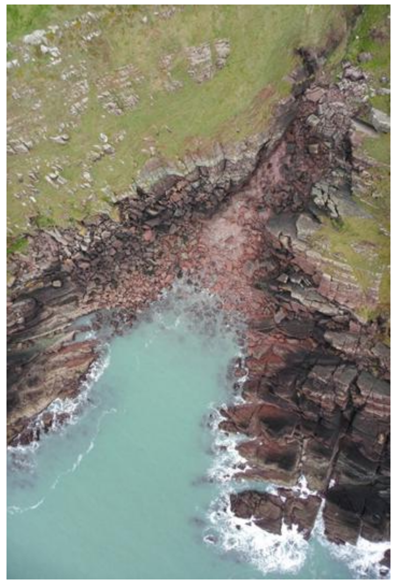
mWave Marine Energy Device and Onshore Infrastructure

ENVIRONMENTAL STATEMENT



June 2019

CHAPTER 9: Marine Mammals

Table of Contents

Table of Tables

Table of Figures

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.
Haul-out	Hauling-out is a behaviour associated with pinnipeds (e.g. grey seal (*Halichoerus grypus)* temporarily leaving the water. Hauling-out typically occurs between periods of foraging activity. Rather than remain in the water, pinnipeds haul-out onto land or sea-ice for reasons such as reproduction and rest.
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.
Subsea Umbilical Termination Unit	Underwater connection box approx 1.5m^2. mWave umbilical and ADCP will connect into unit.

Acronyms

Acronym	Description
ADCP	Acoustic Doppler Current Profiler
ADD	Acoustic Deterrent Devices
CCW	Countryside Council for Wales
CGNS MU	Celtic and Greater North Seas MU
DMS	dimethyl sulphide
DP	Dynamic Positioning
EEA	European Economic Area
HF	High Frequency
IAMMWG	Inter-Agency Marine Mammal Working Group
IS MU	Irish Sea MU
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature and Conservation Committee
LF	Low Frequency
MarLIN	Marine Life and Information Network
MCZ	Marine Conservation Zones
MF	Medium Frequency
MPS	Marine Policy Statement
MRESF	Marine Renewable Energy Strategic Framework for Wales
MSFD	Marine Strategy Framework Directive
MU	Management Units
NRWa	Natural Resources Wales Advisory
NRW-PS	Natural Resources Wales Permitting Services
OCWS MU	Offshore Channel, Celtic Sea and South West England MU
ORED	Offshore Renewable Energy Devices
PTS	Permanent Threshold Shift
Rms	root-mean squared
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SI	Serious Injury
SMRU	Sea Mammal Research Unit
SUTU	Subsea Umbilical Termination Unit
SSC	Suspended Sediment Concentration
TTS	Temporary Threshold Shift
UXO	Unexploded Ordinance
VER	Valued Ecological Receptor
WWBIC	West Wales Biodiversity Information Centre
ZOI	Zone of Impact

Units

Unit	Description
GW	Gigawatt (power)
kW	Kilowatt (power)
cm	Centimetre
dB	Decibels
mg/l	Milligrams per litre
m	Metre
m^2	Metres squared
µPa	micropascal
%	Percentage

9. MARINE MAMMALS

9.1 Introduction

9.1.1.1 This chapter of the Environmental Statement presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of the mWave project on marine mammals. Specifically, this chapter considers the potential impact of the mWave project during its three phases, namely, installation, operation and maintenance, and decommissioning.

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

- Coastal processes (chapter 5);
- Fish and shellfish (chapter 8);
- Underwater noise (chapter 6); and
- Shipping and navigation (chapter 12).

9.2 Purpose of this chapter

9.2.1.1 The primary purpose of the Environmental Statement is to support the marine licence application for the mWave project, including the full scale WEC, marine communications cable up to MHWS, Acoustic Doppler Current Profiler (ADCP), Subsea Umbilical Termination Unit (SUTU) and navigational markers (if needed). The Environmental Statement will also support the planning application for the onshore section of the communication cable (from MLW), the termination box, cable anchor point and onshore control station.

9.2.1.2 This Environmental Statement chapter:

- Presents the existing environmental baseline established from desk studies, and consultation;
- Presents the potential environmental effects on marine mammals arising from the mWave project, based on the information gathered and the analysis and assessments undertaken;
- Identifies any assumptions and limitations encountered in compiling the environmental information; and
- Highlights any necessary monitoring and/or mitigation measures which have been incorporated into the project or could be used to prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

9.3 Study area

9.3.1.1 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.

9.3.1.2 Two study areas have been defined for this chapter, in order for baseline characterisation of marine mammal receptors in the mWave project area to be assessed in the context of a wider geographic area.

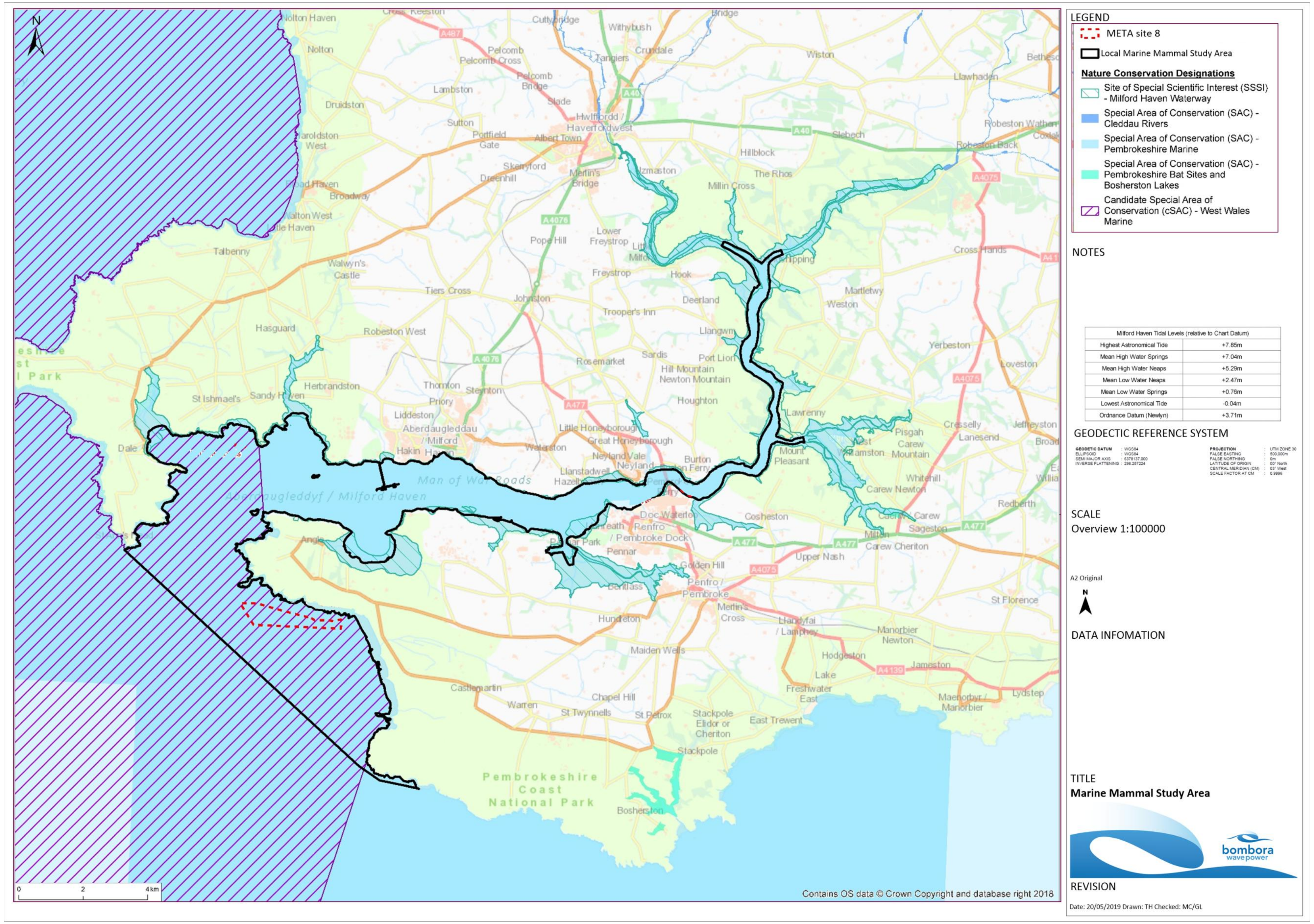
9.3.1.3 The two study areas defined are:

- The 'local marine mammal study area'; and
- The 'regional marine mammal study area'.

9.3.1.4 The local study area has been defined for baseline characterisation of marine mammals (within this chapter, marine mammals means cetaceans and pinnipeds) in the vicinity of the mWave project. The local marine mammal study area includes the Waterway and extends south-west to St. Ann's Head and south-east to Crow Rock (Figure 9.1). This study area captures the magnitude of impact identified in coastal processes and underwater noise.

9.3.1.5 The regional marine mammal study area is defined by a 100 km buffer from the centre of the Waterway (Figure 9.2). The regional study area provides a wider geographic context for comparison with the local study area in terms of the species present and their relative abundance. Sites designated for the conservation for these species within this region provide a useful context for understanding the relative importance of the species found within the regional study area, and consequently within the local study area. It should be noted that the regional study area does not delineate populations of marine mammals but does provide a sufficiently large area within which ecological patterns of the key species can be understood.

9.3.1.6 The bathymetry of the regional and local study areas is given in Figure 9.3.



Milford Haven Tidal Levels (relative to Chart Datum)	
Highest Astronomical Tide	+7.85m
Mean High Water Springs	+7.04m
Mean High Water Neaps	+5.29m
Mean Low Water Neaps	+2.47m
Mean Low Water Springs	+0.76m
Lowest Astronomical Tide	-0.04m
Ordnance Datum (Newlyn)	+3.71m

Figure 9.1: Local marine mammal study area showing designated sites.

