.12 Barriers, such as weirs and dams, and pollution, can pose an obstacle to lamprey, leading to a decline in their population.

8.7.3.13 Records of sea lamprey occurring within the Waterway are limited, with the NBNAtlas indicating no confirmed lamprey sightings, but there are known populations within the Cleddau Rivers. Based on the precautionary principle it can be assumed that sea lampreys are present in the Waterway, however numbers are expected to low compared to other rivers found within the Bristol Channel area.

River Lamprey

8.7.3.14 The river lamprey can be found throughout the UK and western reaches of Europe and shares a similar ecology to the sea lamprey but is morphologically smaller (Maitland, 2003).

8.7.3.15 The river lamprey has been identified as an Annex II species that is a primary reason for the SAC selection of the Cleddau Rivers SAC. A known population occurs within the Cleaddau rivers and therefore can be expected to pass through the Waterway.

Allis and Twaite Shad

8.7.3.16 Both allis and twaite shad are in decline in many parts of Europe due to overfishing, pollution and migratory route obstructions. Measuring 30-50 cm, allis shad are usually larger than twaite shad which rarely exceed 40 cm.

8.7.3.17 Relatively little information is available on the habitat requirements of allis shad in freshwater. It grows in coastal waters and estuaries but migrates into rivers to spawn, swimming up to 800 km upstream in continental Europe. However, allis shad do not readily traverse obstacles to migration such as dams or weirs, and this has been a major cause of their decline. Adults spawn at night; the eggs are released into the current where they settle among gaps in gravelly substrates. Spawning sites tend to be used year after year, and relatively shallow gravelly areas adjacent to deep pools are thought to represent optimal spawning habitat. Almost all adults die after spawning.

8.7.3.18 Twaite shad returns from the sea to spawn in spring, usually between April and June. The habitat requirements of twaite shad are not fully understood. Twaite shad are known to spawn at night in shallow areas near deeper pools. The eggs are released into the water column, sinking into the interstices between coarse gravel/cobble substrates. The majority of adults die after spawning, though UK populations appear to have an unusually high proportion of repeat spawners – up to 25%. After hatching the fry develop and slowly drift downstream. Recruitment seems to be highest in warm years, and high flows between May and August may result in fry being washed prematurely out to sea.

Salmonids

8.7.3.19 Salmonids have a relatively primitive appearance among the teleost fish. They are slender fish, with rounded scales and forked tails. Their mouths contain a single row of sharp teeth. All salmonids spawn in fresh water, but in many cases the fish spend most of their lives at sea, returning to the rivers only to reproduce. Species include Atlantic salmon and sea trout.

8.7.3.20 The juvenile life stage of the Atlantic salmon typically lasts between one to four years before migrating to the sea. Following migration to the sea, salmon are known as post-smolts until the spring of the following year and after one winter a grilse. The adult Atlantic salmon spends the majority of its life at sea growing rapidly, only returning to fresh water environments to spawn from November to December but may extend from October to late February (SNH, 2017). Due to a highly acute sense of smell, the Atlantic salmon is able to remember the river in which it was born and on maturity is able to migrate back to the home river to spawn (Dipper, 2001). The length of time an Atlantic salmon spends in the sea varies from one to five years (Marine Scotland, 2011). Atlantic salmon are widely distributed throughout Wales and are recognised as Annex II (EU Habitats Directive), British Action Plan (BAP) species, a priority marine feature (juvenile) and OSPAR Designations. They are currently both nationally and internationally Important species.

8.7.3.21 The sea trout has a similar ecology to the Atlantic salmon but are smaller in size, have a much larger distribution, and remain within nearshore waters rather that undergoing extensive migration offshore (DECC, 2009). Trout spawn in winter from October to January, with the eggs deposited in redds[2] cut by the female in the river gravel. The sea trout has a large distribution throughout Wales and is recognised as a BAP species.

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[2] 'Nests' of spawning fish.

European Eel

8.7.3.22 The European eel has a complex life history, entering two metamorphization stages. Spawning occurs in the Sargasso Sea (mid Atlantic Ocean), after which larval eels cross the Atlantic Ocean. Once eels have reached the continental shelf, they will have metamorphized into 'glass eels', whereby some remain in the sea and others ascend rivers and move between marine, estuarine and freshwater environments. During this time, the European eel will develop pigmentation and are referred to as 'yellow eels'. The yellow eel state can last from 30-60 years before they enter a final metamorphization into 'silver eels' and return to the Sargasso Sea for spawning.

8.7.3.23 European eels are widely distributed throughout Wales and are recognised as a BAP species, priority marine feature, OSPAR Designations, IUCN Red List (critically endangered), and has a European Union Management Plan. They are currently both nationally and internationally Important species.

Spawning and nursery habitats

8.7.3.24 Juvenile fish assessments indicate that most parts of the Waterway support juvenile flatfish, particularly dab and plaice, but also brill *Scophthalmus rhombus* and turbot, *Scophthalmus maximus* with an above average abundance of dab and plaice when compared to figures for the whole of England and Wales (Riley *et al.,* 1986). Survivors of the first-year fish remain in the Waterway for at least a second year with the majority leaving on reaching sexual maturity. The Waterway is also recognised as a minor nursery area for flatfish (Riley *et al.,* 1986).

8.7.3.25 Herring have been known to spawn at three gravel sites in the Daugleddau (Crothers, 1966; Clarke and King, 1985; Hobbs and Morgan, 1992) although positions vary from year to year according to gravel availability. Over the past couple of decades, herring annual reported catches have decreased from circa 100 tonnes in the 1980s to less than 0.1 tonnes in 2018 as a result of market conditions (ICES, 2017; see Chapter 11: Commercial Fisheries). An interim report on the Milford Haven herring population by Clarke *et al.* (2018) suggests that spawning is greatly reduced compared to previous years (1980s), that herring growth rates were found to be slower (this was reflected across the wider Celtic Sea Herring population possibly due to environmental pressures and not specific to the Milford Haven) and mean length and weight were found to be considerably reduced potentially affecting fecundity of the species. However, this study represents a 'snapshot' in time. The Pembroke River and the tidal waters of the Daugleddau upstream of the Cleddau Bridge have been identified as bass nursery areas, as has an area in Pembroke Bay around the old power station outfall (Pawson *et al.,* 2002).

8.7.3.26 Outside of the Waterway, there are areas used as spawning and nursery grounds, high and low intensity, in particular by sandeel, herring, sole and other species (Figure 8.5 and 8.6).

8.7.3.27 The spawning and nursery habitats present in the fish and shellfish study area are summarised in Table 8.7 for all species for which data exist. Nursery and spawning habitats were categorised by Ellis *et al*. (2012) as either high or low intensity dependant on the level of spawning activity or abundance of juveniles recorded within these habitats. Species with high intensity habitats within or near the wider fish and shellfish study area or have overlap with a mWave site have been given individual species accounts (Figure 8.5 and Figure 8.6).

Cod

8.7.3.28 Cod spawning occurs between January to April with peak spawning during February and March, releasing approximately three to six million buoyant eggs that hatch after 12 days. Upon hatching, larval cod enter the plankton and can be carried for up to two months before settling on the seabed where they'll spend the majority of their life feeding on copepods and progressing on to herring, capelin and haddock (Dipper, 2001).

8.7.3.29 Cod is one of the UKs most important commercial species, however, landings data by ICES rectangle 32E4 and 32E5, encompassing the fish and shellfish study area, suggests relatively little fishing activity with on average landed weight of 2.1 tonnes from 2009 -2017 (see Chapter 13: Commercial Fisheries).

Sandeel

8.7.3.30 Sandeel spawning occurs from November to March, where up to 4,000-20,000 eggs are laid in sand and hatch after a few weeks. Sandeels are predominately a bentho-pelagic species that feed predominately on large diatoms, worms and small crustaceans (Dipper, 2001). Sexual maturity is reached at the age of two. The eggs are laid in clumps within sandy substrate until they hatch, after which they enter the water column. Sandeels will then metamorphose and settle in sandy sediments amongst adults (Van Deurs *et al*., 2009). As a result, there is very little movement between spawning and feeding grounds.

8.7.3.31 Sandeel are present through the wider study area, where suitable habitat exists. They have been categorised as a BAP species but are not of commercial value in the area.

Plaice

8.7.3.32 Plaice are widely distributed demersal flat fish throughout Britain and found within the intertidal region to depths of 8 m, on sand, gravel and mud (Faber Maunsell, 2007). Plaice spawning occurs between December to March, with each female producing up to half a million eggs, which are then laid within well-defined spawning grounds. Plaice are a demersal species and feed predominately on benthic species, cockles *Cerastoderma edule* and razor shells *Ensis magnus*, worms and crustaceans (Dipper, 2001). Plaice spawning and nursery grounds are identified in the upper reaches of the Waterway (Figure 8.5 and Figure 8.6).

8.7.3.33 Plaice is an important commercial fish and caught generally in trawls and seine nets. Average landings data indicates a landed weight of 1.8 tonnes from 2009 – 2017 (see Chapter 13: Commercial Fisheries).

Sole

8.7.3.34 Sole spawning occurs between March to May, releasing eggs into the environment. Sole is a demersal species feeding primarily on bottom-living small crustaceans and molluscs (Dipper, 2001). The main spawning grounds are identified as at the southern extent of the wider study area, though low intensity spawning if found in the offshore area as a whole. Nursery grounds are closer to shore, along the southern coast of the Angle Peninsula and within the Waterway.

8.7.3.35 They are commercially important with an average landed weight of 5.5 tonnes from 2009 – 2017 within the study area (see Chapter 13: Commercial Fisheries).

Herring

8.7.3.36 Herring are widely distributed throughout the UK and can be found in deep waters. Spawning times are dependent on sub-populations, and herring from Welsh waters have been found to spawn March to April (Ellis *et al*. 2010). Sticky Eggs are deposited on a wide range of substrate types, but preferred substrate type is gravel (Drapeau, 1973; Rogers & Stock, 2001). The eggs adhere to the seabed and can form extensive beds. After hatching, the larvae enter the plankton and drift with the current until reaching inshore nursery grounds. After a year they migrate further offshore to join adults at feeding grounds.. Low intensity herring spawning habitat is found along the Pembroke coast, in particular to the south of Angle Peninsula (Figure 8.5), with the mWave deployment area to its east.

8.7.3.37 Herring currently have a BAP in place and are under an EU management plan to ensure fish stocks are exploited at a maximum sustainable yield.

Sprat

8.7.3.38 Sprat is a coastal pelagic species, often found in shallow water close to shore, and sometimes tolerant of very low salinities (to 4%) (Whitehead, 1985). Sprat are a schooling species, with strong migrations between winter-feeding and spring and summer spawning grounds. Spawning occurs almost throughout the year, either near to coast or up to 100 km out to sea, mainly in April to August (Atlantic and Baltic) or as early as January in the English Channel. The eggs of sprat are pelagic and float either at the surface or in mid-water at a depth of 25 to 50 m. Spawning takes place in the open sea, although some small populations may spawn close to the coasts. The eggs hatch in three to four days, and the larvae drift inshore. The young of the year live close inshore in shallow water, often in schools with first-year herring. Nursery areas have been identified throughout the Waterway.

Whiting

8.7.3.39 Whiting is a widely distributed demersal species occurring at depths between 30 and 100m throughout UK waters. Whiting has a prolonged spawning period from February to June throughout its range. The eggs and larvae are pelagic, and the young remain pelagic until they attain a length of about 10 cm when they adopt a demersal habit. The nursery grounds tend to be located inshore and juveniles will remain in these areas for one or two years (Faber Maunsell, 2007). Whiting have been categorised as a BAP species.

Table 8.7: Summary of spawning and nursery habitat within the fish and shellfish study area from data present in Coull *et al.* (1998) and Ellis *et al.* (2010, 2012) (High intensity habitats that overlap with the wider fish and shellfish study area have been highlighted in grey).

Species	Latin / scientific name	Spawning habitats		Nursery habitats	
		Description	Distance to wider fish and shellfish study area (km)	Description	Distance to wider fish and shellfish study area (km)
Tope	*Galeorhinus galeus*	Location and temporal stability of specific parturition grounds are not well established. Spawning time: Viviparous species.	Not available	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Thornback ray	*Raja clavata*	As above. Spawning time: February – September (peak spawning: April – August).	Not available	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Spotted ray	*Raja montagui*	As above. Spawning time: May – July.	Not available	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Herring	*Clupea harengus*	Spawning habitat last dated in 2018 indicates small/none spawning populations of Herring. However, personal communication with D. Clarke (SEACAMS) positively identified spawning herring near Cleddau Bridge in the Waterway Spawning time: January – March.	0	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Cod	*Gadus morhua*	High intensity spawning grounds within the fish and shellfish study area.	0	Low intensity nursery habitat found to the west of the fish and shellfish study area.	0.25
Whiting	*Merlangius merlangus*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: February – June.	0	Low intensity nursery habitat coinciding with the fish and shellfish study area	0
Ling	*Molva molva*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: February – May.	0	Low intensity nursery habitat found to the west of the fish and shellfish study area.	0.25
European hake	*Merluccius merluccius*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: January – June.	0	Low intensity nursery habitat coinciding with the fish and shellfish study area	0
Anglerfish	*Lophius piscatorius*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: February – June.	0	As above.	0
Horse mackerel	*Trachurus trachurus*	Low intensity spawning habitat found within the fish and shellfish study area. Spawning time: March – August (Peak Spawning: May – June).	0	Not data available	Not data available
Sandeel	*Ammodytidae*	High intensity spawning habitat found within the wider fish and shellfish study area. Spawning time: November – March.	0	Low intensity nursery habitat within the wider fish and shellfish study area.	0
Mackerel	*Scomber scombrus*	Low intensity spawning habitat found within the fish and shellfish study area. Spawning time: March – July.	0	As above.	0