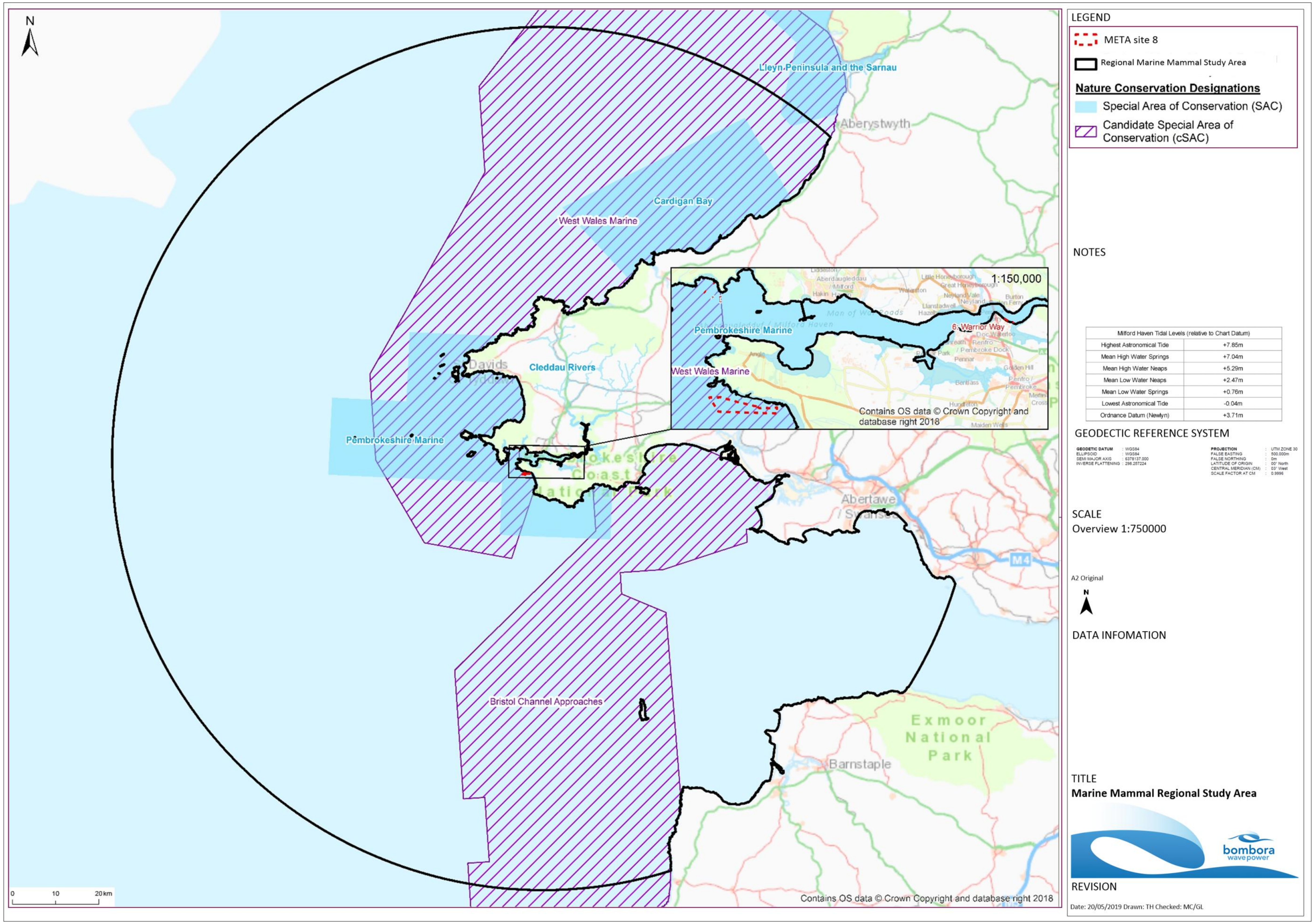


Figure 9.2: Regional marine mammal study area

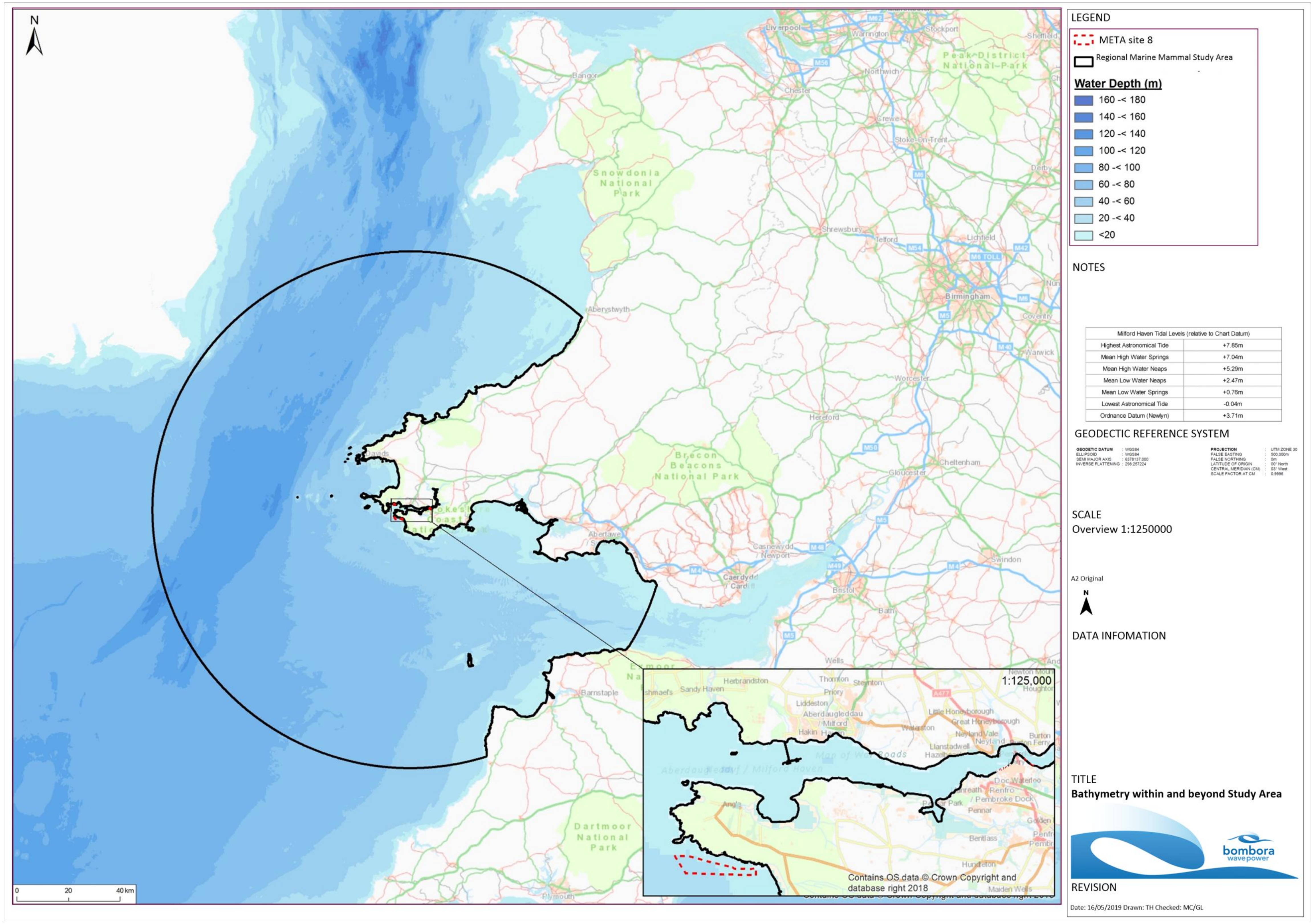


Figure 9.3: Bathymetry within and beyond the regional marine mammal study area.

9.4 Policy context

9.4.1 National Policy Statements

9.4.1.1 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 ES. Chapter 3: Needs and Alternatives outlines the policy context for the mWave project, and how the mWave project has adhered to the UK marine Policy Statement and the draft Welsh National Marine Plan. Table 9.1 below summarises the guidance specific to marine mammals.

Table 9.1: Summary of NPS EN-3 policy relevant to marine mammals

Summary of relevant policy framework	How and where considered in the Environmental Statement
Where necessary the assessment of the effects on marine mammals should include details of: likely feeding areas; known birthing areas/haul out sites; nursery grounds; known migration or commuting routes; duration of potentially disturbing activity including cumulative/in-combination effects; baseline noise levels; predicted noise levels in relation to mortality, Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS); soft-start noise levels; and operational noise (NPS EN-3; paragraph 2.6.92).	All of the specified marine mammal ecology details are included in this chapter (9.7). The mWave project assessment has considered the relevant marine mammal behaviour for key species present in the regional study area. An assessment of installation and operational noise impacts and their likely effects upon marine mammal behaviour and ecology has been undertaken (section 9.11). This assessment also considers the cumulative impacts of the mWave project and other relevant plans or projects (section 9.13). Chapter 6: Underwater noise considers the underwater noise impacts from installation activities; note there will be no drilled pin piling or impulsive piling employed for the mWave project (see chapter 2: Project Description).
The conservation status of marine European Protected Species, and seals, are of relevance to the Secretary of State. The Secretary of State should take into account the views of the relevant statutory advisors (paragraph 2.6.95 of NPS EN-3).	The conservation status of species has been factored into the assessment of significance (Table 9.6).

9.4.2 Other relevant policies

9.4.2.1 A number of other policies are relevant to this assessment.

9.4.2.2 The UK Marine Policy Statement (MPS) notes that marine planning authorities should be mindful of the high-level marine objectives set out by the UK in order to ensure due consideration of marine ecology and biodiversity interests. It also recognises the role of conservation of ecologically sensitive areas throughout the planning process and mitigation or compensatory actions where significant harm cannot be avoided (paragraph 2.6.1 of the MPS). The MPS also considers the effects of noise and vibration on wildlife and how these can be mitigated and minimised taking account of known sensitivities to particular frequencies of sound (paragraph 2.6.3 of the MPS).

9.4.2.3 The Draft Welsh National Marine Plan (dWNMP) introduces a framework to support sustainable decision-making for the marine environment. Details of how the mWave project adhere to the guidance set out in the dWNMP is outlined in Chapter 3: Need and Alternatives.

The Draft Welsh National Marine Plan includes guidance on what matters are to be considered in the following assessment. These are summarised in Table 9.2.

Table 9.2: Summary of the Draft Welsh National Marine Plan relevant to marine mammals

Summary of relevant policy framework	How and where considered in the Environmental Statement
Introduction of energy, including underwater noise: proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference: *a) avoid adverse impacts; and/or* *b) minimise impacts where they cannot be avoided; and/or* *c) mitigate impacts where they cannot be minimised.* If significant adverse impacts cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding.	The mWave project assessment has considered installation and operational noise impacts and their likely effects upon marine mammal behaviour and ecology (see sections 9.11 through to 9.13).
Implementation guidance: if marine mammals could potentially be impacted, assessment should take into account impacts within the appropriate Marine Mammal Management Units (MMMUs) identified by the UK Statutory Nature Conservation Bodies (NRW in Wales). If necessary, proposals should set out noise avoidance, minimisation or mitigation measures to manage the impact of man-made noise.	Appropriate marine mammal Management Units (MU) have been identified (see section 9.7.2 *et seq.*) and the assessment has taken into account impacts within these appropriate MUs (see impact assessment sections, section 9.11 through to 9.13) The mWave project assessment has considered installation and operational noise impacts and their likely effects upon marine mammal behaviour and ecology (see section 9.11 through to 9.13).
Ecosystem interaction: removal of species that act as a food source for other species may have wider food-chain impacts; other fish and marine mammal species can be caught incidentally; physical impacts on the seabed and benthic habitats can occur. These impacts, if not properly managed, can affect the future productivity of the resource for future generations by undermining ecosystem resilience.	This assessment has taken into account the following potential impacts: Changes in fish and shellfish communities (see section 9.11.2.99 *et seq.*); Entanglement risk (see section 9.11.3.49 *et seq.*); and Increases in suspended sediment concentration (SSC) (see section 9.11.2.78 onwards; and section)

9.4.2.4 Guidance provided within the Marine Strategy Framework Directive (MSFD), adopted in July 2008 (Defra, 2014) has also been considered in the mWave project assessment for marine mammals. The relevance of the MSFD to the mWave project is described in Appendix 3.1.

9.5 Consultation

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 marine mammals is outlined below in Table 9.3, together with how these issues have been considered in the production of this Environmental Statement chapter.

Table 9.3: Summary of key consultation issues raised during consultation activities undertaken for the META project which are relevant to mWave.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
12 October 2017	NRW – meeting with James Moon	Marine mammal: Interactions with wave device - NRW raised that interactions are likely to be relatively benign and more of a concern with tidal devices, and it was suggested that these sites should be consented separately.	mWave is a standalone WEC project.
28 March 2019	NRW – Advice from ABPmer	Potential disturbance effects on marine mammals as a result of increased underwater noise due to vessels involved in installation, operation and maintenance activities are proposed to be scoped into the EIA. The proposed approach for further assessment is to determine the potential increase in baseline levels of vessel traffic during these activities and to undertake a desk-based review of the types of vessels to be utilised and the potential for noise disturbance. Given the likely scale and nature of vessel activity associated with the META Project, this proposed approach is considered appropriate.	No change made – consultee agrees with approach
28 Mar 2019	NRW Scoping Opinion	The scoping report states that potential effects on marine mammals from the noise generated during the installation and decommissioning of devices are proposed to be scoped out of the EIA on the basis that the expected sound pressures levels of drilled piling (which are lower than expected from miscellaneous small vessels) are unlikely to result in injury to marine mammals. Potential effects on marine mammals during the operation of tidal turbines are also proposed to be scoped out on the basis that available data suggest the levels of noise generated by these devices is low and, in the context of existing high levels of baseline noise present within the Waterway, are unlikely to be a significant issue. This does not correspond with the underwater noise section of the Scoping Report (Section 6.7) which presents a proposed approach to assessing the effects of the installation and operation of devices on marine mammals. We disagree with the proposed scoping out of installation and decommissioning activities, and tidal turbines during the operational phase. The potential effects of noise on marine mammals during installation, operation and decommissioning must be assessed in the EIA (see comments in section 6.7). If geophysical surveys are proposed, then a noise impact of these activities should be considered.	These two impacts have been included in the Marine Mammals chapter for assessment and have clearly referenced the underwater noise assessment
1 March 2019	NRW – preliminary scoping opinion	Increased Underwater Noise – installation and decommissioning activities: Disagree that this can be scoped out. The predicted noise levels from installation could potentially cause injury at close range or disturbance to marine mammals. We don't agree that this can be scoped out as a potential impact at this stage.	As above, this potential impact has now been included in impact assessment.
1 March 2019	NRW – preliminary scoping opinion	Increased anthropogenic noise –tidal turbines during operational phase – we disagree that this can be scoped out at this phase. There is limited published literature on the noise levels from operational tidal turbines. Furthermore there is no information in this report on the likely device types to allow any comparison with the existing knowledge on operational devices, so it is impossible to rule out a potential impact from operational noise from tidal turbines.	As above, this potential impact has now been included in impact assessment.
1 March 2019	APBmer – preliminary scoping opinion	The underwater noise assessment should also include a desk-based review of the latest available scientific evidence of the observed responses of marine mammals to different types of underwater sounds for context	The Marine Mammal chapter includes recent and relevant peer-reviewed journal articles on observed responses to different types of underwater sounds.
1 March 2019	NRW – preliminary scoping opinion	We note that basking sharks have been included in the marine mammals chapter rather than fish ecology. This should be changed for the final EIA. Note that Basking Shark and Otters are included in the Marine Mammal baseline chapter. They should not be within this section.	Marine mammal chapter now termed 'Marine Mammals for clarity. Basking shark is included in Chapter 8 Fish and Shellfish, whilst otter are addressed in Chapter 17 Terrestrial Ecology.
1 March 2019	NRW – preliminary scoping opinion	NRW agree with the conclusion of the most likely marine mammal species to be found in the area, and the relative importance of the area for those species. However, the baseline description fails to note that the study area overlaps with the largest and most important breeding colony of Grey seals in the Celtic & Irish sea; Greater consideration should be given to the presence of Grey seals (papers to download suggested). No data collection required if the data sources provided by NRW are taken into consideration.	Further information on grey seals have been provided in the baseline, following further research (9.7.3); Suggested data sources accessed and taken into consideration for informing baseline (Table 9.4) and therefore also within the impact assessment. As per NRW comment, no additional data collection is proposed.
1 March 2019	NRW – preliminary scoping opinion	Missing impact pathway: Changes to hydrodynamics resulting in potential impairment of foraging opportunities for marine mammals. This should be informed by an assessment of coastal processes.	This potential impact is assessed within section 9.11.2 – informed by new impact under chapter 5: Coastal Processes.
1 March 2019	NRW – preliminary scoping opinion	Depending on the outcome of the noise assessments – there may be a requirement to use marine mammal observers to minimise risk of injury to marine mammals during construction. However, this will depend on the outcome of noise assessments.	The mWave device will be towed to site using two vessels and then lowered onto the seabed. The device uses a gravity foundation and as such there will be no piling. Bathymetry data for the deployment area confirms that there will be no requirement for site clearance or seabed levelling before deployment. Cable laying will use one vessel. An assessment of noise impact during installation is presented in this chapter based on data for a range of installation techniques identified in Chapter 6. The results of the assessment concludes a minor short term impact and as such no mitigation is required.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
1 March 2019	NRW – preliminary scoping opinion	We would recommend consideration of all marine mammal SACs within the relevant management unit. While most sites have been included in the assessment, for completeness the assessment should also list North Anglesey Marine SAC. Potential impacts should be considered on harbour porpoise from all 3 SACs within the management unit.	All Harbour Porpoise SACs within MU included in Designated Sites table (Table 9.7).
	NRW	Overall we are satisfied with the identification of impact pathways, and the environmental features (marine mammals) that could potentially be affected.	NRW comment noted.
		Table 6-9 'Designated sites' has omitted Cardigan Bay SAC – suggest this is a typo, since it does appear in the preceding list of sites for consideration.	Cardigan Bay SAC is considered in this chapter (section 9.7.2)
28 Mar 2019	NRW – Scoping Opinion	The potential for transboundary impacts has not been considered in the Scoping Report. The nearest other Member State to the META Sites is the Republic of Ireland14. There are unlikely to be any transboundary effects in relation to marine noise given the scale and nature of the activities proposed at the Phase 2 sites. The potential for cross-border impacts with England is also considered unlikely.	Potential for transboundary effects are considered in section 9.14. NRW's comment relating to lack of cross-border impacts is noted.

9.6 Methodology to inform the baseline

9.6.1 Desktop study

9.6.1.1 Information on marine mammals within the local study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 9.4 below. Where reports and data are over ten years old, up-to-date data and information have been used to ensure these sources are still valid.

Table 9.4: Summary of key desktop reports.

Title	Source	Year	Author
Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017.	Department of Communications, Climate Action & Environment, Irish Government	2018	Rogan *et al.*
Bottlenose Dolphin Monitoring in Cardigan Bay 2014 - 2016	Natural Resources Wales	2018	Lohrengel *et al.*
Grey Seal Breeding Census Skomer Island 2017	Natural Resources Wales	2017	Büche and Stubbings
Skomer MCZ Grey Seal Survey, Marloes Peninsula 1992-2016	Natural Resources Wales	2017	Lock *et al.*,
Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys	SCANS III	2017	Hammond *et al.*
Scientific Advice on Matters Related to the Management of Seal Populations	Special Committee on Seals (SCOS)	2011, 2012, 2013, 2014, 2015, 2016, 2017	SCOS
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area	JNCC Report No. 544	2015	Heinänen and Skov
The use of harbour porpoise sightings data to inform the development of Special Areas of Conservation in UK waters	JNCC Report No. 565	2015	IAMMWG
Management Units for cetaceans in UK waters	JNCC Report No. 547	2015	IAMMWG.
Atlas of the Marine Mammals of Wales. 2nd Ed.	Countryside Council for Wales (CCW)	2012	Baines and Evans
RPS Studies of Marine Mammals in Welsh High Tidal Waters	Marine Renewable Energy Strategic Framework for Wales (MRESF)	2011	Gordon *et al.*
Atlas of the Marine Mammals of Wales	Countryside Council for Wales	2009	Baines and Evans
Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008	Wildfowl and Wetland Trust aerial surveys	2009	WWT Consulting Ltd.
Marine Conservation Society Outer Bristol Channel Megafauna Surveys	Marine Conservation Society and Environment Agency	2007	Solandt
Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management	SCANS II	2006	Hammond *et al.*
RPS Shore-based Observational Marine Mammal Survey 2006	RPS on behalf of RWE nPower	2006	Shepherd and Rowson
Pembrokeshire marine SAC grey seal monitoring report 2005	Countryside Council for Wales	2006	Strong *et al.*
UK Cetacean Status Review	Sea Watch Foundation	*2003*	Evans *et al.*
Atlas of cetacean distribution in north-west European waters	JNCC	2003	Reid *et al.*
Abundance of Harbour Porpoise and other Cetaceans in the North Sea and Adjacent Waters	SCANS I	2002	Hammond *et al.*
The West Wales Grey Seals Census CCW Monitoring Report No. 131	The West Wales Grey Seals Census	1995	Baines *et al.*

9.6.2 Identification of designated sites

9.6.2.1 All designated sites within the local marine mammal study area which list marine mammals as a qualifying interest feature that could be affected by the installation, operation and maintenance, and decommissioning phases of the mWave project were identified using the three-step process described below. The proposed North of Celtic Deep MCZ, which falls inside the regional study area recognises that this area as a feeding ground for passing whales and dolphin, however no marine mammal species is listed as a feature of this proposed MCZ.

- Step 1: All designated sites of international, national and local importance within the regional study area were identified using a number of sources. These included international, national and local designations including MCZs, SACs, SPAs, and SSSIs identified by examining the JNCC's website, the European Site European Nature Information System (EUNIS) database, 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 marine mammal features for each of these sites. The known occurrence of each of the relevant species within the regional study area was based on relevant desktop information;
- 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;
  - Sites and associated features were located within the potential Zone of Impact (ZoI) for impacts associated with the mWave project;
  - Marine mammal qualifying 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 a national site falls outside of an international site, but within the local 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.

9.6.3 Management Units

9.6.3.1 The Interagency Marine Mammal Working Group (IAMMWG) has recommended Management Units (MU) for the most common species of marine mammals in the UK (IAMMWG, 2013), with a supplementary report provided in 2015 providing revised cetacean MUs (IAMMWG, 2015). MUs are transboundary areas. For each MU, IAMMWG recommend reference populations (abundance and geographic area) against which to measure potential effects of development and these are presented in the individual species accounts.

9.6.3.2 A special Committee on Seals (SCOS) was appointed to formulate scientific advice on matters related to the management of seal populations in the UK. Management Units were defined based on the presence of known populations, with divisions proposed on the basis of ecological evidence. There have been 11 management units defined for seal species in the UK. The boundaries of the MUs outside of Scotland have been defined to accommodate the Conservation of Seals (England) Order 1999 (IAMMWG, 2013).

9.6.4 Site specific surveys

9.6.4.1 No site-specific surveys were deemed necessary to characterise the marine mammal baseline for the mWave project due to the availability of existing data and reports.

9.7 Baseline environment

9.7.1 Key species

9.7.1.1 The following species could be encountered in the regional and local study areas:

- Harbour porpoise (*Phocoena phocoena*);
- Bottlenose dolphin (*Tursiops truncatus)*;
- Short-beaked common dolphin *(Delphinus delphis)*;
- Risso's dolphin *(Grampus griseus)*;
- Minke whale (*Balaenoptera acutorostrata*);
- Grey seal (*Halichoerus grypus*);

9.7.2 Cetaceans (whales and dolphins)

9.7.2.1 The regional study area consists mainly of inshore waters less than 80 m deep. Western parts however, approach deeper water habitats of the Celtic Sea consisting of waters up to 145 m deep (see Figure 9.3) which support a more diverse cetacean community than coastal waters (Hammond *et al.* 1995; (Reid *et al*. 2003; Evans *et al.* 2003; Baines and Evans, 2012). The Celtic Deep is an area of particularly deep water (< 145 m deep) and lies inside and to the south west of the study area, and can be seen on Figure 9.3. This area, along with waters off the western end of the Lleyn peninsula and Anglesey supports the highest cetacean species diversity in Welsh waters. The high species diversity likely results from the possible influence of two major frontal systems in the Irish Sea, the Celtic Sea and Irish Sea Fronts (Baines and Evans, 2012).

Harbour porpoise (Phocoena phocoena)

9.7.2.2 The harbour porpoise has a widespread distribution throughout the north Atlantic, occurring in temperate waters, largely found over the North Atlantic continental shelf. The species is the most numerous marine mammal in north-western European shelf waters (Reid *at al.* 2006).

9.7.2.3 Harbour porpoise normally live for approximately 12 years, although they have been recorded to reach a maximum age of 24. Harbour porpoise reach sexual maturity at between three and four years of age; reproduction is highly seasonal, with mating occurring between June and August and a corresponding peak in birth rates in June to July around the British Isles, following a 10 to 11-month gestation period (Lockyer, 1995; Boyd *et al*., 1999). There is little data on the inter-birth interval of harbour porpoises, but Lockyer *et al*. (2001) reported an ovulation interval of between 1 and 2.4 years.

9.7.2.4 Often associated with near-shore headlands and strong tidal currents, porpoise are commonly observed within shallow bays, estuaries and narrow tidal channels (Pierpoint, 2008; Baines and Earl, 1999). They are however known to exhibit strong vessel avoidance. Harbour porpoise exhibit diet flexibility, feeding on a varied diet of fish, cephalopods and crustaceans, thought to help this species to avoid being adversely affected by local anthropogenic over-exploitation of any one fish species.

9.7.2.5 The harbour porpoise is the most common and widespread species of cetacean in Welsh waters (Baines and Evans, 2012) with hot spots identified off the Pembrokeshire coast; the Lleyn Peninsula (to a lesser extent); in southern Cardigan Bay; and in the Bristol Channel off the south coast of Wales (around the Gower Peninsula and in Newport Bay) (Baines and Evans, 2012) (see Figure 9.4).

9.7.2.6 Along the Pembrokeshire coast, the harbour porpoise is the most commonly encountered cetacean (Reid et al., 2003a, Baines and Evans, 2012) and the species is present throughout the year (Pierpoint, 2001, Evans et al., 2003). The whole of the West Wales Marine SAC (see Figure 9.2) has been identified as an important summer area for harbour porpoise, and a smaller section to the south of the site, around Cardigan Bay, has also been identified as winter habitat for this species. Survey data has identified the West Wales Marine SAC as an area with persistently higher density of porpoises in relation to other areas (IAMMWG, 2015). Survey data from 2006 – 2011, supporting the designation of the West Wales Marine SAC, identifies the regional study area as hosting a discrete and persistent area of relatively high harbour porpoise density in comparison to the wider marine area, with concentrations of animals identified off Strumble Head, Pembrokeshire Islands, and in the vicinity of Cemaes Head and the Teifi Estuary at Cardigan (Heinänen and Skov, 2015; Pierpoint, 2001). Surveys carried out between March and November (2015) on Skomer Island show that harbour porpoise were sighted almost daily for much of this time, which is fairly typical of this species (noted to be 'abundant' in Skomer waters) (Bueche and Stubbings, 2015).

9.7.2.7 Data obtained from incidental sightings (1979 - 2018) and small vessel surveys from Neyland (just north-west of Warrior Way) to the Celtic Deep, provided by the West Wales Biodiversity Information Centre (WWBIC, 2019) (see Appendix 9.1 for full dataset) show that harbour porpoise have been sighted at the mouth of the Waterway and within the local study area. This data shows that harbour porpoise have been sighted as far east as South Hook Pier, east of Dale Roads (site 7) (see Figure 9.5).