Species	Latin / scientific name	Spawning habitats		Nursery habitats	
		Description	Distance to wider fish and shellfish study area (km)	Description	Distance to wider fish and shellfish study area (km)
Plaice	*Pleuronectes platessa*	Low intensity spawning habitat found within the wider fish and shellfish study area. High intensity habitat can be found to the south of the fish and shellfish study area (out with the study area). Spawning time: December – March.	0	As above.	0
Sprat	*Sprattus sprattus*	Low intensity spawning habitat found within the fish and shellfish study area. Spawning time: May – August (Peak Spawning: May – June).	0	Nursery areas have been identified throughout the Waterway. Overlaps the fish and shellfish study area	0
Sole	*Solea solea*	Low intensity spawning habitat found within the wider fish and shellfish study area. High intensity habitat can be found to the south of the fish and shellfish study area. Spawning time: March – May.	0	High intensity nursery habitat can be found within the wider fish and shellfish study area.	0
Nephrops		Low density spawning habitat found adjacent to the north west corner (at the 12 NM contour) of the fish and shellfish study area. Spawning time: January – December (Peak spawning: April – June).	linimal overlap with wider study area	Low intensity nursery habitat adjacent to the north west corner (at the 12 NM contour) of the fish and shellfish study area	Minimal overlap with wider study area

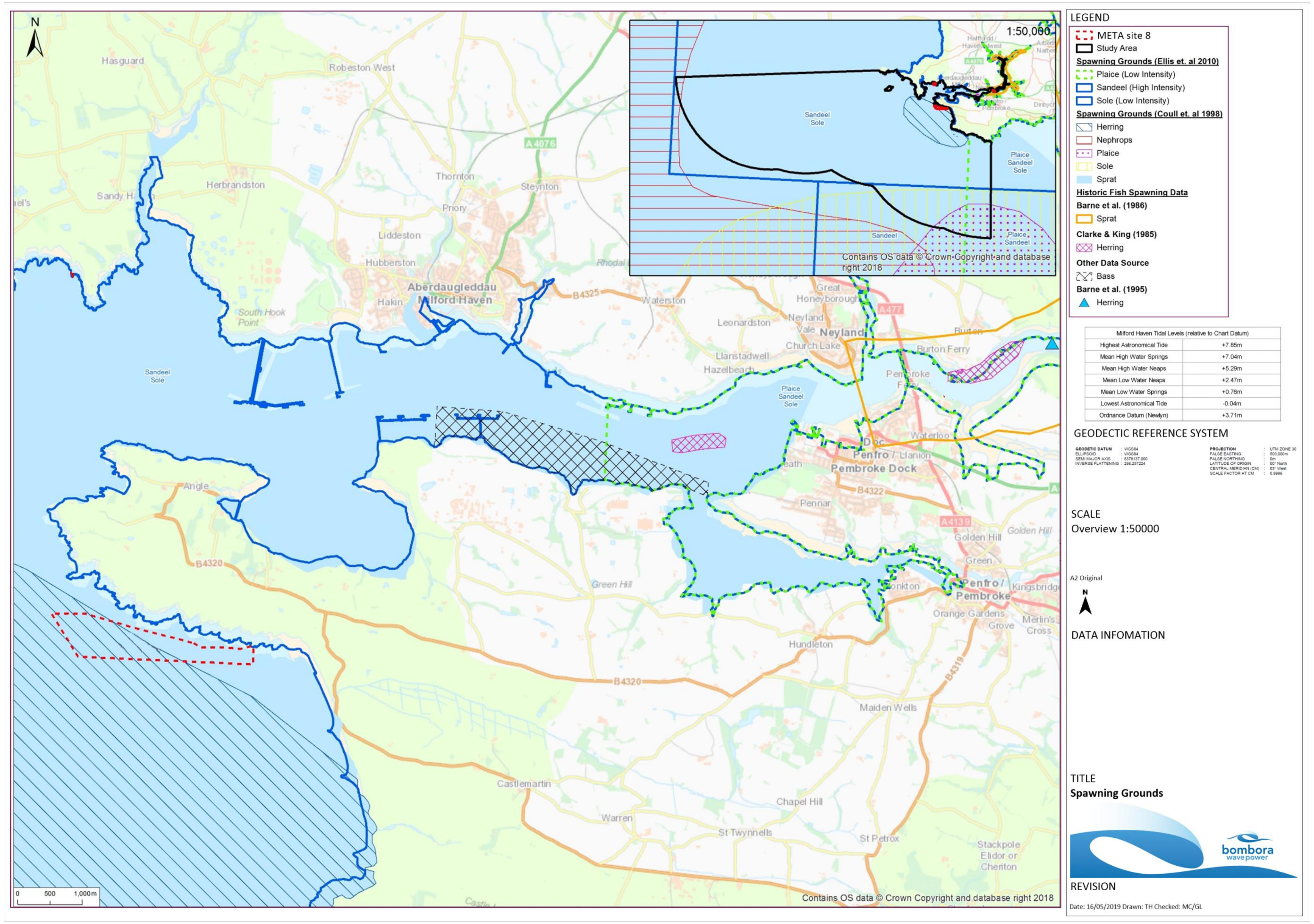

Figure 8.5: Spawning grounds within the wider fish and shellfish study area.

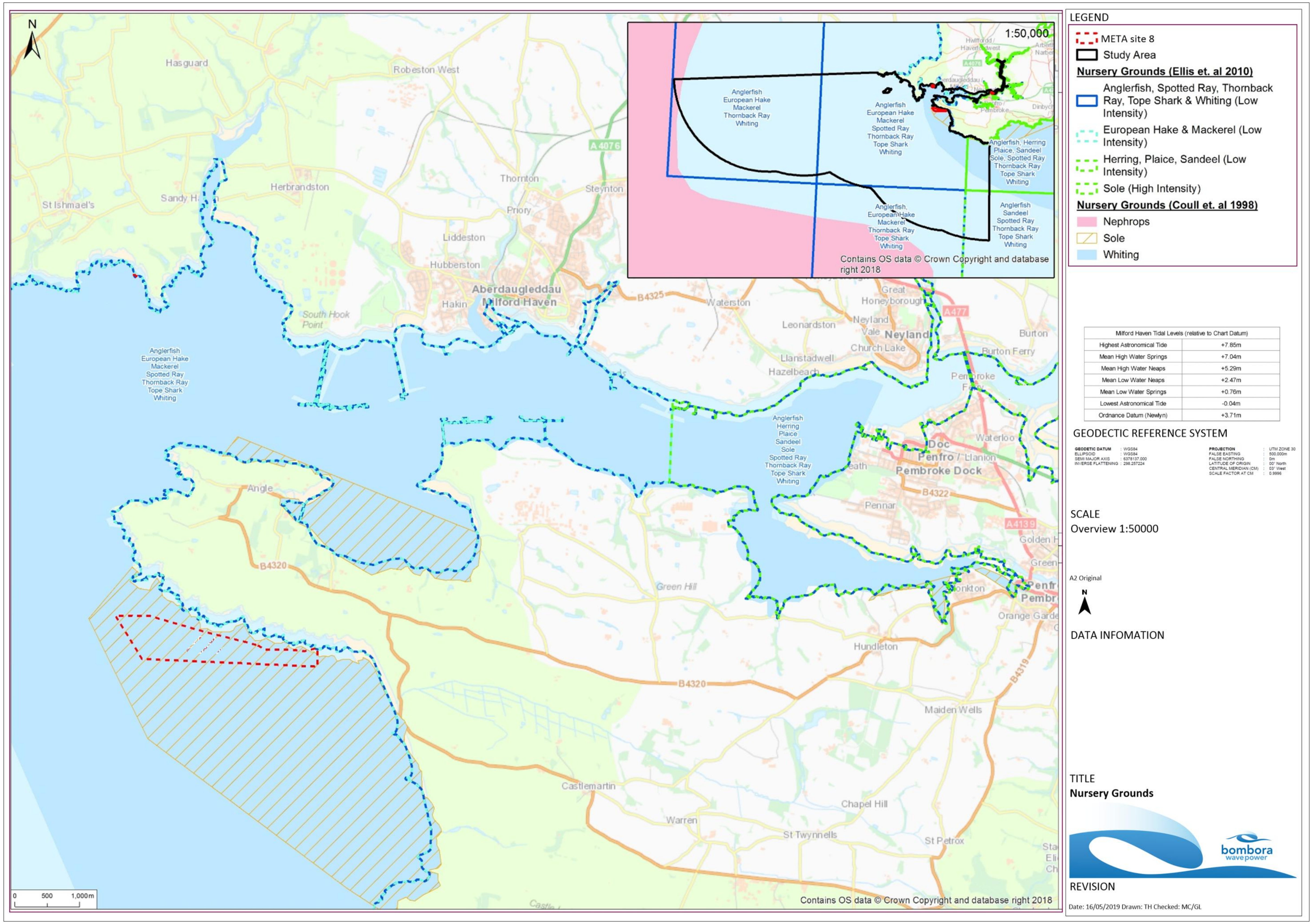

Figure 8.6: Nursery grounds within the wider fish and shellfish study area.

8.7.4 Local Shellfish Assemblage

8.7.4.1 Historically, the fish and shellfish study area has been harvested for cockles and Pacific oyster *Crassostrea gigas*, and in recent years the fisheries market has grown to include permits for carpet shell clams *Venerupis corrugata*, razors *Pharidae* spp. and native oysters *Ostrea edulis,* with aquaculture sites located off Swansea, Angle Bay and Castlebeach Bay. The large area and diverse marine habitats and sediment types has resulted in a variety of shellfish species including the native oyster, edible mussels *Mytilus edulis*, lobsters *Homarus gammus* and prawn *Palaemon serratus,* some of which have conservation and commercial value (see Chapter 11: Commercial Fisheries).

8.7.4.2 The DDV survey undertaken off East Pickard Bay, near the mWave deployment site, in June 2018 recorded shellfish assemblages of brown/edible crab *Cancer pagurus*, spiny spider crab *Maja squnado*, Portunida (includes swimming crabs). Pawson *et al.* (2002) describe the Pembrokeshire coast as a valuable potting ground. Potting for lobster, green shore crab *Carcinus maenas*, spider crab and velvet crab *Necora puber* is common in the fish and shellfish study area.

Spider Crab

8.7.4.3 Spider crabs have been recorded within the fish and shellfish study area, from Angle Bay up to Milford Haven Dock, with sightings around the coast of Pembrokeshire. Spider crabs generally feed on algae present on rocky substrata.

Velvet Crab

8.7.4.4 The velvet crab is a commonly occurring species whose distribution ranges from the lower intertidal/sublittoral *fringe* to depths of 80 m on rocky substrata (Clark, 1986). The species has an affinity for rocky substrata and is widespread around the UK coastline. Therefore, it is reasonable to assume that the species will occur in the fish and shellfish study area.

Green Crab

8.7.4.5 Green (shore) crabs can be found on all types of shores, from high water to depths of 60 m. Green crabs have been found throughout the year in the fish and shellfish study area and are abundant intertidally come spring. Shrimp have also been found on the seafloor, up to Lawrenny Quay.

Whelk

8.7.4.6 Whelk (*Buccinidae*) is a large sea snail is also found off the coast of Pembrokeshire. The species is commercially fish with pots being deployed to target the species.

Edible Mussel

8.7.4.7 Edible mussel beds are classed as a UK BAP Priority Habitat and currently on the OSPAR List of threatened and/or declining species and habitats. *Mussel* beds can also be key features of habitats listed in Annex I of the Habitats Directive. Wild stocks are present in patches throughout the wider fish and shellfish study area, either present on rocky shores or raised beds acting as 'nursery' areas for larvae. The main raised beds are found between the Cleddau Bridge and Picton Point at Lawrenny Quay, Coedcanlas and Sprinkle Pill. Jenkins Point, at the confluence of the Daugleddau the Carew and the Creswell Rivers, and Mount Pleasant are both Class B mussel beds (see Chapter 13: Commercial fisheries).

Native Oyster

8.7.4.8 Due to the specificity and sensitivity of the native oyster, it has been classified as a threatened species and is covered by a UK BAP. The species is of principal importance for conservation of biodiversity under the NERC Act 2006 and is on the OSPAR list of threatened and/or declining species.

8.7.4.9 Native oysters are found in the fish and shellfish study area with stocks present from Milford Haven town up to Picton Point. Native oyster beds found upstream of the Cleddau Bridge from Burton to Llangwm were sufficiently productive to support a historic fishery and were dredged commercially, especially at the known points of relative abundance at Lawrenny, Beggars Reach and Black Tar (Hobbs and Morgan, 1992). However, no permits for collection of native oysters have been awarded within the Waterway since 2010 (PNP, 2017), to allow recovery of shellfish stocks, except for two aquaculture sites which have been awarded permits in 2019.

Shellfish Waters

8.7.4.10 Historically, the Waterway has been harvested for wild cockles and Pacific oyster and in recent years the fisheries market has grown to include permits for carpet shell clams, razors. and native oysters. There are two areas within the Waterway that have been designated as shellfish waters under The EC Shellfish Waters Directive (79/923/EEC) directive. The waters within the Carew river were designated shell fish waters from 11th October 1999. The Milford Haven Cleddau (east and western Cleddau rivers) was also designated in 1999, however, following a review of designations in 2003/2004, the area was extended in March 2004. There are no designated shellfish waters off East Pickard Bay.

The EC Shellfish Waters Directive (79/923/EEC), adopted 30th October 1979, aims to protect or improve shellfish waters in order to support shellfish life and growth, therefore contributing to the high quality of shellfish products directly edible by man.