9.7.2.8 Harbour porpoise in most of the eastern North Atlantic are generally considered to behave as a 'continuous' biological population that extends from the French coasts of the Bay of Biscay, northwards to the arctic waters of Norway and Iceland (IAMMWG, 2015). The IAMMWG, for practical management purposes however, has identified three Management Units (MUs) as appropriate for harbour porpoise: North Sea (NS), West Scotland (WS) and Celtic and Irish Seas (CIS). The regional and local study areas falls within the CIS MU which extends from the north west coast of France, to north west coast of the Republic of Ireland and east from South west coast of Scotland, including the entirety of Welsh waters (see Figure 9.6).

9.7.2.9 Four candidate SACs (cSACs) were proposed within the CIS MU, based on sea-based and land-based sightings data, formalised in February 2019 as SACs (see Table 9.7 for full details on relevant designated sites) (IAMMWG, 2015). Given that harbour porpoise are generally considered to behave as a 'continuous' biological population, any harbour porpoise observed within the local marine mammal study area are likely to have connectivity to one or more of these SACs. The total harbour porpoise abundance for the CIS MU was estimated as 104,695 animals (95% Confidence Interval 25,611 to 87,092) (IAMMWG, 2015). Where a quantitative assessment of impact is possible, the MU abundance estimate has been used as the reference population against which to assess the impact. Where only qualitative assessment has been undertaken, the MU reference population has been used to put any potential impacts into context.

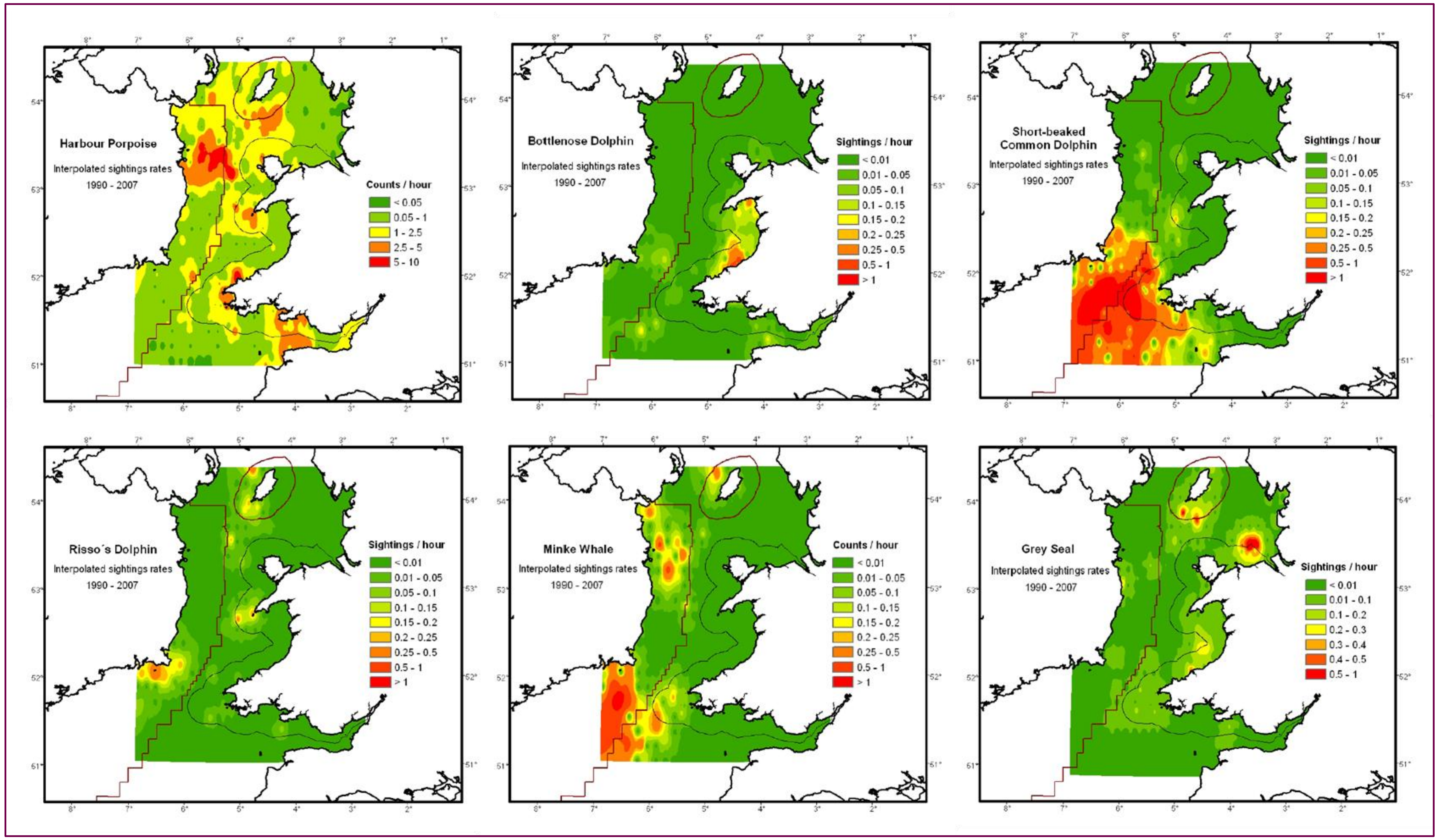


Figure 9.4: Marine mammal distribution in Welsh waters, based on long-term interpolated sightings data (Baines and Evans, 2009).

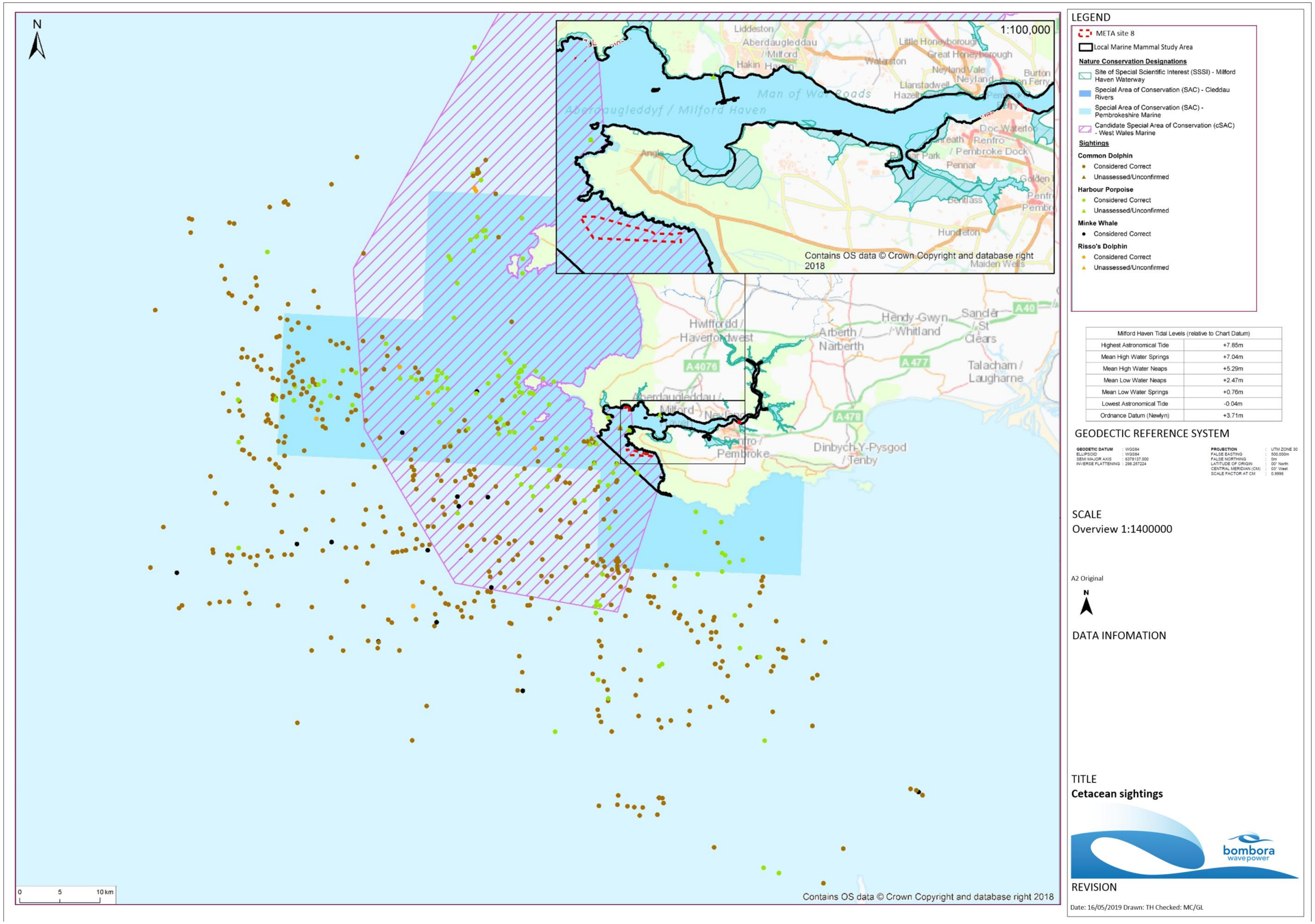


Figure 9.5: Cetacean sightings from small-vessel surveys (2005-2015) and incidental sightings (1979 – 2018) (WWBIC, 2019).

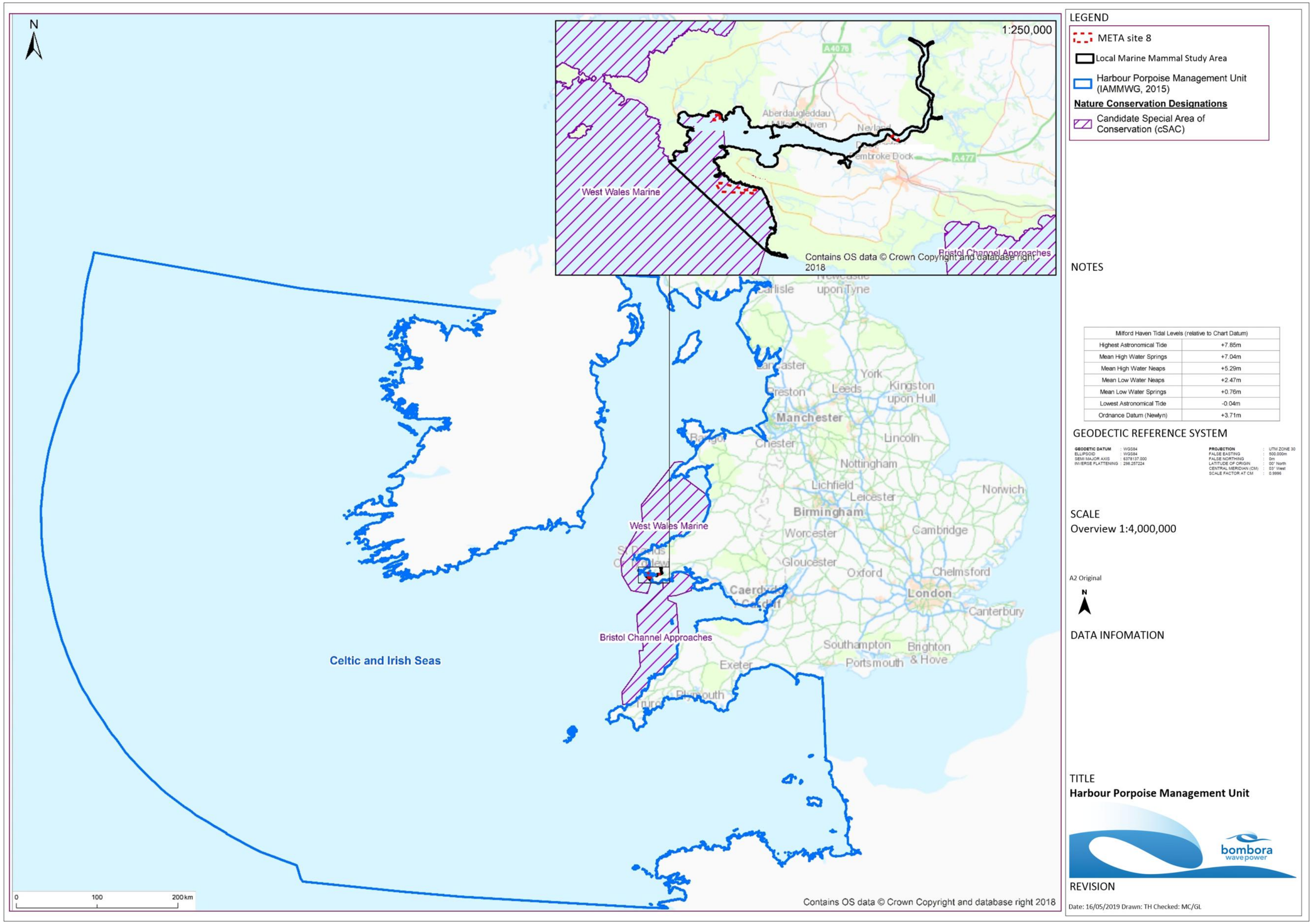


Figure 9.6: Harbour porpoise Management Unit.

Bottlenose dolphin (Tursiops truncatus)

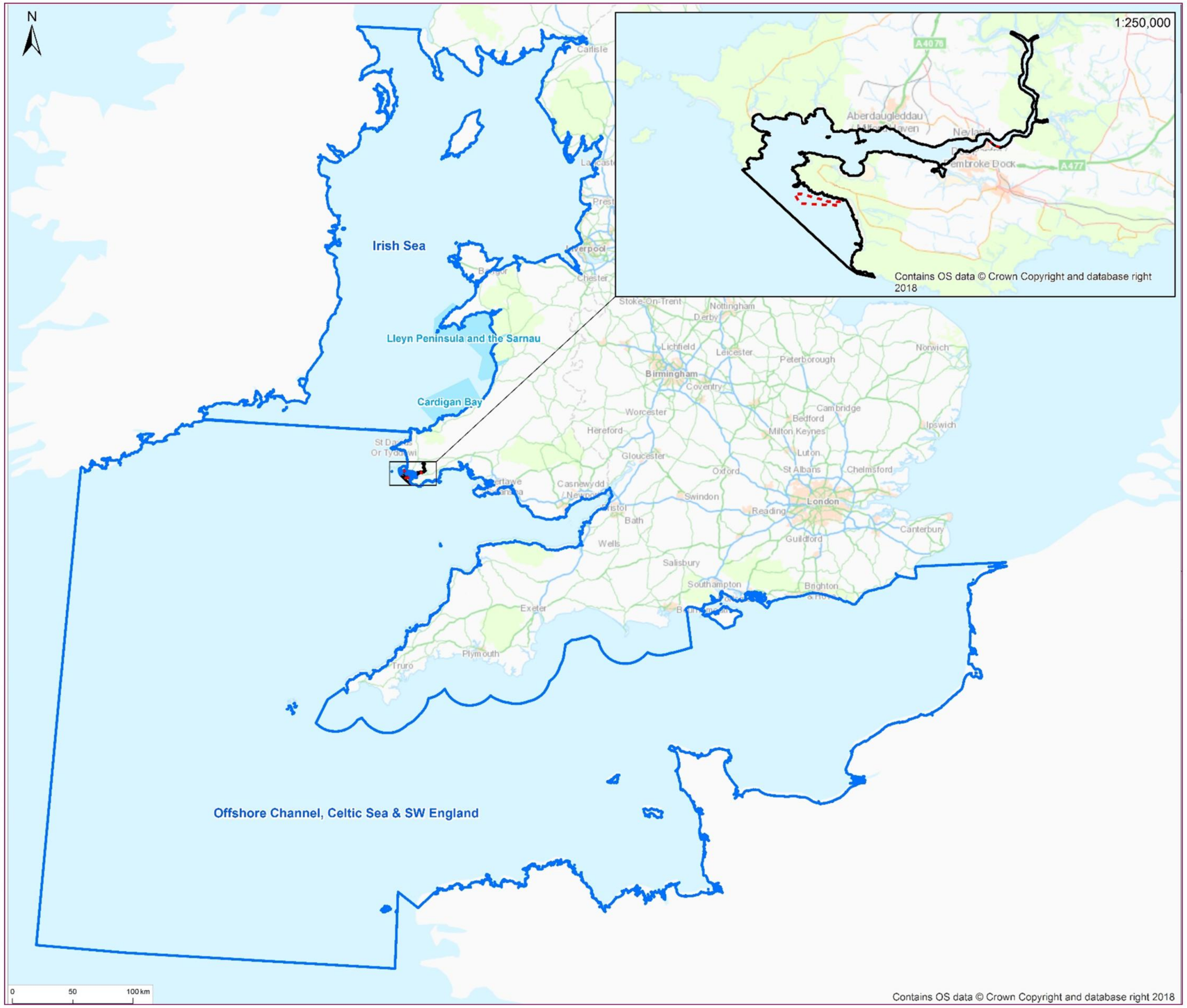
9.7.2.10 The bottlenose dolphin has a worldwide distribution, occurring in tropical and temperate waters. The species occurs in a diverse range of habitats from shallow estuaries and bays, to the continental shelf and beyond into deeper waters. Bottlenose dolphins in the north east Atlantic have a predominantly coastal distribution (Baines and Evans, 2012). Female bottlenose dolphins typically begin breeding at five to 13 years of age, with gestation lasting for 12 months. Bottlenose dolphins give birth to a single individual which will remain with its mother for several years. This species feeds on a wide variety of fish, cephalopods and occasionally shrimp and small rays and sharks. They pursue schooling prey and solitary prey throughout the water column as well as into the air above and into the sand below (Mann *et al.,* 2000).

9.7.2.11 Bottlenose dolphins, after harbour porpoise, are the next most frequently recorded cetacean species in Welsh waters Identified hot spots are located in southern Cardigan Bay; Tremadog bay; and north and east of Anglesey (Baines and Evans, 2009, see Figure 9.4). The species is present throughout the year in Welsh waters but animals are more likely to be found in small groups in coastal waters in summer (centred around Cardigan Bay), dispersing widely and generally north in winter, forming much larger groups (Baines and Evans, 2012). Bottlenose dolphin are the primary feature of Cardigan Bay SAC and a qualifying feature of Pen Llŷn a'r Sarnau SAC in northern Cardigan Bay. The semi-resident population of bottlenose dolphins found in Cardigan Bay is one of two major coastal populations in the UK (Lohrengel *et al.,* 2018), occurring in the regional study area; the population is thought to be composed of transients, occasional visitors and resident animals (Feingold and Evans, 2014). Any bottlenose dolphins sighted within the local study area are likely to have connectivity to one or both of these SACs. The second semi-resident population in the UK is found in the Moray Firth, Scotland.

9.7.2.12 Abundance estimates for the Cardigan Bay SAC produced an estimate of 64 individuals (CI = 19-220; CV = 0.65) in 2015 and 84 (CI = 44-160; CV = 0.33) in 2016; and for the wider Cardigan Bay, 277 (CI = 138-555; CV = 0.36) in 2015, 289 (CI = 184-453; CV = 0.23) in 2016 (Lohrengel *et al.,* 2018). Some individuals move north to the Isle of Man in winter months (the northernmost confirmed limit of the population's range), however it is believed that a proportion of the Cardigan Bay population remains within the SAC year round (Lohrengel *et al.,* 2018). Bottlenose dolphin births have been recorded throughout the year with a peak July and September, when 65% of births occur.

9.7.2.13 Whilst bottlenose dolphins are likely to be sighted within the regional study area, sightings within and in the vicinity of the local study area are extremely limited; the WWBIC data does not identify bottlenose dolphin as a sited species in either incidental sightings data or small vessel survey data (see Figure 9.5) (WWBIC, 2019, see Appendix 9.1 for full dataset). However, given that bottlenose dolphin is considered to be a wide-ranging species, known movements include that of coastal regions, and they are a qualifying interest feature of the Cardigan Bay SAC (which is within foraging range of bottlenose dolphin from the mWave project) a precautionary approach has been taken, and bottlenose dolphins will be included in the impact assessment.

9.7.2.14 The IAMMWG has identified two MUs for bottlenose dolphin which dissect the regional study area: The Irish Sea (IS) MU and the Offshore Channel, Celtic Sea and South West England (OCSW) MU (see Figure 9.7). The IS MU occurs to the east of the Republic of Ireland, from south west Scotland to the northern coast of Pembrokeshire. The OCSW MU is found at the bottom edge of the IS MU, from the north coast of Pembrokeshire, to the east coast of the Republic of Ireland, and to the north coast of France. The total bottlenose dolphin abundance for the IS MU was estimated as 397 animals (95% Confidence Interval 362 to 414); The total bottlenose dolphin abundance for the OCSW MU was estimated as 4,856 animals (95% Confidence Interval 1,638 to 14,398 (IAMMWG, 2015). Where a quantitative assessment of impact is possible, the MU abundance estimate for both MUs has been combined and will be used as the reference population against which to assess the impact.



LEGEND

META site 8

Local Marine Mammal Study Area

Bottlenose Dolphin Management Unit (IAMMWG, 2015)

Nature Conservation Designations

Special Area of Conservation (SAC)

NOTES

Milford Haven Tidal Levels (relative to Chart Datum)	
Highest Astronomical Tide	+7.85m
Mean High Water Springs	+7.04m
Mean High Water Neaps	+5.29m
Mean Low Water Neaps	+2.47m
Mean Low Water Springs	+0.76m
Lowest Astronomical Tide	-0.04m
Ordnance Datum (Newlyn)	+3.71m

GEODECTIC REFERENCE SYSTEM

GEODETIC DATUM : WGS84
ELLIPSOID : WGS84
SEMI MAJOR AXIS : 6378137.000
INVERSE FLATTENING : 298.257224

PROJECTION : UTM ZONE 30
FALSE EASTING : 500,000m
FALSE NORTHING : 0m
LATITUDE OF ORIGIN : 00° North
CENTRAL MERIDIAN (CM) : 03° West
SCALE FACTOR AT CM : 0.9996

SCALE

Overview 1:3,000,000

A2 Original

N

DATA INFOMATION

TITLE

Bottlenose Dolphin Management Unit

REVISION

Date: 16/05/2019 Drawn: TH Checked: MC/GL

Figure 9.7: Bottlenose dolphin Management Unit

Short-beaked common dolphin (Delphinus delphis)

9.7.2.15 The short-beaked common dolphin has a worldwide distribution and is amongst the most abundant of the world's cetacean species. This species has a largely offshore distribution and occurs in warm-temperate and tropical waters (Reid *et al.* 2006).

9.7.2.16 In Welsh waters, distribution is centred upon the Celtic Deep at the southern end of the Irish Sea, in water depths ranging from 50-150 metres (see Figure 9.3), which extends eastwards towards the coast and islands of west Pembrokeshire (see Figure 9.4). The species also occurs in low densities in the Irish sea in a central band which extends northwards towards the Isle of Man (Baines and Evans, 2012). The short-beaked common dolphin is primarily a summer visitor although persists in the Celtic Deep until November (Baines and Evans, 2012).

9.7.2.17 Common dolphins in the north-east Atlantic exhibit reproductive seasonality, with a uni-modal calving/mating period extending from April to September, with gestation periods lasting up to 12 months. The diet of common dolphin, over continental shelves, consists largely of a combination of the locally most abundant species of small pelagic shoaling fish or, rarely, cephalopod (Murphy *et al.,* 2013). This species has been recorded diving, presumably whilst feeding, of up to 260 m, however most dives are thought to be less than 100 m deep (Evans 1994; Perrin 2002).

9.7.2.18 Sightings data provided by the WWBIC (WWBIC, 2019, see Appendix 9.1 for full dataset) show that common dolphins have been sighted frequently within and throughout the regional study area. A cluster of sightings occurred just outside the local study area, with one (unconfirmed) sighting occurring inside the local study area (see Figure 9.5) (WWBIC, 2019).

9.7.2.19 Both the local and regional study areas fall within the Celtic and Greater North Seas (CGNS) MU which extends from the north of the Shetland Isles, to the west of the Irish landmass, and east to mainland Europe (see Figure 9.8). The total common dolphin abundance for the CGNS MU was estimated as 56,556 animals (95% Confidence Interval 33,014 to 96,920) (IAMMWG, 2015).

Risso's dolphin (Grampus griseus)

9.7.2.20 Risso's dolphins occur in almost all of the world's oceans between 60° south and 60° north. In UK waters, Risso's have largely been recorded over depths of 50-100m (Reid *et al.* 2006) (see Figure 9.3) showing preference for habitats over steep slopes. Knowledge on reproductive seasonality is limited however reports of births are year-round, occurring mostly from April to September (Pereira, 2008).

9.7.2.21 Clusters of sightings have been identified in the southern Irish Sea (Reid *et al.* 2006) and a relatively localised distribution has been identified in Welsh waters, forming a wide band which runs SW-NE, encompassing west Pembrokeshire; the western end of Lleyn Peninsula and Anglesey, the south-east coast of Ireland in the west and the waters around the Isle of man in the north (Baines and Evans, 2009, see Figure 9.4).

9.7.2.22 Risso's dolphin have a temporal distribution; they are mainly summer and autumn visitors to the regional study area with highest numbers of sightings in July to September. They are also known to breed in the regional study area (Baines and Evans, 2012).