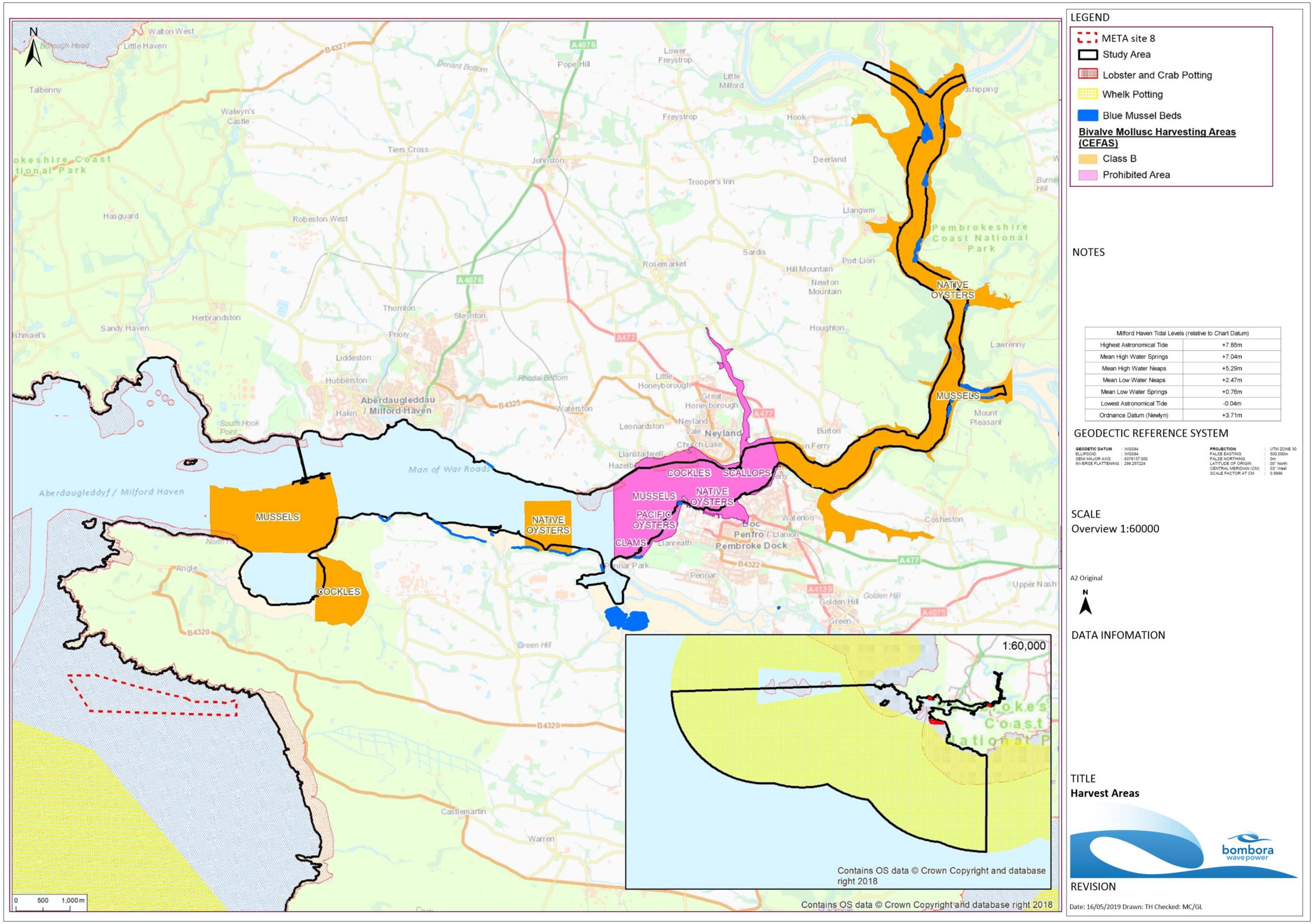

Figure 8.7: Shellfish areas within the wider fish and shellfish study area. Species identified which may be harvested within each Class B Bivalve Mollusc Harvesting Area (orange) are listed under each area identified. The area identified as a Prohibited Bivalve Mollusc Harvesting Area (pink), the species listed within this pink area may not be harvested at any time

8.7.5 Trends in abundance

8.7.5.1 Interrogation of landings data reveals that the amount of fish and shellfish taken from the wider fish and shellfish study area has on average remained constant during throughout 2009 – 2017 (Figure 8.8). The decline in landed weight in 2009 – 2010 may have been due to the implementation of the Marine and Coastal Access Act 2009, allowing for better management of the South Wales fisheries and therefore a reduction in landed weight (see Chapter 11: Commercial Fisheries for more information on fishing effort). From 2010 onwards, the observed trend oscillates around a mean of 2600 tonne of fish and shellfish caught per year indicating a consistent stock of fish and shellfish population.

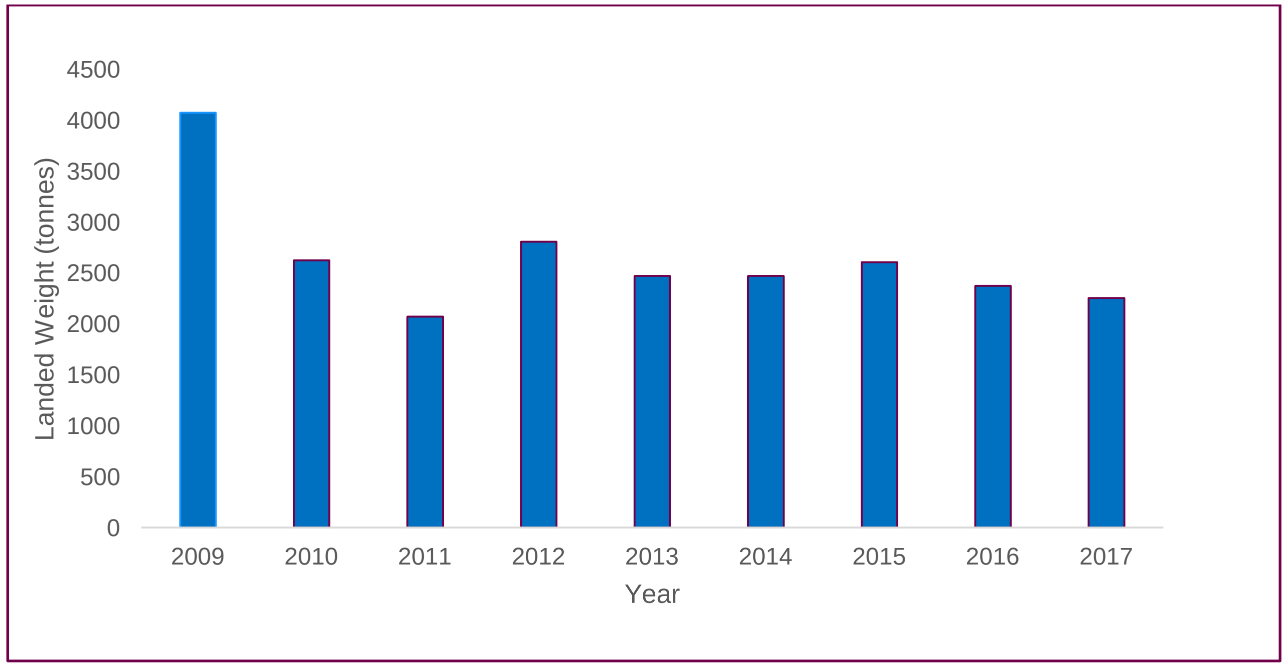

Figure 8.8: Total landings of fish and shellfish from the UK fleet landings per year (ICES rectangle 32E4 and 32E5).

8.7.6 Designated sites

8.7.6.1 Designated sites within the wider study area, which have fish and shellfish notified interest features and which have been considered in the fish and shellfish assessment are described in Table 8.8 below. Further screening of these features in relation to the mWave project is undertaken in Table 8.10.

Table 8.8: Designated sites and relevant qualifying interest features within the fish and shellfish assessment (light grey indicates species scoped out based on species ecology[3]).

Designated Site	Closest Distance to mWave site, (km)	Relevant Qualifying Interest Feature
Pembrokeshire Marine/ Sir Benfro Forol SAC	0	Sea lamprey *Petromyzon marinus*[1]; River lamprey *Lampetra fluviatilis*[1]; Allis shad *Alosa alosa*[1]; and Twaite shad *Alosa fallax*[1]
Cleddau Rivers/ Afonydd Cleddau SAC	17	Brook lamprey *Lampetra planeri*[1]; River lamprey *Lampetra fluviatilis*[2]; Bullhead *Cottus gobio*[2]; and Sea lamprey *Petromyzon marinus*[1]
Skomer Marine Conservation Zone	14	King scallop (*Pecten maximus*); Crawfish *Palinurus elephas*; Sunfish *Mola mola*.

[1] Annex II species present as a qualifying feature, but not a primary reason for site selection
[2] Annex II species that are a primary reason for selection of this site

8.7.7 Valued Ecological Receptors

8.7.7.1 The value of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM, 2016). Based on the Chartered Institute for Ecology and Environmental Management (CIEEM, 2016) guidelines for determination of VER, the following VER category definitions have been utilised (Table 8.9).

[3] Species are only present within a freshwater environment, therefore no route to impacts.

Table 8.9: Valued Ecological Receptors Categorisation for fish and shellfish.

Value of VER	Criteria to define value
Very high	• Internationally designated sites. • Species protected under international law (i.e. Annex II species listed as features of SACs).
High	• Nationally designated sites. • Species protected under national law. • Annex II species which are not listed as features of SACs in the fish and shellfish study area. • Nationally important populations of a species (particularly within the context of species that may be rare or threatened within the UK[a]) that occur within the fish and shellfish study area such as: UK BAP priority species (including grouped action plans) that continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework; MCZ/rMCZ features (species classified as features of conservation importance and broad scale habitats), NERC species of principal importance in Wales, or NIMF • Species that have spawning or nursery areas within the fish and shellfish study area that are important nationally (e.g. may be primary spawning/nursery area for that species).
Medium	• Regionally important populations of a species (particularly within the context of species that may be rare or threatened within the UK) that occur within the fish and shellfish study area such as: UK BAP priority species (including grouped action plans) that continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework, MCZ/rMCZ features (species classified as features of conservation importance and broad scale habitats), NERC species of principal importance in Wales or NIMF. • Species that are of commercial value to the fisheries which operate within the fish and shellfish study area. • Species that form an important prey item for other species of conservation or commercial value and that are key components of the fish assemblages within the fish and shellfish study area. • Species that have spawning or nursery areas within the fish and shellfish study area that are important regionally (i.e. species may spawn in other parts of the UK but that this is key spawning/nursery area within the fish and shellfish study area as the region of interest).
Low	• Species that are of commercial importance but do not form a key component of the fish assemblages within the fish and shellfish study area (e.g. they may be exploited in deeper waters outside the fish and shellfish study area). • The spawning/nursery area for the species are outside the fish and shellfish study area. • The species is common throughout the UK but forms a component of the fish assemblages in the fish and shellfish study area.

[a] Measured against criteria such as OSPAR threatened/declining species and IUCN Red List of threatened species.

8.7.7.2 Based on the baseline characterisation above, a number of Valued Ecological Receptors (VER) were identified within the wider fish and shellfish study area. These have been amalgamated into VER groupings of similar/representative species and are presented in Table 8.10 and Table 8.11. Justification for these groupings are also provided in these tables. The species factors considered as part of the VER assessment include:

- Populations present within the fish and shellfish study area, based on commercial fisheries landing data were available (Chapter 11: Commercial Fisheries);
- Spawning or nursery grounds within the study area;
- Conservation value within the study area; and
- Commercial value within the study area.

8.7.7.3 For some of the VERs, whilst there are in the wider study area, the potential for impact from the mWave project is highly unlikely and as such these have been scoped out of the assessment. These VERs are italicised within the table and justification for scoping out is provided .

Table 8.10: Fish ecology VERs in the fish and shellfish study area including justification for those scoped out of further assessment (*italicised*)

Fish VERs	Representative species	Value within the study area	Justification
Estuarine and coastal fish assemblage	• **Gobies** • **Dab** • **Mullet** • **Sand smelt** • **Sea bass** • **Flounder** • **Solenette** • **Lesser spotted dogfish** • **Catshark**	**Low**	**Species that form a key component of the ecosystem: no specific protection although some species may be commercially valuable to local fisheries** **Wales BAP priority species commonly found in the region** **Regionally important population of Annex II species also listed as OSPAR threatened or declining species and UK BAP Priority species.**
	• **Plaice** • **Cod**	**Medium**	
	• **Thornback ray** • **Tope shark**	**Medium**	
Migratory fish species	• *Sea trout* • *European eel* • *Atlantic salmon*	*High*	*All the species identified migrate to the waters of the Waterway, using different mechanisms for wider and local navigation such as solar cues, currents and olfactory trails (Binder 2011).* *mWave is a WEC which will be deployed off East Pickard Bay on the open coastal waters south of Angle Peninsula and some 3.5km to the south east of the mouth of the Waterway. The device sits on the seabed and it will generate energy through the displacement of air from membrane covered cells which are present on the top of the device. The displaced air is passed through an enclosed generator before being re-circulated through the device. By its very nature the mechanisms within the device has to be contained to prevent air escaping, and as such there are no areas which contain moving parts which will impact on fish. As such if a migrating fish were to follow the coastline to the Waterway the physical presence of the mWave device would not hinder or impact on their passage.* *Bathymetric survey confirmed that the deployment site for mWave is flat even sand (Titan 2018). The installation of mWave requires no site preparation, no installation of foundation and no piling. The device is simply towed to site on the surface by two vessels (and accompanied by a guard boat) and then gently lowered to the seabed through reduction in buoyancy. Once on the seabed the gravity foundation will settle into the sand up to a depth of 1m. Ballast in the form of chain will be added to trays. The marine cable from mWave to the coast will be laid on the seabed, with no trenching or burial, using one vessel. As such increased suspended sediments as a result of installation works will be minimal and short term (Chapter 5: Coastal Processes).* *Within Chapter 6 an assessment of underwater noise during installation activities was undertaken. Review of noise data confirmed that as there is no piling or site levelling works, the most significant noise would originate from the range of vessels on site, with cable laying activities being most persistent. Any ballast installation would require a short time on site before the vessel returns to port to repeat the process. The worst case potential distance for disturbance for fish during installation is 21m as a result of the vessel used for cable laying. Cable laying activity will be of short duration, undertaken on up to 3 days, with the installation of mWave taking up to 3 days, and placement of ballast 5 days. Based on this information it is concluded that the short term deployment of mWave will not impact on the movement of migratory fish to and from the Waterway. See table 8.13 for further information on underwater noise.* *In addition to this, whilst noise data is not available for the operation of mWave, data is available for other marine energy devices such as Pelamis P2 (a semi submerged surface WEC) and OpenHydro (tidal turbine) (Chapter 6 Underwater Noise). Both of these devices are considered to be worst case in comparison to mWave with respect to noise. For instance, noise surveys for Pelamis P2 indicated a significant noise component associated with mooring lines and its movement on the surface, neither of which is relevant to mWave. Significant noise can also be generated from turbines in particular through cavitation. The mWave turbine operates in air at subsonic speeds meaning there is no equivalent noise source. During operation worst case disturbance distance identified was between 6m - 78m. Even taking into consideration the worst case exclusion area based on Pelamis data, due to the coastal location of mWave, with it being positioned approximately 415m from MLWS at 11m below CD (Chapter 2: Project Description), it will not inhibit fish movement along the coast.* *To conclude, due to the short term low impact installation method and the benign operational nature of the device, it is considered that mWave will not impact on migratory fish accessing the Waterway and as such these species have not been considered further.*
	• *Allis shad* • *Twaite shad* • *River lamprey* • *Sea lamprey*	*Very high*	