9.7.2.23 Sightings data provided by the WWBIC (WWBIC, 2019, see Appendix 9.1 for full dataset) show that Risso's dolphin have been sighted within the regional study area. The closest sighting (considered correct) to the local study area, occurred due south of Skomer Island, due west of East Pickard Bay, outside of this study area (WWBIC, 2019) (Figure 9.5).

9.7.2.24 The local and regional study areas fall within the Celtic and Greater North Seas (CGNS) MU which extends from the north of the Shetland Isles, to the west of the Irish landmass, and east to mainland Europe (see Figure 9.8). Due to lack of data, there is no current abundance estimate for Risso's dolphin for this MU (Hammond, 2017).

Minke whale (Balaenoptera acutorostrata)

9.7.2.25 The common (or northern) minke whale is extensively distributed throughout the northern hemisphere in tropical, temperate and polar seas. High densities are known to occur in relatively cool waters over the Atlantic continental shelf (< 200m). (Reid *et al.* 2003; 2006). The minke whale is the most frequently recorded baleen whale (or mysticete) in British shelf waters (Evans, 2008). Although fin whales and humpback whales have been occasionally sighted in the regional study area, minke whale is the only baleen whale sighted with any regularity within UK waters and is therefore the only species of baleen whale being carried forward for assessment.

9.7.2.26 Minke whale typically live up to 60 years. Male minke whale reach sexual maturity at approximately 6.9 m in length (aged five to eight years) and females at about 7.3 m in length (aged six to eight years). Gestation occurs over a ten-month period. In the UK, minke whale tend to feed on sandeels predominantly, followed by clupeids and, to a lesser extent, mackerel (Anderwald and Evans, 2007).

9.7.2.27 The species has a largely offshore distribution with highest densities occurring in the Celtic Deep (see Figure 9.3), although the species is found in lower concentrations northwards towards the Isle of Man (Baines and Evans, 2012; Reid *et al.* 2006) (see Figure 9.4). Minke whale have a temporal distribution, and are mainly sighted in summer months, with few sightings in winter, however it is noted that this could be affected by higher sighting effort in summer (Baines and Evans, 2012).

9.7.2.28 Sightings data provided by the WWBIC (WWBIC, 2019, see Appendix 9.1 for full dataset) show that minke whale have been sighted within the regional study area. The closest sighting (considered correct) to the local study area, occurred about 16 km north-east of the western edge of this study (WWBIC, 2019) (see Figure 9.5). Both the local and the regional study areas fall within the Celtic and Greater North Seas (CGNS) MU which extends from the north of the Shetland Isles, to the west of the Irish landmass, and east to mainland Europe (see Figure 9.8). The total minke whale abundance for the CGNS MU was estimated as 23,528 animals (95% Confidence Interval 13,989 to 39,572) (IAMMWG, 2015).

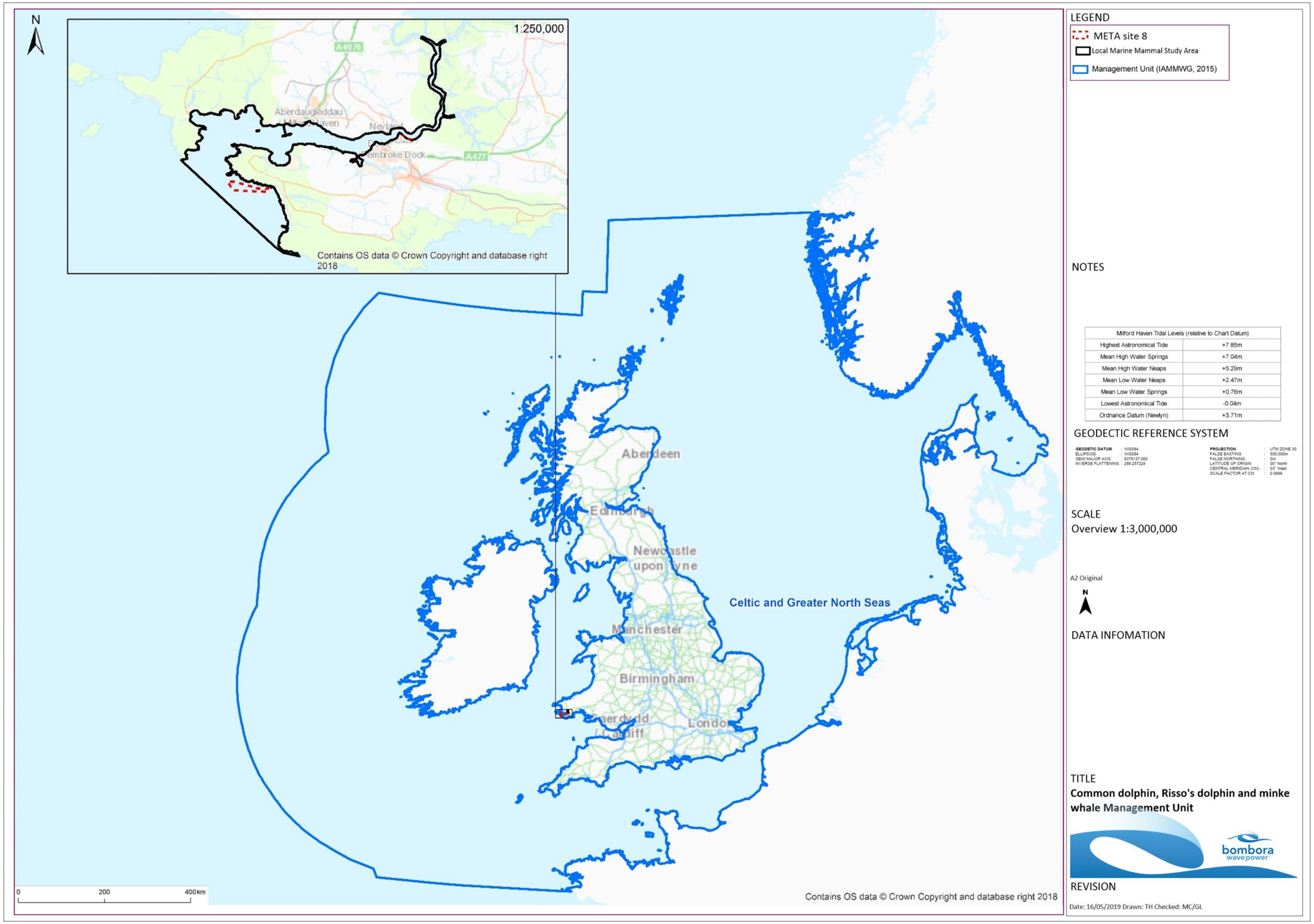


Figure 9.8: Common dolphin, Risso's dolphin and minke whale Management Unit

9.7.3 Pinnipeds (seals)

9.7.3.1 Grey seal is the only pinniped species which breeds in Wales. Whilst harbour seals (*Phoca vitulina*) are prevalent on the east coast of England and throughout the Scottish coast, there are no resident or breeding populations in Wales (IAMMWG, 2013). As such, harbour seal has not been considered for this assessment.

Grey seal (Halichoerus grypus)

9.7.3.2 Globally, there are three hotspots of grey seal abundance; one in eastern Canada and north-east USA; a second smaller population in the Baltic Sea; and the third along the coast of the UK (38% of the World's grey seals breed in the UK) (SCOS, 2017). Grey seals can live for over 20 to 30 years, with females tending to live longer than males (SCOS, 2015). Sexual maturity is reached at approximately ten years in males, and five years in females (SCOS, 2015) and gestation occurs over 10 to 11 months.

9.7.3.3 While grey seals are known to travel up to 2,100 km on foraging trips, most foraging trips remain within 145 km from haul-out sites (SCOS, 2015). Seals are highly mobile and feed mainly at the benthos in shelf seas (Thompson, 2012; Chen *et al.,* 2016). Telemetry studies of animals tagged on Welsh haul-out sites indicate that grey seals may make foraging trips to very localised areas, with animals from a particular locality tending to remain in that region (Strong *et al.,* 2006).

9.7.3.4 Grey seals are widely distributed in Welsh waters. Breeding colonies in northwest Pembrokeshire, particularly on Ramsey Island, extending southwards to Skomer Island and northwards to southern Ceredigion (see Figure 9.9) (Baines and Evans, 2009). Small concentrations occur around the Lleyn Peninsula and the coast of Anglesey. These breeding colonies act as haul-out sites in the non-breeding season. Approximately 5,000 grey seals use habitats on the Welsh coast, which is the most important breeding colony for grey seal in the southern U and the most significant breeding colony of grey seal in the Celtic and Irish sea, overlaps with the local study area. K. Approximately 5% of UK grey seal pups are born on the coasts of SW Wales and SW England each year (Duck, 1995; Baines *et al*., 1995; SCOS, 2017). Grey seals are a feature of the Skomer Marine Conservation Zone (MCZ) (see Figure 9.10) and seal pupping sites are found at both Skomer Island and Marloes peninsula sites (Lock *et al.,* 2017). The Marloes peninsula contributes, on average, 41% of the total pup production in the Skomer MCZ.

9.7.3.5 In 2015, 465 pups were born in North Pembrokeshire and 379 pups born on Skomer and adjacent mainland sites in 2015 (SCOS, 2017). In 2017, 383 pups were born within the Skomer Marine Conservation Zone (the highest number of seal births within the whole of the MCZ since records began) with 225 pups born on Skomer Island (the second highest total ever recorded) and 158 born on Marloes Peninsula (Büche and Stubbings, 2018),Pupping occurs between July and November, and in 2017 the highest number of pups were born in September (n = 146) and October (n = 57). Büche and Stubbings (2018) identified *Castle Bay*, *North Haven* and *Matthew's Wick* (all on east Skomer Island, see Figure 9.10) as the most important haul-out sites within the MCZ, with average daily numbers of seals recorded as 44, 33 and 24 seals respectively. The Garland Stone does not appear to play a major role as a haul-out sire during the autumn, however seals use it all year round. Weather conditions are most likely the most significant determining factor on number of seals hauled-out per site day to day (Büche and Stubbings, 2018).

9.7.3.6 The Grey Seal Breeding Census Skomer Island 2017 (Büche and Stubbings, 2018) identified two seals hauled-out on North Haven beach, with tags which identified them as having originated 105km. Two seals which originated from the Skomer MCZ were identified in Cornwall, 147km and 131km away.

9.7.3.7 Sightings data provided by the WWBIC (WWBIC, 2019, see Appendix 9.1 for full dataset) show that grey seal have been sighted within both the regional study area and throughout the local study area (see Figure 9.10).

9.7.3.8 Both the local and the regional study areas fall within the South and West England and Wales MU which extends from the bottom of south west Scotland, the length of the coast of Wales and south west England to east of the Isle of Wight (see Figure 9.11). The total grey seal summer population size estimate for this MU is 6,000. The estimated grey seal summer population size for this MU is 6,000 (IAMMWG, 2013). Where a quantitative assessment of impact is possible, the MU abundance estimate has been used as the reference population against which to assess the impact.