	• **Common skate** • **Blue whiting** • **Blue ling** • **Ling** • **Horse mackerel**	**Low**	**Spawning or nursery grounds in wider region but no overlap with fish and shellfish study area.**
Spawning or nursery grounds in the study area	• **Hake** • **Anglerfish** • **Herring** • **Mackerel** • **Plaice** • **Whiting** • **Sprat** • **Tope shark** • **Thornback ray** • **Spotted ray**	**Medium**	**Low intensity spawning, or nursery habitat overlaps the fish and shellfish study area.**
	• **Cod** • **Sole** • **Sandeel**	**High**	**High intensity spawning, or nursery habitat overlaps the fish and shellfish study area.**
Basking Shark	• *Basking shark*	*Very High*	*Whilst Basking shark are an internationally protected species / European Protected Species and they have been recorded migrating through the wider regional study area, it is considered that mWave will not have a detrimental effect on this species. The mWave device will sit on the seabed and will generate energy through the movement of air from membrane covered cells which are present on the top of the device. The displaced air is passed through an enclosed generator before being re-circulated through the device. By its very nature the mechanisms within the device have to be contained to prevent air escaping, and as such there are no areas which contain moving parts which may cause impact to migrating fish such as basking shark.* *Bathymetric survey confirmed that the deployment site for mWave is flat even sand (Titan 2018). The installation of mWave requires no site preparation, no installation of foundation and no piling. The device is simply towed to site on the surface by two vessels (and accompanied by a guard boat) and then gently lowered to the seabed through reduction in buoyancy. Once on the seabed the gravity foundation will settle into the sand up to a depth of 1m. Ballast in the form of chain will be added to trays. The marine cable from mWave to the coast will be laid on the seabed, with no trenching or burial, using one vessel. As such increased suspended sediments as a result of installation works will be minimal and short term (Chapter 5: Coastal Processes).* *Within Chapter 6 an assessment of underwater noise during installation activities was undertaken. Review of noise data confirmed that as there is no piling or site levelling works, the most significant noise would originate from the range of vessels on site. The worst case potential distance for disturbance for fish during installation is 21m as a result of the vessel used for cable laying. Cable laying activity will be of short duration, up to 3 days, with the installation of mWave taking up to 3 days, and placement of ballast 5 days, with* any ballast installation vessel being on site for a short time before returning to port to repeat the process.. *Based on this information it is concluded that the short term deployment of mWave will not impact on the movement of basking sharks.* *In addition to this, whilst noise data is not available for the operation of mWave, data is available for other marine energy devices such as Pelamis P2 (a semi submerged surface WEC) and OpenHydro (tidal turbine) (Chapter 6: Underwater Noise). Both of these devices are considered to be worst case in comparison to mWave with respect to noise. For instance, noise surveys for Pelamis P2 indicated a significant noise component associated with mooring lines and its movement on the surface, neither of which is relevant to mWave. Significant noise can also be generated from turbines in particular through cavitation. The mWave turbine operates in air at subsonic speeds meaning there is no equivalent noise source. During operation worst case disturbance distance identified was between 6m - 78m. Even taking into consideration the worst case exclusion area based on Pelamis data, due to the coastal location of mWave, with it being positioned approximately 415m* from *MLWS at 11m below CD (Chapter 2: Project Description), its presence will not restrict basking shark movement along the coast, as they can easily pass inshore or offshore of the device, as such this species has not been considered further.*

Table 8.11: Shellfish ecology VERs in the fish and shellfish study area, including those scoped out of further assessment.

Shellfish VERs	Representative species/habitats	Value within the study area	Justification
Designated shellfish waters	• *Cleddau Rivers (Eastern and Western)* • *Carew River*	*High*	*Areas within the Waterway are designated to protect the quality of shellfish waters under the EC Shellfish Waters Directive. mWave will be deployed off East Pickard Bay on the open coastal waters south of Angle Peninsula, some 3.5km distant from the mouth of the Waterway. As such no direct or indirect impact is predicted on the designated shellfish waters within the Waterway. VER not considered further.*
Estuarine and coastal shellfish assemblage	• *Native oyster (Oyster beds on shallow subtidal muddy sediment)*	*High*	*Designated feature of the Milford Haven waterway SSSI. Populations widespread through study area and commercially exploited; OSPAR threatened/declining species and UK/Wales BAP priority species. mWave will be deployed off East Pickard Bay on the open coastal waters south of Angle Peninsula, some 3.5km distant from the mouth of the Waterway. As such no direct or indirect impact is predicted on the Oyster beds within Milford Haven Waterway SSSI . VER not considered further.*
	• **Mussel beds**	**Medium**	**Populations widespread through study area and commercially exploitation; OSPAR threatened/ declining species and UK/Wales BAP priority species.**
	• **Common cockle** • **Carpet shell clam** • **Common periwinkle** • **King scallop** • **European lobster** • **Spider crab** • **Velvet swimming crab** • **Green (shore) crab** • **Common prawn**	**Low**	**Commonly recorded within the Waterway but no conservation value. There is some small-scale commercial exploitation of these species and Pembroke coast is used as a potting ground for whelks and crustacean species.**
Spawning or nursery grounds in the study area	• *Nephrops*	*Low*	*Spawning or nursery grounds in wider region but only very slight overlap with wider fish and shellfish study area at 12 NM contour to north west of study area. Due to mWaves short installation and decommissioning times, the lack of piling and ground preparation works, and its distance to the spawning/nursery grounds, no impact is anticipated from mWave. VER not considered further.*

8.7.8 Sensitivity to marine energy devices

8.7.8.1 The Scottish Marine Renewables SEA (Faber Maunsell, 2007) summarised the sensitivity of fish and shellfish species to impacts associated with marine devices. This data has been derived from the MarLIN website and the criteria for determining species sensitivity can also be found there.

- Sprat: Considered to be of medium sensitivity to temporary increases in suspended sediments;
- Sandeel: Considered to be of high sensitivity (spawning areas) to temporary changes in habitat, and low sensitivity to temporary increases in suspended sediments;
- Herring: Considered to be of high sensitivity (spawning areas) to temporary increases in suspended sediments.
- Brown (edible) crab: Considered to be of medium sensitivity to temporary changes in habitat; and*Common w*helk: considered to be of low sensitivity to temporary increases in suspended sediments.

8.7.9 Future baseline scenario

8.7.9.1 The (Marine Works (EIA) Regulations 2007 (as amended 2017)) requires that *"a description of the relevant aspects of the current state of the environment (baseline scenario), and an outline of the likely evolution thereof without implementation of the project, as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*" is included within the Environmental Statement.

8.7.9.2 In the event that the mWave project does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

8.7.9.3 Recent research has suggested that there have been substantial changes in the fish communities within the fish and shellfish study area over several decades, as a result of a number of factors including climate change and anthropogenic activities (i.e. industrialisation of the fish and shellfish study area, fishing, aquaculture etc.) (DECC, 2016a). These communities consist of species that have complex interactions with one another and the natural environment.

8.7.9.4 Overall, climate change may influence fish distribution and abundance, affecting growth rates, recruitment, behaviour, survival and response to changes of other trophic levels. However, due to the short time scale of mWave Project (18 months) there is unlikely to be a discernible difference in the baseline scenario.

8.7.10 Data limitations

8.7.10.1 Mobile species, such as fish, exhibit varying spatial and temporal patterns. All survey data across the fish and shellfish study area that has been utilised in the baseline characterisation, provides a semi-seasonal description of the fish and shellfish assemblages. However, this may vary considerably over time. In addition to this, survey methods employed may vary in their efficiency to catch species (i.e. otter trawls for pelagic species versus a benthic trawl for sandeels and prawn).

8.7.10.2 The desk-based review indicated the presence of fish and shellfish species within the fish and shellfish study area and whether spawning and nursery behaviour occurs. The following assumptions have been made:

- Spawning and nursery habitat data spatially and temporally varies over time (Ellis *et al.,* 2010), with data only being available at a very coarse level. It has therefore been assumed that if the fish and shellfish study area overlap with either habitat, then fish are present, unless evidence suggests otherwise (i.e. incompatible ecological parameters e.g. freshwater species in marine environments); and
- Migratory patterns of fish and shellfish species are not clearly defined in available literature. Where available evidence suggest presence, it is assumed that the species is present.

8.7.10.3 Any data limitations outlined above will not affect the conclusions of the impact assessment.

8.8 Key parameters for assessment

8.8.1 Introduction

8.8.1.1 The design parameters (from Chapter 2: Project Description) identified in Table 8.12 have been selected as those most likely to have the potential to result in the greatest potential effect on an identified receptor or receptor group. A report by Freeman *et al.* (2013) for the Natural Environment Research Council, identified the key potential impacts on fish and shellfish from wave and tidal devices from full scale devices currently installed/operating in UK waters. Key impacts identified were 'barrier effects on movement and migration' (wave and tidal devices), 'underwater collision' (primarily tidal devices) and 'habitat creation' (wave and tidal devices) in Table 8.12 and 'underwater noise' (primarily tidal devices), and 'EMF emissions' (primarily tidal devices) in Table 8.13.

8.8.1.2 Impacts, such as 'sediment deposition' for the fish and shellfish chapter have been amalgamated into the 'temporary increases in suspended sediments' impact.

8.8.1.3 The fish and shellfish assessment will be used to inform the following assessments:

- Chapter 9: Marine Mammals;
- Chapter 10: Marine Ornithology; and
- Chapter 11: Commercial Fisheries.

8.8.1.4 The fish and shellfish assessment have been informed by the following assessments:

- Chapter 5: Coastal Processes; and
- Chapter 7: Benthic Subtidal and Intertidal Ecology.

8.8.2 Impacts scoped out of the assessment

On the basis of the baseline environment and the project description outlined in Chapter 2: Project Description, a number of impacts have been scoped out of the assessment for fish and shellfish. These impacts are outlined, together with a justification for scoping them out, in Table 8.13.

Table 8.12: Design parameters considered for the assessment of potential impacts on fish and shellfish.

Potential impact	Design parameter	Justification
Installation and decommissioning phases		
Temporary changes in fish and shellfish habitat	• Six temporary anchors will be positioned in advance of vessels moving to site to deploy or retrieve mWave. Whilst the mooring spread will be of the order 40,000m², the actual area affected will be much less (each mooring comprising an 4m x 4m anchor and 65m of 4.4cm chain). • Temporary habitat disturbance arising from mWave gravity base (1032m²). • Gravity foundation to 1m depth. Device height above sea bed will be 7m. • Cable will initially cross sandy substrate and as such there will be temporary disturbance of sediments (approx 210m²). Use of 4 rock bags to stabilise the offshore section of cable. • Total area <1900m². (including possible scour protection)	The introduction of hard structures, such as a marine energy device, gravity base, have the potential to result in temporary habitat loss, disturbance or creation. The structures will be placed directly on the seafloor, resulting in potential changes to fish and shellfish supporting habitat. Further assessment of the effect of mWave on habitats in the medium term are considered under operational effects.
Temporary increases in suspended sediments	• Temporary disturbance from pre-installed moorings required for installation, 200m x 200m = 40,000m² • Temporary habitat disturbance arising from mWave gravity base (1032m²) • Cable will initially cross sandy substrate and as such there will be temporary disturbance of sediments (approx 210m²). Use of 4 rock bags to stabilise the offshore section of cable. • A total of 3 vessels, including guard boats, will be required for the deployment of mWave over a 3 day period. Installation of ballast into trays and therefore won't affect suspended solids. • One vessel will be required for up to three days for cable laying. • Total area <1900m². (including possible scour protection)	Installation of mWave and ancillary infrastructure within a sandy substrate environment will result in sediment plumes being generated. Vessel movement associated with device deployment and cable laying may also result in suspended sediments through propeller backwash. Six temporary anchors will be positioned in advance of vessels moving to site to deploy mWave. Whilst the mooring spread will be of the order 40,000m², the actual area affected will be much less (each mooring comprising an 4m x 4m anchor and 65m of 4.4cm chain). As such this assessment is worst case.
Accidental Pollution	• A total of 3 vessels, including guard boats, will be required for the deployment of mWave over a 3 day period. Maximum size of vessel 50m with 6m draught. • 14 vessel trips over 5 days for delivery of ballast. • One vessel will be required for up to three days for cable laying. Size of vessel 50m with 6m draught.	Installation of mWave and cable may result in an unforeseen accidental pollution event.
Operational phase		
Colonisation of Hard Structures	• Presence of new structures - mWave gravity base (1032m²) and ADCP base and SUTU (4m²). • Communication cable approx 210m². • Scour protection (approx 668 m²) - whilst not anticipated an allowance of 2m area around the edge of mWave has been allowed as a worst case assessment. • Total area <1900m² (including possible scour protection)	Introduction of a novel structure, such as mWave, may lead to marine fauna and flora colonising these hard structures which may attract fish.
Medium term habitat loss	• Medium term habitat loss arising from mWave gravity base (1032m²) and ADCP and SUTU base (4m²). • Cable approx 210m². • Scour protection (approx 668 m²) - whilst not anticipated an allowance of 2m area around the edge of mWave has been allowed as a worst case assessment. • Total area <1900m². (including possible scour protection)	Whilst testing of mWave will last 6 - 12months, the device will be in the water for a longer duration, namely up to 18 months. This represents the maximum period of time that could lead to habitat loss.
Accidental Pollution	Maximum duration of mWave testing activity is 6-12 months, with a total project time of 18 months. • O&M visits during testing activity with up to three vessels once per month for 2 days giving 24 visits in 12 months. • 50m max length, 6m draught.	There is a risk of accidental pollution from vessel spills during O&M operations.

Table 8.13: Impacts scoped out of the assessment for fish and shellfish.

Potential impact	Justification
Installation and Decommissioning Phases	
Underwater noise	There is potential for installation vessels and activities such as cable laying to produce noise during installation of mWave. The noise emissions from the types of vessels that may be used in the mWave Project are quantified in Chapter 6: Underwater Noise. No dynamic positioning will be required for installation vessels and there will be no pile drive pilling or sea bed clearance associated with mWave deployment. The device is simply towed to site on the surface by two vessels (and accompanied by a guard boat) and then gently lowered to the seabed through reduction in buoyancy. Once on the seabed the gravity foundation will settle into the sand up to a depth of 1m. Ballast in the form of chain will be added to trays. The communication cable will be laid on the seabed surface and not trenched. Review of noise data confirmed that as there is no piling or site levelling works, the most significant noise would originate from the range of vessels on site. During installation the worst case noise would be generated from the vessels laying the cable which would occur for up to 3 days in total. Any ballast installation would require a short time on site before the vessel returns to port to repeat the process. Chapter 6: Underwater Noise shows the calculated ranges of injury to fish with swim bladders in line with ASA guidelines, based on exceedance of 170 dB re 1 μPa (rms) over 48 hours continuous exposure, and the potential disturbance radius to fish based on the WSDOT criterion of 150 dB re 1 μPa (rms). Fish with a swim bladder (maximum adverse) (Table 6.9 Chapter 6) would have to be within 3m to have the potential for high risk of injury due to exposure to installation noise associated with the mWave project (cable laying) based on ASA qualitative criteria. SELs have been estimated for each source based on 24 hours continuous operation. The behavioural disturbance during installation would occur up to 21m for all fish. SELs for cable laying vessels have been recorded at 229 dB re 1 μPa^2s with miscellaneous small vessels at 221 dB re 1 μPa^2s, which currently transit the wider area throughout the year Chapter 6: Underwater Noise). All installation activities will be of short duration (3-5days). It is therefore unlikely that a significant change in fish behaviour will occur as a result of the installation vessels off East Pickard Bay as it will be short term, most likely resulting in fish moving away from the installation site and returning to the area following cessation of installation works. Noise monitoring will be undertaken during the testing phase of the mWave deployment to confirm these conclusions. In terms of disturbance from installation vessels, the worst case potential distance is 21m as a result of the vessel used for cable laying. Cable laying activity will be of short duration, up to 3 days, with the installation of mWave taking up to 3 days, and placement of ballast 5 days, with any ballast installation vessel being on site for a short time before returning to port to repeat the process. Based on this information it is concluded that the short term deployment of mWave will not significantly impact on the fish. No further assessment is proposed.
Operational phase	
Underwater noise	The mWave project will be the first deployment of the full-scale device and as such device specific operational noise data is not available. As data was not available, a data review of operational noise from marine renewable devices was undertaken and data from a Pelamis P2 WEC and OpenHydro tidal turbine were identified (Chapter 6: Underwater Noise). The Pelamis P2 WEC is a semi submerged, articulated structure composed of cylindrical sections linked by hinged joints. Motion from the waves is resisted by hydraulic rams, which pump high-pressured oil through a system of hydraulic motors via smoothing accumulators. As such the mechanical motion of the Pelamis WEC, which is used to generate electricity is likely to be significantly noisier than the displacement of air from membrane covered cells on mWave. Whilst this data is of value to provide an assessment of potential impact it is likely to be conservative. An assessment of the distance to onset of injury from each marine renewable device is presented in Chapter 6: Underwater Noise based on the SEL cumulative exposure criterion, along with an assessment of potential disturbance zones. As noted previously, the potential radii for injury are based on exposure levels over a 24-hour period. In reality, an animal is highly unlikely to spend 24 hours within a short range of an operating device and the radii can therefore be considered as a maximum scenario, highly precautionary zone. The ASA radius of potential recoverable injury assuming continuous exposure within 48 hours is 4m for a wave device (Pelamis P2), with an associated 78m radius of disturbance. A tidal device (OpenHyrdo tidal turbine) may have a radius of potential recoverable injury of 0m with an associated 6m disturbance radius. Chapter 6: Underwater Noise concludes that, based on the ASA guideline criterion for potential injury to fish with swim bladders involved in hearing of 170 dB re 1 μPa (for 48 hours exposure), it is not expected that any fish will experience injury as a result of exposure to noise from the operation of mWave. It is concluded that it is unlikely that the operation of mWave will result in a significant change in fish behaviour and that when operating (when waves are present), the fish can move away from the area if need be, returning to the area following cessation of operation. Noise monitoring will be undertaken during the testing phase of the mWave deployment to confirm these conclusions. No further assessment is proposed.
Collision of fish	mWave is a WEC device which sits on the seabed using a gravity foundation and will occupy about 7m above the seabed. mWave generates energy through the displacement of air from membrane covered cells which are present on the top of the device. The displaced air is passed through a generator which is totally enclosed. As such there are no external areas of mWave which contain moving parts which will impact on fish. No further assessment is proposed.
Electromagnetic field (EMF)	EMF emitted by communications cables during the operational phase is expected to have negligible impact on receptors. The cable will primarily be used for communication with the mWave, therefore it will only carry a very small voltage when waves pass overhead, and will result in little or no EMF that may act as a barrier to movement.
Fish ingress	As discussed previously mWave is a WEC device which sits on the seabed. It generates energy through the displacement of air from membrane covered cells which are present on the top of the device. The displaced air is passed through a generator. By its very nature it has to be contained to prevent air escaping, as such there are no areas which contain moving parts into which a fish can ingress. No further assessment is proposed.

8.9 Impact assessment methodology

8.9.1 Overview

8.9.1.1 The fish and shellfish assessment has followed the methodology set out in Chapter 4: Environmental Impact Assessment Methodology. Specific to the fish and shellfish assessment, the following guidance documents have also been considered:

- Consenting, EIA and HRA Guidance for Marine Renewable Energy Developments in Scotland. Part Four – Wave and Tidal Annex (EMEC and Xodus, 2010).

8.9.1.2 In addition, the fish and shellfish EIA has considered the legislative framework as defined by the Wildlife and Countryside Act 1981 (as amended), the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the Habitats Directive), the Marine and Coastal Access Act, 2009, and the Conservation of Habitats and Species Regulations 2017 (consolidates and updates the Conservation of Habitats and Species regulations 2012).

8.9.2 Impact assessment criteria

Sensitivity

8.9.2.1 The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The terms used to define sensitivity and magnitude and are described in further detail in Chapter 4: Environmental Assessment Methodology.

8.9.2.2 The criteria for defining sensitivity in this chapter are outlined in Table 8.14.

8.9.2.3 The sensitivity of fish and shellfish VERs has been determined by an assessment of the combined vulnerability of the receptor to a given impact, and the likely rate of recoverability to pre-impact conditions. Vulnerability is defined as the susceptibility of a species to disturbance, damage or death, from a specific external factor. Recoverability is the ability of the same species to return to a state close to that which existed before the activity or event which caused change. It is dependent on its ability to recover or recruit subject to the extent of disturbance/damage incurred. Information on these aspects of sensitivity of the fish and shellfish VERs to given impacts has been informed by the best available evidence. These assessments have been combined with the assessed status (i.e. the level of designation/importance resulting in a valuation) of the affected receptor presented in Table 8.9. The overall sensitivity of a receptor/receptor group to an impact has been identified from a five-point scale as presented in Table 8.14.

Table 8.14: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
Very High	Very High or High VER with high vulnerability and no ability for recovery.
High	Medium VER with high vulnerability and no ability for recovery. Very High or High VER with high vulnerability and low recoverability.
Medium	Low VER with high vulnerability and no ability for recovery. Medium VER with medium to high vulnerability and low recoverability. Very High or High VER with medium vulnerability and medium recoverability.
Low	Low VER with medium to high vulnerability and low recoverability. Medium VER with low vulnerability and medium to high recoverability. Very High or High VER with low vulnerability and high recoverability.
Negligible	Receptor is not vulnerable to impacts regardless of value/importance. Low VER with low vulnerability and medium to high recoverability.

Magnitude

8.9.2.4 The criteria for defining magnitude in this chapter are outlined in Table 8.15.

Table 8.15: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (adverse).
	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (positive).
Moderate	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (adverse).
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (positive).
Minor	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (adverse).
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of adverse impact occurring (positive).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (adverse).
	Very minor benefit to, or positive addition of one or more characteristics, features or elements (positive).
No change	No change from baseline conditions.

Significance

8.9.2.5 The significance of the effect upon fish and shellfish is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in Table 8.16. Where a range of significance of effect is presented in Table 8.16, the final assessment for each effect is based upon expert judgement.

8.9.2.6 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of the EIA Regulations.

Table 8.16: Matrix used for the assessment of the significance of the effect.

		Magnitude of impact				
Sensitivity of receptor		No change	Negligible	Minor	Moderate	Major
	Negligible	Negligible	Negligible	Negligible or minor	Negligible or minor	Minor
	Low	Negligible	Negligible or minor	Negligible or minor	Minor	Minor or moderate
	Medium	Negligible	Negligible or minor	Minor	Moderate	Moderate or major
	High	Negligible	Minor	Minor or moderate	Moderate or major	Major or substantial
	Very high	Negligible	Minor	Moderate or major	Major or substantial	Substantial

8.9.3 Designated sites

8.9.3.1 As identified in Table 8.8 mWave will be deployed within or in proximity to a number of internationally designated sites. In terms of the fish and shellfish features of these designated sites considered within this chapter, as identified in Table 8.10, no impact is predicted from the installation, operation or decommissioning of the project on these species and as such no further assessment is proposed.

8.9.4 Measures adopted as part of the mWave Project

8.9.4.1 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 8.17). As there is a commitment to implementing these measures, they are considered inherently part of the design of the mWave project and have therefore been considered in the assessment presented in section 8.10 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 8.17: Designed-in measures adopted as part of the mWave project.

Measures adopted as part of the mWave project	Justification
The offshore deployment location selected is on sandy substrate (Chapter 2:Project Description, 2.5.2).	Away from sensitive habitats, such as Annex I Reef which would be valuable foraging habitat (Chapter 7, section 7.7.3).
The cable landfall is over low diversity habitat	DDV survey confirmed that the habitats and communities across the bedrock reef at East Pickard Bay were relatively low in diversity, thereby avoiding valuable foraging habitat (Chapter 7, section 7.7.6).
Flat sandy seabed. No requirement for seabed preparation in advance of deployment (section 2.5.2).	Minimises disturbance during installation and potential for suspended sediments.
Gravity foundation. (section 2.5.2).	Simple installation, requires no moorings.
No external moving parts which may cause impact to marine life (section 2.5.2).	Minimises potential for collision and impact on marine life.
Anticipated lower operation noise compared to other WEC.	Due to design (using movement of air) noise levels are anticipated to be lower than conventional WEC (see Chapter 6, Offshore Noise).
Cable laid on surface and not trenched either offshore or onshore (Section 2.5.3).	Minimises disturbance during installation and potential for suspended sediments.
Minimal requirement for offshore vessels required during all phases of project (Chapter 2).	Minimises noise disturbance, potential for collision and reduces potential for accidental pollution.
EMP - Environmental Management Plan. The Environmental Management Plan (EMP) will cover both the offshore and onshore elements of the project. (Appendix 2.2)	The marine section of EMP will include planning for accidental spills, including measures to reduce the risk of an incident. In addition to this it will include an INNS assessment using NRW-PS Biosecurity Risk Assessment.
EMMP - Environmental Monitoring and Mitigation Plan. The EMMP will cover both the offshore and onshore elements of the project. (Appendix 2.3)	Linked closely to the EMP, this document will provide details of any requirements identified within this chapter to minimise potential effects on ecology prior to installation, as well as any recommended monitoring.

8.10 Assessment of significance

8.10.1.1 The potential impacts of the installation, operation and maintenance, and decommissioning of the mWave project has been assessed for fish and shellfish receptors.

8.10.2 Installation phase

Temporary changes to fish and shellfish habitat

8.10.2.1 Installation activities such as marine cable laying, pre-installed temporary moorings and the deployment of mWave, SUTU and ADCP monitoring device on the seabed, have the potential to result in temporary changes to habitat for fish and shellfish. Temporary changes to, or disturbance of habitat, may affect species both positively and negatively and these potential changes are outlined below.

8.10.2.2 The gravity foundation will result in temporary disturbance to or loss of seabed habitat or compaction of sediment (i.e. gravity base foundation placement and potential scour protection). The nature of mWave being placed on the seabed means that during installation it will temporarily disturb the seabed and water column, and result in a reduction in water-column availability (7m) during operation. These changes have the potential to reduce the availability of marine habitat, including spawning, nursery or feeding habitats. These changes may result in a temporary reduction in fish and shellfish species abundance or diversity within the affected area. Substratum loss will only directly affect species utilising the seabed, including the potential shellfish and demersal species listed in Table 8.10 and Table 8.11, and a temporary reduction in sections of water column will only directly affect pelagic species.