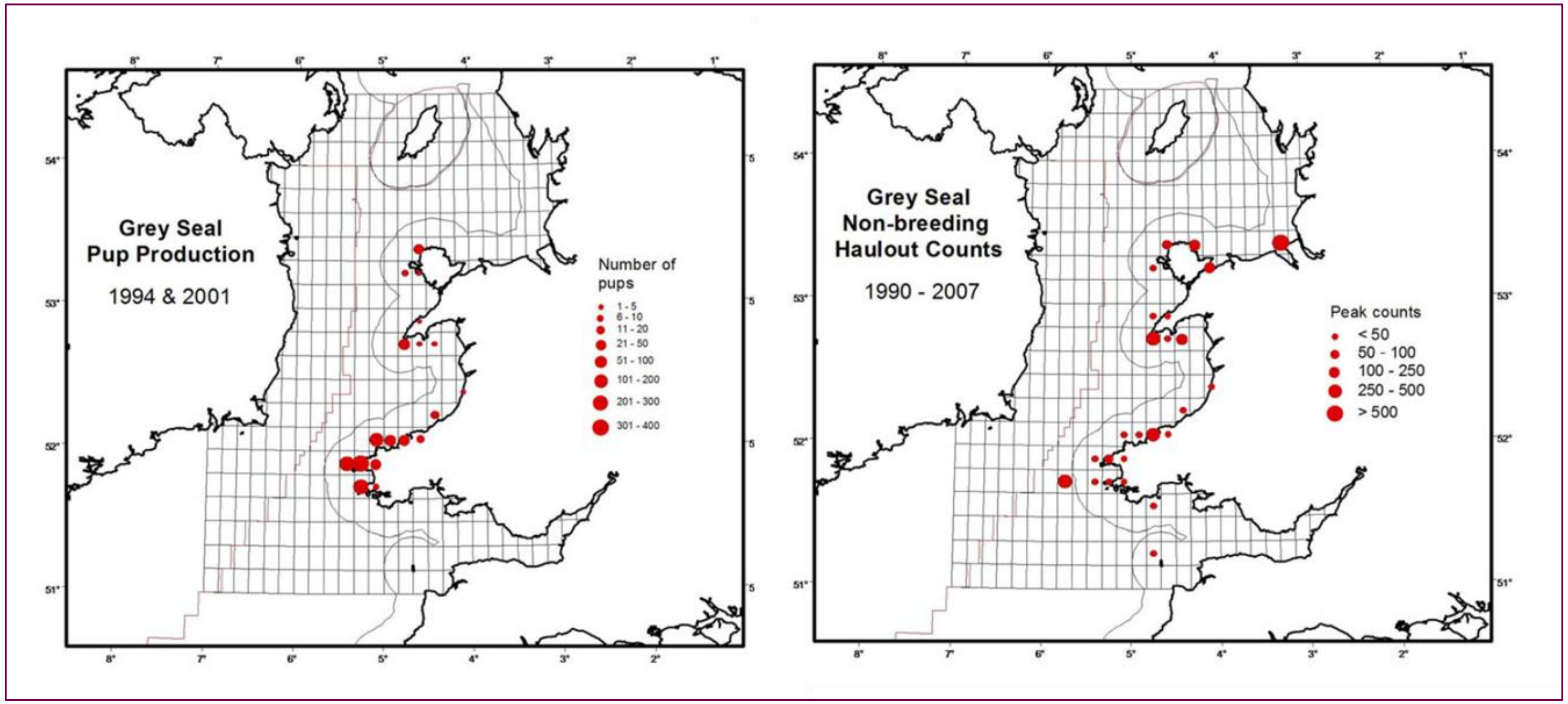


Figure 9.9 Grey seal pup production (1994 and 2001) and grey seal non-breeding haulout counts (1990 - 2007) in Welsh waters (Baines and Evans, 2009).

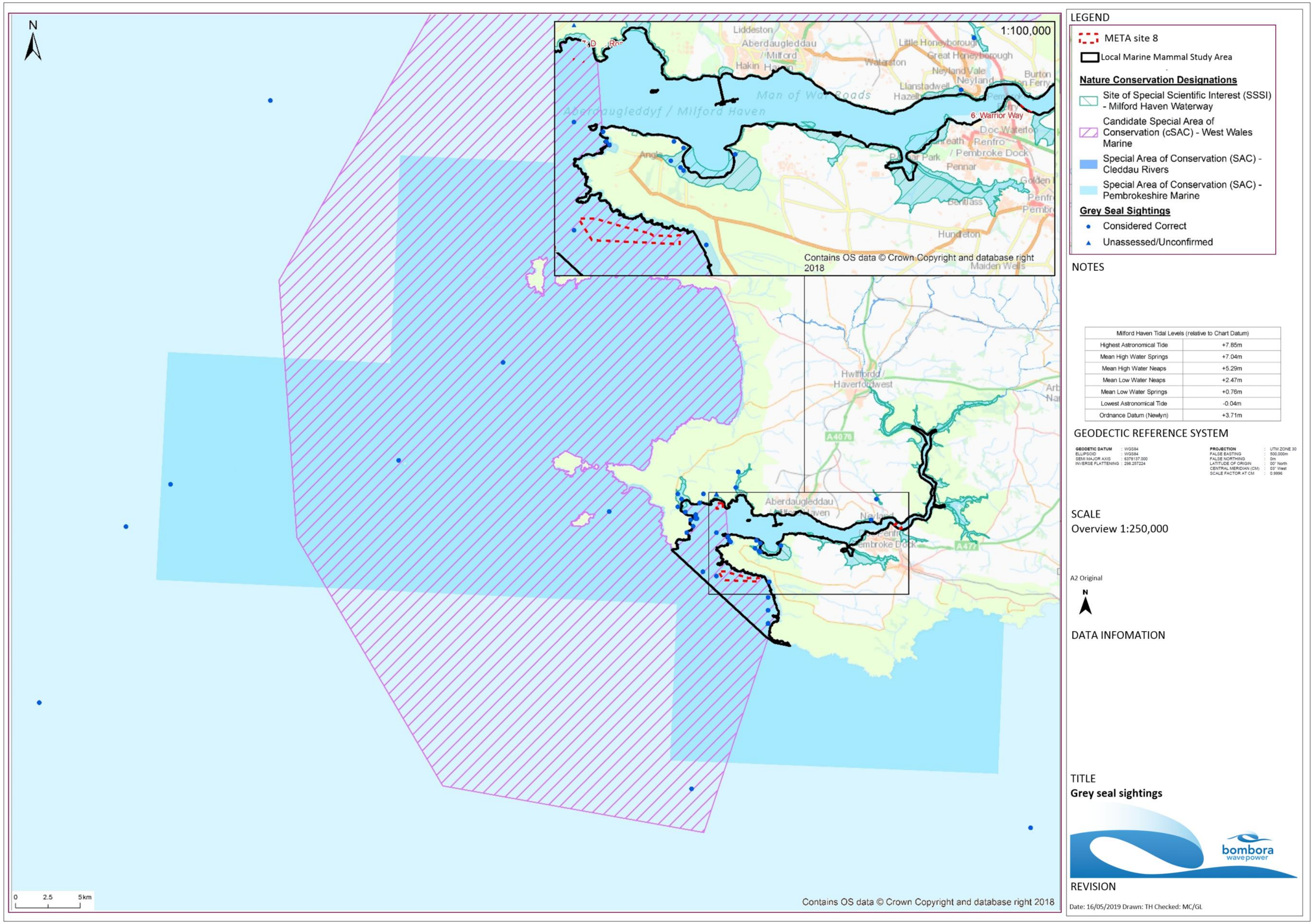


Figure 9.10: Grey seal sightings from small-vessel surveys (2005-2015) and incidental sightings (1979 – 2018) (WWBIC, 2019)

LEGEND

- META site 8
- Local Marine Mammal Study Area
- Grey Seal Management Unit (IAMMWG, 2013)

Nature Conservation Designations

- Special Area of Conservation (SAC)

NOTES

Milford Haven Tidal Levels (relative to Chart Datum)	
Highest Astronomical Tide	+7.85m
Mean High Water Springs	+7.04m
Mean High Water Neaps	+5.29m
Mean Low Water Neaps	+2.47m
Mean Low Water Springs	+0.76m
Lowest Astronomical Tide	-0.04m
Ordnance Datum (Newlyn)	+3.71m

GEODECTIC REFERENCE SYSTEM

GEODETIC DATUM : WGS84
ELLIPSOID : WGS84
SEMI MAJOR AXIS : 6378137.000
INVERSE FLATTENING : 298.257224

PROJECTION : UTM ZONE 30
FALSE EASTING : 500,000m
FALSE NORTHING : 0m
LATITUDE OF ORIGIN : 00° North
CENTRAL MERIDIAN (CM) : 03° West
SCALE FACTOR AT CM : 0.9996

SCALE

Overview 1:2,500,000

A2 Original

N

DATA INFOMATION

TITLE

Grey Seal Management Unit

REVISION

Date: 16/05/2019 Drawn: TH Checked: MC/GL

Figure 9.11: Grey seal Management Unit.

9.7.4 Designated sites

9.7.4.1 Designated sites identified for the marine mammal, assessment are described in Table 9.5 below.

Table 9.5: Designated sites and relevant qualifying interest features for the mWave project marine mammals

Designated Site	Approximate distance to mWave site (km)	Relevant Qualifying Interest Feature
Pembrokeshire Marine/ Sir Benfro Forol SAC	0	Annex II Species Grey seal (*Halichoerus grypus*)
West Wales Marine cSAC / Gorllewin Cymru Forol cSAC	0	Annex II Species Harbour porpoise (*Phocoena phocoena)*
Bristol Channel Approaches / Dynesfeydd Môr Hafren cSAC	15	Annex II Species Harbour porpoise (*Phocoena phocoena)*
Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC	102	Annex II Species Bottlenose Dolphin (*Tursiops truncatus*) Grey seal (*Halichoerus grypus*)
Cardigan Bay / Bae Ceredigion SAC	50.5	Annex II Species Bottlenose dolphin (*Tursiops truncatus*) Grey seal (*Halichoerus grypus*)
North Anglesey Marine / Gogledd Môn Forol Site of Conservation Importance (SCI)	174	Annex II Species Harbour porpoise (*Phocoena phocoena*)
North Channel SAC	281	Annex II Species Harbour porpoise (*Phocoena phocoena*)
Lundy Island SAC	58.1	Annex II Species Grey seal (Halichoerus grypu

9.7.5 Valued Ecological Receptors

9.7.5.1 The value of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM, 2016). The most straightforward context for assessing ecological value is to identify those species and habitats that have a specific biodiversity importance recognised through international or national legislation or through local, regional or national conservation plans. The following table shows the criteria applied to determining the value of ecological receptors (VERs) within the geographic frame of reference applicable to the regional study area (Table 9.6)

Table 9.6: Valued Ecological Receptors categorisation for marine mammals

Value of VER	Criteria to define value
Very high	Internationally protected species that are listed as a qualifying interest feature of an Internationally protected site (i.e. Annex II protected species designated feature of a European designated site i.e. Natura 200 site).
High	Internationally protected species (including EPS) that are not qualifying features of a candidate or designated European Site but are regularly recorded within the regional marine mammal study area, but in relatively low densities and therefore the area is not considered to be important for the species in an international context. Internationally protected species that are not qualifying features of a European designated site but are recognised as a Biodiversity Action Plan (BAP) priority species either alone or under a grouped action plan, and are listed on the local action plan relating to the regional marine mammal study area.
Medium	Internationally protected species that are not qualifying features of a European designated site and are infrequently recorded within the regional study area in very low numbers compared to other regions of the British Isles.
Low	There are no criteria given for local due to the high level of protection under international law for all marine mammal species which makes this category irrelevant.

9.7.5.2 The six species presented in section 9.7 are very high or high VERs. The valuation is based on their protected status and their abundance and distribution within the regional study area, as well as their wider distribution and abundance within their natural range. Table 9.7 presents the VERs identified for the marine mammal impact assessment.

Table 9.7: Marine mammal VERs identified for the mWave project impact assessment.

Receptor	Value	Justification
Harbour porpoise	Very High	Annex II species protected under international legislation and designated feature of West Wales Marine / Gorllewin Cymru Forol SAC and Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC.
Bottlenose dolphin	Very high	Annex II species protected under international legislation and designated feature of Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC and Cardigan Bay / Bae Ceredigion SAC.
Short-beaked common dolphin	High	Internationally protected species regularly sighted in the regional marine mammal study area
Risso's dolphin	High	Internationally protected species regularly sighted in the regional marine mammal study area
Minke whale	High	Internationally protected species regularly sighted in the regional marine mammal study area
Grey seal	Very high	Large haul out to the south west of the marine mammal study area. Annex II species protected under international legislation and designated feature of Pembrokeshire Marine SAC, Cardigan Bay / Bae Ceredigion SAC and the Lleyn Peninsula and Sarnau / Pen Llyn a`r Sarnau SAC

9.7.6 Future baseline scenario

9.7.6.1 The (Marine Works (EIA) Regulations 2007 (as amended)) 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.

9.7.6.2 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.

9.7.6.3 Marine mammal populations naturally fluctuate over space and time, however given the very short nature of the mWave project (up to 18 months), identifiable fluctuations are unlikely to occur over the lifetime of the project. Their distribution is, to a large extent, mediated by the distribution and abundance of prey species. Many species range over large distances and, to a certain extent, can adapt to gradual changes in the environment, such as those that may occur as a result of climate change (Hoegh-Guldberg and Bruno, 2010). This is not the case for all species. Those that have more restricted habitat ranges are likely to be more vulnerable to changes in their environment. For the marine mammal VERs identified in Table 9.7, species such as grey seal, whose natural foraging range is more restricted than cetacean species (most foraging trips remain within 145 km from haul-out sites (SCOS, 2015), may be more sensitive to long-term changes.

9.7.6.4 The impact of anthropogenic-induced climate change has so far been recorded as decreased productivity of the oceans, altered food-web dynamics, reduced abundance of habitat-forming species, shifting species distributions and a greater incidence of disease (Hoegh-Guldberg and Bruno, 2010). Temperature changes in northern Europe may affect cold-water shelf species such as harbour porpoise. Increased sea levels modifying shallow seas could affect the availability of protected cave sites for breeding seals, as well as low-lying areas and other haul out sites (e.g. grey seal) (Evans *et al*., *2010*).