8.10.2.3 Habitat disturbance also has the potential to result in the creation of new temporary feeding opportunities for fish and shellfish receptors. Intermittent disturbance to an environment has been found to increase species richness in local fish and shellfish populations, as described by the intermediate disturbance hypothesis (Wilkinson, 1999). Langhamer *et al.* (2009) concluded that wave and tidal devices and their ancillary structures have the potential to create new habitats by introducing novel surfaces for colonisation; preference for colonisation was found for vertical surfaces rather than horizontal ones. Species that may benefit from temporary disturbance include benthic and demersal fish species, and shellfish species.

Magnitude of impact

8.10.2.4 There will be no requirement for site clearance or levelling in advance of mWave deployment as the seabed is relatively flat featureless sand (Chapter 7, Benthic, Subtidal and Intertidal Ecology). Habitat disturbance, in particular associated with temporary marine cable lay and gravity foundation placement preparation may result in temporary loss of habitat beneath deployment areas. Any mounding of sediments due to marine renewable device or ancillary structure placement is however expected to disperse in the relatively energetic marine areas and will re-join the naturally occurring sedimentary processes off East Pickard Bay. Changes to habitat are therefore considered to be temporary and fish and shellfish VERs are expected to recolonise these areas rapidly.

8.10.2.5 Installation will only take a few days, with up to 3 days for the mWave device and up to 3 days to lay the marine cable (note the deployment of ballast will be into trays and as such won't affect seabed habitat). The total seabed footprint of mWave, the ADCP, SUTU and cable to MHWS is limited in extent at <1900m^2. This represents a negligible proportion of the fish and shellfish study area.

8.10.2.6 The potential impact of temporary habitat changes from installation activities is therefore predicted to be of local spatial extent, short term duration and reversible. It is predicted that the potential impact may affect fish and shellfish receptors directly through loss of habitat, and indirectly through changes in prey availability. The magnitude is therefore considered to be minor (adverse/beneficial).

Sensitivity of the receptor

8.10.2.7 Many of the species found within the fish and shellfish study area are likely to make use of benthic and pelagic habitats for foraging and migratory movement. The fish and shellfish VERs are likely to be vulnerable to changes in/loss of habitat in the short-term but are considered likely to recover rapidly. Mobile fish and shellfish species are generally considered likely to avoid temporary changes in habitat (EMU, 2004) as they are able to move away from temporary areas of disturbance. Newell *et al.* (1998) found that following cessation of disturbance events, marine communities conform with well-established principles of ecological succession, that communities associated with sandy/coarse gravel sediments are well adapted to rapid recolonization with 'optimistic/pioneering' species establishing initially and later longer-lived and slow-growing organisms.

Estuarine and coastal fish assemblage VER

8.10.2.8 Fish species associated with the estuarine and coastal fish assemblage VER such as plaice, cod, thornback ray and flounder (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the very short-term when mWave and ancillary equipment are deployed. However mobile species are likely to move away from any area of temporary disturbance and use alternatively available habitat. Re-colonisation of any habitats that experience temporary changes or disturbance is expected to be rapid as adults and juvenile animals move back into areas temporarily disturbed. Estuarine and coastal fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of low to medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Fish spawning or nursery grounds VER

8.10.2.9 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to temporary habitat disturbance or loss of habitat in the very short term when mWave and its ancillary equipment is deployed, however recovery is likely to be rapid as extensive alternative habitat is available in the area. The waters off East Pickard bay lie within sprat spawning grounds and a whiting nursery ground and as such these species may be more vulnerable to disturbance. However as outlined above potential impact on these areas will be short-duration (2 - 5 days) and of minimal extent (<1900m^2). In addition, it can be expected that there will be no change to the substrate type of the area, as a result of mWave, and therefore any eggs that are laid in close proximity will not be affected. The proximity to spawning and nursery grounds can also increase re-colonisation of temporarily disturbed habitats through larval recolonization (Phua *et al.,* 2002). Fish spawning or nursery grounds VER has been deemed to be of medium vulnerability due to the proximity to spawning and/or nursery grounds, high recoverability and of low - high value (Table 8.10), there the sensitivity of the receptor is considered to be low-medium.

Estuarine and coastal shellfish assemblage VER

8.10.2.10 Shellfish species associated with the estuarine and coastal shellfish assemblage VER (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the very short term when mWave and its ancillary equipment are deployed. However recovery for mobile species is likely to be very high as extensive alternative shellfish habitat is available throughout the fish and shellfish study area. The most vulnerable species are likely to be demersal, non-mobile or slow moving species such as mussel beds or whelk.

8.10.2.11 Any temporary changes in availability of suitable habitat are likely to be temporary with recovery of sediments and associated shellfish communities considered to be rapid. Any changes to sediment disturbance and deposition will be low therefore it is considered unlikely to result in a reduction in abundance of this VER. Shellfish species are therefore considered to be of medium vulnerability to changes in habitat, with a high likelihood of recovery.

8.10.2.12 Estuarine and coastal shellfish assemblage VER has therefore been deemed to be of medium vulnerability, high recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be medium.

Significance of the effect

Estuarine and coastal fish assemblage VER

8.10.2.13 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.10.2.14 The sensitivity of the receptor is considered to be low-medium and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **negligible - minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Estuarine and coastal shellfish assemblage VER

8.10.2.15 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **minor (adverse/beneficial)** significance, which is not significant in EIA terms.

8.10.2.16 Overall, the sensitivity of the VERs is considered to be negligible – high, and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will therefore be of **negligible - minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.10.2.17 No further mitigation is considered necessary.

Temporary increases in suspended sediments

8.10.2.18 Increases in suspended sediments can lead to adverse effects on fish and shellfish. Temporary increases in suspended sediments may affect sessile organisms (e.g. mussels) and filter-feeders, potentially damaging feeding and breathing organs. Juvenile fish and shellfish, and eggs may be more susceptible, resulting in increased fatalities, than adult fish and shellfish, as adult species are more able to move away from the source (Wilber, 2001). Increases in suspended sediments may also lead to a reduction in foraging ability due to reduced visibility and olfactory response.

8.10.2.19 The substrate off East Pickard Bay is poorly sorted coarse sand with medium to fine sand further to the east (Chapter 6: Benthic Subtidal and Intertidal Ecology). As such installation activities have the potential for temporary increases in suspended sediments.

8.10.2.20 The main activity that will contribute to increases in suspended sediments will be the placement of mWave on the seabed, installation of the temporary communications cable, placement of the ADCP, SUTU or the navigational marker buoys if required. Vessel movements may also lead to very short-term increases in suspended sediment due to vessel manoeuvring particularly during cable laying.

Magnitude of impact

8.10.2.21 There will be no requirement for seabed preparation in advance of mWave deployment as the deployment site is relatively flat featureless sand (Chapter 7, Benthic, Subtidal and Intertidal Ecology section 7.7). As such seabed disturbance and associated temporary increases in suspended sediments will be due to placement of mWave and ancillary infrastructure which will be of short duration (3 days). Cable laying activities will be up to 3 days. As such both are considered to be of very short duration with negligible increases in suspended sediments.

8.10.2.22 In addition to this, in order to gain an understanding of the distance any disturbed sediments could travel, an estimation was made by examining a theoretical volume of material mobilised, taking into consideration current speed and the bed material. The illustration used an intrusive installation method, namely levelling with a backhoe, over the area of the mWave device. As mentioned previously the mWave deployment site is flat sand and as such no advanced site levelling works are required. Based on the sediment present off East Pickard Bay the resultant sediment plume of 70mg/l would be expected to settle following cessation of works after one hour.

8.10.2.23 The potential impact of temporary increases in suspended sediment is therefore predicted to be of local spatial extent, short-term duration and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor

Estuarine and coastal fish assemblage VER

8.10.2.24 Fish species associated with the estuarine and coastal fish assemblage VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term when mWave and ancillary equipment are deployed. However recovery is likely to be high as the coastal waters off East Pickard Bay are high energy thereby dispersing any suspended sediments rapidly. Adult fish species will be less vulnerable to impact from suspended sediments as they are highly mobile and are likely to show avoidance behaviour within any areas affected by SCC (Kjelland, 2015). Species are expected to recover as mentioned in section 8.10.2.7. Estuarine and coastal fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), there the sensitivity of the receptor is considered to be low.

Spawning or nursery grounds VER

8.10.2.25 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term during installation. Spawning and nursery grounds may be at higher risk of impact as juvenile fish and eggs are likely to have a higher mortality associated with increases in suspended sediments (section 8.10.2.18). This is because juvenile fish are more likely to be affected due to decreased mobility and therefore a lower likelihood of avoidance of areas of increased SCC, and eggs may be become smothered by SSC resulting in a decrease of gas diffusion to the egg, leading to cell death. However, due to the installation method (no site preparation and device placement on the seabed) any increases in SSC in is likely to be negligible and any disturbed sediments would settle within a short time . Similarly, this level of sediment is unlikely to result in a change to the baseline sediments of the area where fish lay their eggs.

8.10.2.26 Spawning or nursery grounds VER has therefore been deemed to be of medium vulnerability, low to medium recoverability and of low - high value (Table 8.10), there the sensitivity of the receptor is considered to be medium.

Estuarine and coastal shellfish assemblage VER

8.10.2.27 Shellfish species associated with the estuarine and coastal shellfish assemblage VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term during installation. However, due to the installation methods suspended sediments are likely to be negligible. For any sediments that are disturbed and effect shellfish, recovery is likely to be high at the mWave deployment site since it is located in a high energy environment, and therefore any suspended sediments will be rapidly dispersed. Mobile species of shellfish will have access to alternative feeding areas and are likely to avoid any direct impacts from suspended sediment. Sessile species of shellfish are potentially more vulnerable to temporary increases in suspended sediment. However, impacts from mWave will be very negligible and localised.

8.10.2.28 Many shellfish species are known to be tolerant of suspended sediment (e.g. brown crab), however mobile shellfish species are likely to avoid areas of temporary increased SSC as some species rely on visual acuity during predation (Neal and Wilson, 2008).

8.10.2.29 Estuarine and coastal shellfish assemblage VER has therefore been deemed to be of low vulnerability, medium recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be low.

Significance of the effect

Estuarine and coastal fish assemblage VER

8.10.2.30 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible. The effect will therefore be of **negligible - minor (adverse)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

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

Estuarine and coastal shellfish assemblage VER

8.10.2.32 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of **negligible - minor (adverse)** significance, which is not significant in EIA terms.

8.10.2.33 Overall, the sensitivity of the VERs is considered to be negligible – high, and the magnitude of the impact is deemed to be negligible. The effect will therefore be of **negligible – minor (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.10.2.34 No further mitigation is considered necessary.

Accidental Pollution

8.10.2.35 During the installation of mWave and ancillary infrastructure, accidental spillages or release of chemicals, such as fuel, oil and lubricants into the marine environment, could potentially lead to contamination of the marine environment and harm fish and shellfish receptors. It is likely that over time, these pollutants would be dispersed by tidal currents and wave action. Static receptors and less mobile species unable to avoid accidental pollution events are the most likely to be adversely impacted.

Magnitude of impact

8.10.2.36 As identified in Table 8.12 during the installation phase, the maximum size of vessel used at the mWave site is 50 m length and 6 m draught. There will be up to three vessels involved in the deployment of mWave over a 3 day period including a guard boat. Ballast will be delivered to site over 5 days using a smaller vessel (26m by 2.5m draught). Cable laying will require a similar vessel (up to 50m with 6m draught). By the very nature of the work all vessels will be slow moving and the work will be undertaken in good sea conditions.

8.10.2.37 If a spill occurs, the magnitude of this impact on fish and shellfish ecology is dependent upon the quantities and nature of the spillage, the dilution and dispersal properties of the waters and the bio-availability of the contaminant to species. The more toxic components of fuel spills are volatile and relatively short-lived. Heavier hydrocarbons, while less toxic, may persist for longer in the marine environment. Pollutants within a low energy environment such as closed harbours, are able to accumulate to potentially toxic levels, however, the waters off East Pickard Bay are a relatively high energy environment. Should any pollutants be accidentally released, dilution and the local hydrodynamic regime will aid in dispersal to levels below that of biological toxicity.

8.10.2.38 Accidents, by definition, are unknown, and with the implementation of an MPCP, the likelihood of a potential effect occurring is considered extremely unlikely. The potential impact of accidental pollution from installation activities is therefore predicted to be of local spatial extent, short term duration reversible. The potential for a pollution event occurring is considered to be unlikely. The magnitude is therefore considered to be negligible (adverse).

Sensitivity of the receptor

Estuarine and coastal fish assemblage VER

8.10.2.39 Fish species associated with the estuarine and coastal fish assemblage VER (Table 8.10) may be at short-term risk from pollutants accidentally released during installation into the marine environment. Estuarine adult fish species are less likely to be vulnerable to pollutants due to detection and avoidance behaviours and are expected to move away from high concentrations of pollutants. Juvenile fish and eggs are considered more vulnerable to accidental release of pollutants. Estuarine fish and coastal assemblage VER is therefore deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be medium.

Spawning or nursery grounds VER

8.10.2.40 Fish, eggs and juvenile fish associated with the spawning or nursery grounds VER (Table 8.10) are the most likely to be affected by accidental pollution. Spawning and nursery grounds may be at higher risk of impact as juvenile fish are likely to have a higher mortality associated with accidental pollution. Juvenile fish and eggs are likely to be affected due to decreased avoidance response and less efficient cellular/ compartmentalisation repair mechanisms. The spawning or nursery grounds VER has been deemed to be of medium vulnerability, medium recoverability and of low - high value (Table 8.10), therefore the sensitivity of the receptor is considered to be high.

Estuarine and coastal shellfish assemblage VER

8.10.2.41 Shellfish species associated with the estuarine and coastal shellfish assemblage VER (Table 8.10) may be vulnerable to accidental pollution release in the very short-term when devices/ancillary equipment are deployed, however recovery is likely to be high as mWave is located in a high energy environment, therefore dispersing any pollutants rapidly. Mobile species of shellfish will have access to alternative feeding areas and are likely to detect and avoid areas of pollution. Sessile species of shellfish are potentially more vulnerable to temporary increases in accidental release of pollutants, however mWave lies out-with areas known to support mussel beds, and therefore the vulnerability of shellfish to impacts from activities associated mWave are considered medium.

Significance of effect

Estuarine and coastal fish assemblage VER

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

Spawning or nursery grounds VER

8.10.2.43 The sensitivity of the receptor is considered to be high and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Estuarine and coastal shellfish assemblage VER

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

8.10.2.45 Overall, the sensitivity of the VERs is considered to be negligible – high, and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of M**inor (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

Future monitoring

8.10.2.46 No fish and shellfish monitoring to test the predictions made within the installation phase impact assessment is considered necessary.

8.10.3 Operational and maintenance phase

8.10.3.1 The potential environmental impacts arising from the operation and maintenance stage of the mWave Project are listed in Table 8.12, against which each potential has been assessed.

Colonisation of hard structures

8.10.3.2 The introduction of a mWave and its associated ancillary infrastructure presents a novel surface for colonisation by fish and shellfish. Although antifoulant will be used in small localised areas around sensors and connector plates, an environmentally friendly option will be used which will be EU compliant. Notwithstanding this, the cable, potential scour protection and the ancillary structures, could potentially be used by fish to lay eggs on, whilst crustaceans may colonise rock scour protection, if required.

Magnitude of impact

8.10.3.3 The area of mWave itself is $1032m^2$, and an allowance for $668m^2$ rock scour protection has been included in the assessment. The communication cable will provide an additional $210m^2$ of habitat which will extend across the sand substrate to the rock coastal fringe. The WEC and cable will be in place for up to 18 months. Whilst this area is relatively small, as mWave will be located in a flat featureless sand area (See Section 7.7, Chapter 7 Benthic, subtidal and intertidal ecology), these surfaces may be more attractive in their own right.

8.10.3.4 The potential impact of colonisation of hard structures from operation and maintenance activities is therefore predicted to be of local spatial extent, short term duration, reversible. The magnitude is therefore considered to be negligible (adverse/beneficial).

Sensitivity of the receptor

Estuarine and coastal fish assemblage VER

8.10.3.5 Fish species associated with estuarine fish assemblage VER (Table 8.10) are unlikely to be affected by the colonisation of hard structures. However, the structures may indirectly act as a fish aggregation structure and act as beneficial area for hunting, or conversely, for protection from predation, although the size of the structure is unlikely to provide enough refuge to change fish populations (Wilhelmsson, 2014). Therefore, the sensitivity of the receptor is considered to be medium.

Spawning or nursery grounds VER

Fish, eggs and juvenile fish associated with the spawning or nursery grounds VER (Table 8.10) are likely to be affected by hard structures as they may lay eggs on the surface as opposed to the environment.

Fish known to have a high intensity spawn and nursery ground and are at most risk are cod, sandeel, sole and herring. The first three species do not ‘adhere’ their eggs onto substrate but broadcast spawn and are therefore not at risk from a structure being removed following an egg laying event. The high intensity herring spawning areas are remote from mWave. Spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low - high value (Table 8.10), there the sensitivity of the receptor is considered to be negligible.

Estuarine and coastal shellfish assemblage VER

8.10.3.6 Shellfish species associated with the estuarine and coastal shellfish assemblage VER (Table 8.10) are likely to be affected by the presence of a novel hard structure. Mobile shellfish may use the structure for refuge, whilst more sessile shellfish may colonise and recruit to structures that are present during spawning. It is likely that mobile species will colonise/occupy hard structures, provided there is refuge from predation but will move away without injury, or mortality, upon structure removal. More sessile organisms, such as mussels have been identified as a medium VER. These sessile species tend to cluster together within identifiable ‘beds’, of which none are found near mWave deployment site. Whilst it is possible for species larvae to settle on these hard structures, as they will be in place over a spawning cycle, it is unlikely for a sufficient number of species to colonise the structure to form a ‘bed’ as the structure will be removed after 18 months. In addition, these species are more likely to be present and form beds on rocky reef habitat as opposed to the sandy sediments found within each site.

8.10.3.7 Estuarine and coastal shellfish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of low-medium value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Significance of effect

Estuarine and coastal fish assemblage VER

8.10.3.8 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will therefore be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.10.3.9 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Estuarine and coastal shellfish assemblage VER

8.10.3.10 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

8.10.3.11 Overall, the sensitivity of the VERs is considered to be negligible - medium, and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will therefore be of **negligible adverse/beneficial)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.10.3.12 No fish and shellfish monitoring to test the predictions made within the installation phase impact assessment is considered necessary.

Medium term habitat loss

8.10.3.13 The presence of mWave and ancillary infrastructure may result in a medium term (up to 18 months) habitat loss from the area. It can be expected that impacts are similar to the temporary changes to fish and shellfish at the installation phase. This impact may affect fish and shellfish species both positively and negatively (see section 8.10.2.2 and 8.10.2.3).

Magnitude of impact

8.10.3.14 As identified above the combined total area for mWave and ancillary infrastructure would have a habitat loss is up to 1900 m^2. Whilst mWave will be tested for only 6 - 12month the device is likely to be in the water for longer, with a maximum period of 18 months.

8.10.3.15 The potential impact of medium-term habitat loss from operation and maintenance activities is therefore predicted to be of local spatial extent, short term duration and reversible. The magnitude is therefore considered to be minor (adverse).

Sensitivity of the receptor

Estuarine and coastal fish assemblage VER

8.10.3.16 Fish species associated with the estuarine and coastal fish assemblage VER such as plaice, cod, thornback ray and flounder (Table 8.10) may be vulnerable to medium term habitat loss. It can be expected that impacts are very similar to temporary changes in habitat as described in section 8.10.2.8, and not reiterated here. However, in addition to those impacts described in the installation phase, it can be expected that fish assemblages will habituate to any habitat loss within the water and most likely will return to site quickly, once removed. Estuarine and coastal fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Fish spawning or nursery grounds VER

8.10.3.17 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the medium term when mWave and ancillary equipment are deployed. It can be expected that impacts are similar to section 8.10.2.9 and not reiterated here. The fish spawning or nursery grounds VER has been deemed to be of medium vulnerability due to the proximity to spawning and/or nursery grounds, high recoverability and of low - high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low-medium.

Estuarine and coastal shellfish assemblage VER

8.10.3.18 Shellfish species associated with the estuarine shellfish assemblage VER (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the medium term when mWave and ancillary equipment are deployed. However recovery for mobile species is likely to be very high as extensive alternative shellfish habitat is available throughout the wider fish and shellfish study area. In addition to this, as identified previously crustaceans may be attracted to the device as a refuge on the seabed. The most vulnerable species are therefore likely to be demersal, non-mobile species such as mussels.

8.10.3.19 Any changes in availability of suitable habitat are likely to be temporary with recovery of sediments and associated shellfish communities considered to be rapid. Any changes to sediment disturbance and deposition will be low therefore it is considered unlikely to result in a reduction in abundance of this VER. mWave deployment site is located outside of any mussel beds and will not directly affect the community. Shellfish species are therefore considered to be of medium vulnerability to changes in habitat, with a high likelihood of recovery.

8.10.3.20 Estuarine and coastal shellfish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of low to medium value (Table 8.11), therefore the sensitivity of the receptor is considered to be medium.

__Significance of effect__

Estuarine and coastal fish assemblage VER

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

Spawning or nursery grounds VER

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

Estuarine and coastal shellfish assemblage VER

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

8.10.3.24 Overall, the sensitivity of the VERs is considered to be negligible – medium, and the magnitude of the impact is deemed to be minor (adverse). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

__Further mitigation and residual effect__

8.10.3.25 No fish and shellfish monitoring to test the predictions made within the installation phase impact assessment is considered necessary.

Accidental Pollution

8.10.3.26 During operation the maximum size of vessels used for O&M testing activities for mWave at East Pickard Bay is 50m length and 6m draught. Whilst vessel movements during the operational and maintenance phase increases up to 76 within the year, it is anticipated that there will be only one visit per month with three vessels over a 2 day period. In addition to this, if scour protection was required this would be undertaken over a 5 day period. As such the potential for accidental pollution incident, as a result of vessel collision, is reduced compared to the installation phase.

8.10.3.27 The magnitude of the impact and sensitivity of receptor is expected to be the same or less than the effects from installation. Therefore, the significance of effect is therefore negligible or minor adverse significance (see section 8.10.2.35 *et seq*.).

__Future monitoring__

8.10.3.28 No fish and shellfish monitoring to test the predictions made within the operation and maintenance phase impact assessment is considered necessary.

8.10.4 Decommissioning phase

8.10.4.1 The impacts of the offshore decommissioning of the mWave project have been assessed on fish and shellfish. The environmental effects arising from the decommissioning of the mWave project are listed in Table 8.12. The impacts during the decommissioning phase are expected to be of the same nature and magnitude as those predicted from the installation phase therefore the assessment of potential impacts on fish and shellfish presented within section 8.10.2 have been assumed for the decommissioning phase and are not reiterated here.

8.11 Cumulative Impact Assessment methodology

8.11.1 Screening of other projects and plans into the Cumulative Impact Assessment

8.11.1.1 The Cumulative Impact Assessment (CIA) takes into account the impact associated with the mWave project together with other projects and plans. The projects and plans selected as relevant to the CIA presented within this chapter are based upon the results of a screening exercise. Each project has been considered on a case by case basis for scoping in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

8.11.1.2 In undertaking the CIA for the mWave project, it is important to bear in mind that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside the mWave project. For example, relevant projects and plans that are already under construction are likely to contribute to cumulative impact (providing effect or spatial pathways exist), whereas projects and plans not yet approved or not yet submitted are less certain to contribute to such an impact due to the short duration of the mWave project (18 months).

8.11.1.3 Table 8.18 presents the projects that have been considered for inclusion in the mWave project CIA.

Table 8.18: List of other projects and plans considered within the CIA.

Project phase	Developer - Reference	Approx. distance to mWave (km)	Spatial/ temporal overlap with the mWave project	Details	Date of Construction	Further Consideration required?	Justification
Dredging sites							
Installation/ Operation and Maintenance	Neyland Yacht Haven ltd. - DML1743	11.5	No spatial overlap. Potential for temporal overlap.	Dredge and disposal from Neyland Marina - annual volume 5500 m^3.	13/12/2017-12/12/2020	No	Dredging impact forms part of baseline and mWave project has no dredging or disposal associated with it. Distant from mWave and therefore highly unlikely to have any impact overlap. No further consideration .
Installation/ Operation and Maintenance	Milford Haven Port Authority - DML1646	4.5	No spatial overlap Potential for temporal overlap.	Maintenance dredging throughout the Milford Haven. Annual volume 362500 m^3.	09/03/2017-08/03/2022	No	Dredging impact forms part of baseline and mWave project has no dredging or disposal associated with it. Distant from mWave project and therefore highly unlikely to have any impact overlap. No further consideration.
Dredge disposal sites							
Installation/ Operation and Maintenance	Neyland dredge disposal site - LU190	11.5	No spatial overlap. Potential for temporal overlap	Location: South of Neyland within the central channel of the Milford Haven, 0.22 nm diameter x 5 m depth Status: Open	Not applicable	No	Disposal impact forms part of baseline and mWave project has no dredging or disposal associated with it. Distant from mWave project and therefore highly unlikely to have any impact overlap. No further consideration.
Installation/ Operation and Maintenance	Milford Haven dredge disposal site - LU170	5	No spatial overlap. No temporal overlap as site is closed.	Location: South of St Ann's Head at the mouth of the Milford Haven estuary, unknown diameter x 30 m depth. Status: Closed	Not applicable	No	Dredge disposal site is not in use therefore no further consideration required.
Installation/ Operation and Maintenance	St Ann's Head dredge disposal site - LU180	5	No spatial overlap. No temporal overlap as site is closed	Location: Within the Milford Haven dredge disposal site, unknown diameter x 30 m depth. Status: Closed	Not applicable	No	Dredge disposal site is not in use therefore no further consideration required.
Installation/ Operation and Maintenance	Milford Haven Two dredge disposal site - LU169	16	No spatial overlap No temporal overlap.	Location: To the south of Milford Haven dredge disposal grounds, unknown diameter x 50 m depth. Status: Open		No	Dredge disposal site is located approximately 16 km from the mWave project. Disposal impact forms part of baseline and mWave project has no dredging or disposal associated with it. It is therefore highly unlikely to have any impact overlap. No further consideration.
Installation/ Operation and Maintenance	Milford Haven Three dredge disposal site - LU169	37	No spatial overlap No temporal overlap.	Location: To the west of Milford Haven dredge disposal grounds, 1 nm diameter x unknown depth. Status: Open		No	Dredge disposal site is located at its closest 37 km from the mWave project, Disposal impact forms part of baseline and mWave project has no dredging or disposal associated with it. Project is highly unlikely to have any impact overlap. No further consideration.
Research							
Installation	Greenlink Interconnector Ltd. - RML1827	0	Potential spatial overlap Temporal overlap	Ground investigations		Yes	Research operations are likely to have vessels present, with equipment for undertaking ground truthing surveys therefore this project cannot be excluded from further consideration in the CIA.
Installation	University College of Swansea - DEML1861	7	Location is assumed to be by the Pembroke Power station. No spatial overlap. Temporal overlap.	Pembroke Power bubble barrier experiment Investigation into the effectiveness of bubble curtains in sediment management	07-2018 - no end date given Band 2 licence issued 12/12/2018 - three-year study	No	Distant from mWave project and therefore highly unlikely to have any impact overlap. No further consideration.
Installation	University College of Swansea - DEML1845	1.5	Potential spatial overlap Temporal overlap	Deposition and subsequent removal of marker buoys with environmental monitoring and mid-water settlement plates.	30/08/2018-29/08/2019	No	Vessels and equipment will be required for the placement of marker buoys. Whilst the ML is currently valid, it is unlikely to have temporal with mWave activities, as ML finishes in August

Project phase	Developer - Reference	Approx. distance to mWave (km)	Spatial/ temporal overlap with the mWave project	Details	Date of Construction	Further Consideration required?	Justification
							2019. No further consideration.
Installation/ Operation and Maintenance	Neyland Yacht Haven Ltd - CML1658	11.5	No spatial overlap. No temporal overlap.	Pile replacement in Neyland Marina.	21/11/2016-20/11/2019	No	Pile replacement is currently ongoing until 2019, which does not overlap with the installation and operational phases of mWave. Given the distance from mWave project it is therefore highly unlikely to have any impact overlap. No further consideration
Installation/ Operation and Maintenance	Mixed use developments - Local Planning Authority Reference: 14/0158/PA	10	No spatial overlap. Temporal overlap remains unknown.	Undetermined planning application. Demolition of several existing buildings and the mixed-use redevelopment of Milford Waterfront comprising up to 26,266 m² of commercial, hotel, leisure, retail and fishery related floorspace. Up to 190 residential properties, up to 70 additional marina berths, replacement boat yards, landscaping, public realm enhancements, access and ancillary works. A decision on this application is yet to be made by the local planning authority.	EIA screening decision was returned on the 30/04/2018 - no further information has been provided	No	Given the distance from mWave project it is therefore highly unlikely to have any impact overlap. No further consideration.
Installation/ Operation and Maintenance/ Decommissioning	Greenlink Interconnector Ltd. - Government reference: qA1296053	0	Spatial overlap at edge of deployment area. Temporal overlap	The Project is a 500MW subsea electricity interconnector linking the power markets in Ireland and Great Britain and is planned for commissioning in 2023. As an EU Project of Common Interest, it is one of Europe's most important energy infrastructure projects. The interconnector is planned to make Landfall at Fresh Water West beach	07/2018 - ongoing	Yes	Given potential for temporal and spatial overlap with mWave this project cannot be excluded from further consideration in the CIA.
Installation/ Operation and Maintenance/ Decommissioning	Valereo - Welsh Government reference: qA1312073		No overlap with the mWave project. Onshore is remote from mWave control station site.	Development of a cogeneration facility to supplement electrical power and steam demands of the refinery all within the refinery boundaries on land.	07/12/2017 - Nationally significant project (ongoing)	No	Project is assumed to have no marine elements to the project. Onshore is remote from mWave control station site (inner face of Haven), therefore there will be no impact overlap. No further consideration.
Installation/ Operation and Maintenance	EGNEDOL Wales Ltd	N/A	Potential temporal overlap	EGNEDOL propose to create an environmentally sustainable centre of excellence in Milford Haven, at the Waterston and Blackbridge sites. The proposal includes providing business units and refurbishing a jetty to serve as a primary supply link to the EGNEDOL electricity generation plan, and for export of products. The land-based green energy scheme may generate up to 350 MW.	Not available	No	Planning permission for the EGNEDOL project was refused on 19/10/2018, therefore it is considered highly unlikely that this project will overlap temporally with the mWave project. No further consideration.
Ministry of Defence sites							
	Ministry of Defence	0.1	Temporal overlap	The Castlemartin Range is located immediately south of the entrance to the Waterway and extends for up to 12 NM from the coast between Little Furznip (at the southern extent of Freshwater West) and St Govan's Head (Milford Haven Port Authority 2019). The southern boundary of the East Pickard Bay (Site 8) site is located adjacent to the northern boundary of the Castlemartin Military Practice Area D113A. The range at Castlemartin supports the training of military personnel (Army) in the firing of a range of munitions at land based targets. The seaward danger area provides a safety zone for overfire and shrapnel which may result from the striking of targets (RPS, 2010). The Castlemartin Range is used every day of the week and on some weekends (RPS, 2010).	Not applicable	Yes	There is a high level of uncertainty as to timing of MOD activities at the MOD site, however on-going activity is likely therefore there is the potential for cumulative impacts with the mWave project.
Aquaculture projects							
Installation/ Operation and Maintenance	Tethys Oysters	3	Temporal overlap	The oyster farm is located on the eastern side of Angle Bay, whereby oysters are grown in baskets on metal supports. The farm will be serviced from the shore by foot	Oct 2017 – Oct 2020 (possible renewal of licence)	No	Whilst there is potential for temporal overlap with the mWave project, it is distant and therefore highly unlikely to have any impact overlap. No further consideration.

Project phase	Developer - Reference	Approx. distance to mWave (km)	Spatial/ temporal overlap with the mWave project	Details	Date of Construction	Further Consideration required?	Justification
Installation/ Operation and Maintenance	Pembrokeshire Scallops	6.5	Temporal overlap	The scallop farm is located within Castlebeach Bay, whereby a system of weighted ropes will be deployed for growing scallops and mix species of native algae. The farm will be serviced by vessels and divers	Jan 2019 – Q4 2020 (possible renewal of licence)	no	Whilst there is potential for temporal overlap with the mWave project, it is distant and therefore highly unlikely to have any impact overlap. No further consideration.
Pembroke Dock Marine Projects							
Installation/ Operation and Maintenance	Milford Haven Port Authority - SC1810: Pembroke Dock Infrastructure	10	No spatial overlap. Potential for temporal overlap	Pembroke Dock redevelopment. Scoping Report submitted. The intention of the Project is to create a flexible and efficient port-related office, industrial, warehousing and distribution, and ancillary operations infrastructure. This will involve the redevelopment of its existing space to incorporate increased deep-water access, internal and external heavy fabrication areas, construction of MEECE and Education/Skills Facility and the construction of a heavy lift facility.	Q3 2019 – Q3 2023	No	Port activity as a result of Pembroke Dock Port operations is distant and therefore highly unlikely to have any impact overlap. No further consideration.
Installation/ Operation and Maintenance	META Project, Site 8	0	Spatial overlap Temporal overlap will occur throughout the duration of the mWave project	The META project will allow the deployment and testing of marine renewable devices in the waters off East Pickard Bay. The maximum scenario is for up to two devices at Site 8. An assessment of the maximum META project design has been undertaken in the ES supporting the consents.	In consenting	Yes	Given potential for temporal and spatial overlap with mWave this project cannot be excluded from further consideration in the CIA
Installation/ Operation and Maintenance/Decommissioning	Marine Energy Wales - DEML1875	9.4	No spatial overlap Potential for temporal overlap	Marine Energy Test Area - Phase 1 Band 2 application submitted. The Project aims to create pre-consented test areas within the Pembroke Dock area. The test areas will have licensable activities to suit testing of initial stage marine renewable devices. These include testing of non-operating components and subassemblies. No full-scale testing is to be support within the test areas	21/04/2019-21/04/2029	No	Project is distant and therefore highly unlikely to have any impact overlap. No further consideration.
Installation/ Operation and Maintenance/Decommissioning	Wave Hub Ltd. - SC1082	20	No spatial overlap No temporal overlap	Demonstration zone Scoping Report submitted The Project entails the development of 90 km2 of seabed with water depths of approximately 50 metres and a wave resource of approximately 19 kW/m; to support the demonstration of wave arrays with a generating capacity of up to 30MW for each project. Consent for this Project could be achieved in 2022, infrastructure could be built by 2024 and the first technology could be installed in 2025.	2024	No	No temporal overlap with the mWave project. No further consideration.

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8.12 Cumulative Impact Assessment

8.12.1.1 The potential impacts identified for assessment as part of the fish and shellfish cumulative impact assessment (CIA) are:

- Temporary changes in fish and shellfish habitat;
- Temporary increases in suspended sediments;
- Colonisation of hard structures;

8.12.1.2 A description of the significance of cumulative effects upon fish and shellfish receptors arising from each identified impact is given below.

Temporary changes in fish and shellfish habitat

8.12.1.3 Changes in fish and shellfish habitat may occur as a result of cumulative effects arising from projects that spatially or temporally overlap with the mWave project, as listed in Table 8.18. The potential impacts of changes in fish or shellfish habitat have been outlined in Section 8.10.2.1 and are not re-iterated here.

Magnitude of impact

8.12.1.4 Research activities are very short duration (days) and of minimal impact on fish and shellfish habitat (temporary deployment of scientific equipment) and are therefore considered unlikely to result in a detectable change on fish and shellfish habitat. Cabling works associated with the Greenlink interconnector and the proposed META Site 8 project, in combination with mWave project, may lead to temporary loss of habitat off East Pickard Bay.

8.12.1.5 Though a number of projects are predicted to overlap either with the installation, operation and maintenance, or decommissioning phases of the mWave project, as mWave is short term (18 months) and as outlined above, potential changes to fish and shellfish habitat are predicted to be of local spatial extent, temporary in nature, short-medium term duration and reversible.

8.12.1.6 It is predicted that the impact will affect the receptor directly through loss of habitat, and indirectly through changes in prey availability. The magnitude is therefore considered to be minor**.**

Sensitivity of receptor

8.12.1.7 Many of the species found within the fish and shellfish study area are likely to make use of benthic habitats for foraging, or the water-column for migratory movement. The fish and shellfish VERs are likely to be vulnerable to changes in/loss of habitat in the short-term but are considered likely to recover rapidly due to availability of alternative foraging and supporting habitat within the wider area.

8.12.1.8 The mWave project assessment of sensitivity for fish and shellfish VERs ranged from negligible to medium (section 8.10.2.16), and it is assumed that this is the same for the CIA.

Significance of effect

8.12.1.9 The magnitude of effect is deemed to be minor, and the sensitivity is deemed to be negligible - medium. The significance of effect is therefore assessed as **negligible – minor (adverse)** which is not significant in EIA terms

Temporary increases in suspended sediments

8.12.1.10 The potential impacts of increases in suspended sediment have been outlined in section 8.10.2.18 and are not re-iterated here.

Magnitude of impact

8.12.1.11 Research activities are very short duration (days) and are considered to have negligible potential to result in increase in suspended sediment. Cabling works associated with the Greenlink interconnector and the proposed META Site 8 deployment may lead to temporary increases of suspended sediment offshore of East Pickard Bay, but these are expected to be short-duration (days) and temporary in nature.

8.12.1.12 Though a number of projects which could lead to increases in suspended sediment within the fish and shellfish study area are predicted to overlap with the installation, operation and maintenance, or decommissioning phases of the mWave project, potential increases in suspended sediment are not predicted to be extensive or long-term due to the high energy environment tidal environment present within the offshore waters. It is considered that increases in suspended sediment could occur in the short-term.

8.12.1.13 The impact is therefore predicted to be of local spatial extent, short- term duration and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be minor.

Sensitivity of receptor

8.12.1.14 The mWave project assessment of sensitivity for fish and shellfish VERs ranged from negligible to high (section 8.10.2.33), and it is assumed that this is the same for the CIA.

Significance of effect

8.12.1.15 The magnitude of effect is deemed to be minor, and the sensitivity is deemed to be negligible – medium. The significance of effect is therefore assessed as **negligible – minor (adverse)** which is not significant in EIA terms

Colonisation of hard structures

8.12.1.16 The potential impacts of hard structures have been outlined in section 8.10.3.2 *et seq.* and are not re-iterated here.

Magnitude of impact

8.12.1.17 The META Site 8 project and the mWave deployment may result in a temporary increase in hard structures in the marine environment. Notwithstanding this, potential increases in hard structures are not predicted to significantly alter the existing fish and shellfish assemblage.

8.12.1.18 The impact is therefore predicted to be of local spatial extent, intermittent and over a long-term duration. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be minor.

Sensitivity of receptor

8.12.1.19 The mWave project assessment of sensitivity for fish and shellfish VERs ranged from negligible - minor (section 8.10.3.5), and it is assumed that this is the same for the CIA.

Significance of effect

8.12.1.20 The magnitude of effect is deemed to be minor, and the sensitivity is deemed to be negligible. The significance of effect is therefore assessed as **negligible – minor (adverse)** which is not significant in EIA terms

Future monitoring

8.12.1.21 No monitoring is proposed to validate the assessment of the CIA.

8.13 Transboundary effects

8.13.1.1 No transboundary impacts are likely to affect the interests of other EEA States, therefore there is no potential for significant transboundary effects with regard to fish and shellfish from the META project.

8.14 Inter-related effects

8.14.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. No significant inter-related effect are predicted as a result of the mWave project.

8.15 Conclusion and summary

8.15.1.1 Table 8.19 summarises the assessment of effects on fish and shellfish associated with the installation, operation and maintenance, and decommissioning of the mWave project, alone and cumulatively with other plans or projects.

Table 8.19: Summary of potential environment effects, mitigation and monitoring at the mWave project.

Description of impact	Measures adopted as part of project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Installation Phase							
Temporary changes to fish and shellfish habitat	n/a	Minor (adverse/beneficial)	Low - Medium	Negligible – Minor (adverse/beneficial) not significant in EIA terms	None	n/a	None
Temporary increases in suspended sediments	n/a	Negligible (adverse)	Low - Medium	Negligible –Minor (adverse) not significant in EIA terms	None	n/a	None
Accidental Pollution	MPCP	Negligible (adverse)	Medium- High	Minor (adverse) not significant in EIA terms	None	n/a	None
Operational Phase							
Colonisation of hard structures	n/a	Negligible (adverse/beneficial)	Negligible	Negligible (adverse/beneficial) not significant in EIA terms	None	n/a	None
Medium term habitat loss	n/a	Minor (adverse)	Low- Medium	Negligible – Minor (adverse) not significant in EIA terms	None	n/a	None
Accidental Pollution	MPCP	Negligible - Minor (adverse)	Negligible - High	Low – Minor (adverse) not significant in EIA terms	None	n/a	None
Decommissioning Phase							
Temporary changes to fish and shellfish habitat	n/a	Minor (adverse/beneficial)	Negligible - High	Negligible – Minor (adverse/beneficial) not significant in EIA terms	None	n/a	None
Temporary increases in suspended sediments	n/a	Negligible (adverse)	Negligible - High	Minor (adverse) not significant in EIA terms	None	n/a	None
Accidental Pollution	MPCP	Negligible (adverse)	Negligible - High	Negligible – Minor (adverse) not significant in EIA terms	None	n/a	None

8.16 References

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PART FOUR – WAVE & TIDAL ANNEX.

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