9.7.6.5 Anthropogenic activities in the marine environment can influence the distribution and abundance of marine mammal populations. In the regional study area, potential impacts include: probable mortality due to bycatch from fisheries (particularly for harbour porpoise); direct or indirect effects of contamination (from pollution incidents, sewage discharge, or litter disposal at sea); injury or disturbance from introduced noise into the marine environment (e.g. from shipping, drilling, piling, seismic surveys, military activity, dredging and disposal, aggregate extraction, Unexploded Ordinance (UXO) detonations, and Acoustic Deterrent Devices (ADD)); death or injury due to collision with physical objects (vessels or renewable energy devices); and removal of prey species by anthropogenic impacts such as overfishing.

9.7.6.6 For grey seals, population trend objectives have been based on pup production, since that metric has been long established as the most robust for determining changes in population dynamics (SCOS, 2017).

9.7.7 Data limitations

9.7.7.1 Mobile species, such as marine mammals exhibit varying spatial and temporal patterns. All historic surveys across the regional study area represent snapshots of the species considered at the time of sampling. Abundance and distribution of species is likely to vary both seasonally and annually.

9.7.7.2 Baines and Evans (2012) note that south Pembrokeshire would benefit from greater marine mammal survey effort.

9.7.7.3 The majority of sightings within the local study area are incidental and as such abundance estimates are unavailable. This means an estimate of abundance within the local study area has not been possible.

9.8 Key parameters for assessment

9.8.1.1 The design parameters (from chapter 2: Project Description) identified in Table 9.8 have been selected as those most likely to have the potential to result in the greatest effect on an identified receptor or receptor group.

9.8.1.2 Although information of impacts of wave energy converter devices, is limited, this assessment draws on available desk-based studies and expert advice. Where relevant there is consideration of the outcome of assessments undertaken to inform the consenting of other UK energy projects at the European Marine Energy Centre (EMEC), in the Sound of Islay, in Strangford Lough and at the Skerries, off the coast of Anglesey, North Wales and the Nova deployments in Shetland.

9.8.1.3 The marine mammal assessment has been informed by the following assessments:

- Coastal Processes (chapter 5)
- Fish and shellfish (chapter 8);
- Underwater noise (chapter 6); and
- Shipping and Navigation (chapter 12).

9.8.2 Impacts scoped out of the assessment

9.8.2.1 On the basis of the characterisation of the baseline environment and the project description outlined in chapter 2: Project Description, a number of potential impacts are proposed to be scoped out of the assessment for marine mammals. These impacts are outlined, together with a justification for scoping them out, in Table 9.9.

Table 9.8: mWave design parameters considered for the assessment of potential impacts on marine mammals

Potential impact	Design parameter	Justification
Installation and decommissioning phases		
Increased anthropogenic underwater noise	• Up to 3 vessels required for mWave deployment and retrieval operations, including guard boat, restricted to daylight hours. • Vessel size - up to 50m in length and 6 m draught • Pre-installed moorings. Mooring spread up to 40,000 m^2 • 3 days for mWave installation. • Installation of chain ballast - 14 vessel trips over 5 days (26m max length, 2.5m draught). • Cable laying one vessel (50m max length, 6m draught). • Cable installation up to 3 days. • Worst case source sound pressure level at 1 m = 179 dB re 1 μPa (rms) / 229 SEL (24h) dB re 1 $μPa^2s$ based on noise from cable laying vessel	• Vessel traffic movements during mWave installation and cable laying activities will be associated with the greatest increase in anthropogenic noise, thereby having the potential to have the greatest impact on marine mammals.
Increased collisions risk with vessels	• Up to 3 vessels required for mWave deployment and retrieval operations, including guard boat, restricted to daylight hours. • Vessel size - up to 50 m in length and 6 m draught. • Pre-installed moorings. • 3 days for mWave installation. • 14 vessel trips over 5 days for ballast chain, 26m max length, 2.5m draught).Cable laying one vessel (50m max length, 6m draught). • Cable installation up to 3 days.	• Increased vessel traffic has been identified as presenting an increased risk to marine mammals through collision between a vessel and an animal and through potential collision of vessel propeller with an animal. • Maximum vessel traffic movements during mWave installation and maximum vessel size will have the potential to have the greatest impact on marine mammals at each site.
Increases in suspended sediment concentration (SSC)	• Up to 3 vessels required for mWave deployment and retrieval operations, restricted to daylight hours. • Cable laying one vessel • Ballast would be placed in trays so no increased suspended solids. • Localised increase in suspended sediments through placement of mWave and ADCP/SUTU on seabed and along offshore sand section of communication cable. Potential installation of scour protection if needed. Seabed footprint – up to 1,900m^2	• Suspended sediments are likely to derive from the installation and retrieval of mWave • Sediment disturbance may arise from a range of installation activities, such as installation of temporary moorings for installation vessels, placement of mWave on the seabed, placement of ADCP, SUTU and laying of communication cable. Elevations in SSC and subsequent deposition of disturbed metocean regime (wave, sand and currents) and marine energy devices has the potential to cause localised scouring of seabed sediments leaving a depression around the structure. • mWave device may interrupt sediment transport pathways • Removal of mWave and infrastructure may result in re-suspension of sediments • The combined seabed area for/and installation activities disturbing fine sediment plus the maximum number of associated vessel movements will result in maximum increases in SSC, thereby having the potential to have the greatest impact on marine mammals.
Changes in fish and shellfish communities	Increased SSC as a result of activities above. • Seabed footprint – up to 1,900 m^2 (including device, cable, ADCP, SUTU, potential scour protection) • Pre installed mooring spread up to 40,000 m^2, though seabed footprint limited.	• There is potential for disturbance or temporary loss of habitat through device and cable installation.
Accidental Pollution	• Up to 3 vessels required for deployment and retrieval operations, restricted to daylight hours. • Cable laying one vessel . • 14 vessel trips over 5 days for ballast chain, 26m max length, 2.5m draught).	• There is a risk of accidental pollution from vessel spills during installation and decommissioning operations.
Operational phase		
Increased anthropogenic underwater noise - vessels	• Maximum duration of mWave testing activity is 6-12 months, with a total project time of 18 months. • O&M visits with up to 3 vessels once per month for 2 days giving 24 visits in 12 months. • 50m max length, 6m draught.	• Assumed maximum vessel traffic movements and maximum vessel size will be associated with the greatest increase in anthropogenic noise, thereby having the potential to have the greatest impact on marine mammals.

Potential impact	Design parameter	Justification
	• Scour protection if needed, 5 days, 10 vessel trips. • Worst case source sound pressure level at 1 m = 179 dB re 1 μPa (rms) / 229 SEL (24h) dB re 1 μPa²s based on noise from cable laying vessel.	
Increased anthropogenic underwater noise – operation of mWave	• Testing of mWave for 6 - 12 months. • Device placed on seabed, Gravity based foundation. Device occupies 7m of water column and 75m by 17m dimensions. Air contained within membrane covered cells pushed through enclosed generator.	• There is potential for noise to be generated from mWave through the operation of the air operated generator and valves.
Increased collisions risk with vessels	• As above for increased anthropogenic underwater noise –vessels	• Increased vessel traffic has been identified as presenting an increased risk to marine mammals through collision between a vessel and an animal and through potential collision of vessel propeller with an animal.
Entanglement risk	• Mooring for O&M vessels - up to 4-standard drag embedment anchors. • Surface navigational marker for WEC, if needed.	• Entanglement risk due to temporary O&M moorings, navigational markers (if required) is recognised as a risk to marine mammals.
Accidental Pollution	• O&M visits with up to three vessels once per month for 2 days giving 24 visits in 12 months. 50m max length, 6m draught. • Scour protection if needed, 10 vessel trips over 5 days.	• There is a risk of accidental pollution from vessel spills during O&M operations.

Table 9.9: Impacts scoped out of the assessment for marine mammals

Potential impact	Justification
Installation/decommissioning	
Impact from increased vessel activity in waters from destination port.	During the installation, vessels will use the Waterway as a base and will transit to site and back. The number of vessels for installation is minimal with three required for the deployment and one for cable laying. Additional 14 additional journeys will be required to deploy ballast chain over 5 days. There is significant vessel movement in the Waterway (Chapter 12: Shipping and Navigation) and the increase in vessels as a result of the project is unlikely to be perceptible against this baseline in terms of the impacts identified in Table 9.8 above. As such impacts in the Waterway has been scoped out of this assessment.
Operation	
Collision risk during operation	mWave is a Wave Energy Converter (WEC) which will sit on the seabed, up to a height of 7m. The WEC uses the change in pressure as a wave passes over the device to displace air from the membrane covered cells at the top of the device, the membranes inflate and deflate to move air within the device. The air from the cells is then passed through an enclosed turbine before being recycled back through the device. As such there are no moving external parts of mWave which may pose a collision risk to marine mammals, and this impact has been scoped out of this assessment.
Changes in fish and shellfish communities	mWave is a Wave Energy Converter (WEC) which will sit on the seabed, up to a height of 7m. The WEC uses the change in pressure as a wave passes over the device to displace air from the membrane covered cells at the top of the device, the membranes inflate and deflate to move air within the device. The air from the cells is then passed through an enclosed turbine before being recycled back through the device. As such there are no moving external parts of mWave which may pose a collision risk to fish or shellfish which would act as a food supply for marine mammals. This impact has been scoped out of this assessment.
Impact from increased vessel activity in waters from destination port.	The O&M vessels will transit from Pembroke Dock in the Waterway to site and back. The number of vessels for O&M is minimal with three required once per month for up to two days. Should scour protection be required, there may be additional journeys of up to 5 days once during the operation of the device. There is significant vessel movement in the Waterway (Chapter 12: Shipping and Navigation) and the increase in vessels as a result of the project is unlikely to be perceptible against this baseline in terms of the impacts identified in Table 9.8 above. As such impacts in the Waterway has been scoped out of this assessment.
Changes in hydrodynamic regime	mWave will sit on the seabed up to a height of 7m. The movement of mWave is through the displacement of air from the membrane covered cells at the top of the device, as opposed to the movement of a turbine blade. As identified in Chapter 5 there will be a local but insignificant effect on the hydrodynamic regime and as such this impact has been scoped out of this assessment.
Electro-magnetic Field (EMF) during operational phase	EMF emitted by array and export cables may potentially affect marine mammal, behaviour, however initial assessment shows that this impact will be negligible due to low voltage travelling through communications cable, and as such this impact has been scoped out.

9.9 Impact assessment methodology

9.9.1 Overview

9.9.1.1 The marine mammal EIA has followed the methodology set out in chapter 4: Environmental Impact Assessment Methodology. Specific to the marine mammal EIA, 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);
- IEEM guidelines for marine ecological impact assessment (IEEM, 2010);
- MarLIN species and ecosystem sensitivities guidelines (Tyler-Walters *et al*., 2001);
- Environmental Impact Assessment (EIA): Guidance for developers at the European Marine Energy Centre (EMEC Orkney, 2010); and
- Towards best environmental practice for cetacean conservation in developing Scotland's marine renewable energy (Dolmans, S and M. Simmonds (2010).

9.9.1.2 In addition, the marine mammal EIA has considered the legislative framework as defined by:

- EC Habitats Directive 92/43/EEC;
- Wildlife and Countryside Act 1981;
- Marine and Coastal Access Act, 2009;
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- Bern Convention; and
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

9.9.2 Impact assessment criteria

Sensitivity

9.9.2.1 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 are based on those used in the Design Manual for Roads and Bridges methodology, which are described in further detail in chapter 4: Environmental Assessment Methodology.

9.9.2.2 The criteria for defining sensitivity in this chapter are outlined in Table 9.10.

9.9.2.3 The sensitivity of marine mammal 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 marine mammal 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 as presented in Table 9.6. The overall sensitivity of a receptor/receptor group to an impact has been identified from a five-point scale as presented in Table 9.10.

Table 9.10: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
Very High	Very High or High VERs 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

9.9.2.4 The criteria for defining magnitude in this chapter are outlined in Table 9.11.

Table 9.11: 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

9.9.2.5 The significance of the effect upon marine mammals is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 9.12. Where a range of significance of effect is presented in Table 9.12. 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 9.12: 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

9.9.3 Designated sites

9.9.3.1 Where Natura 2000 sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the interest features of internationally designated sites as described within section 9.6.2 of this chapter (with the assessment on the site itself deferred to the No Significant Effect Report (NSER) for the mWave project).

9.9.3.2 With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site and where notified interest features of the Natura site are also qualifying interest features of the nationally designated sites (e.g. SSSIs which under-pin a Natura site)), only the international site has been taken forward for assessment. This is because 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). However, where a nationally designated site falls outside the boundaries of an international site, but within the regional marine mammal study area, an assessment of the impacts on the overall site is made in this chapter using the EIA methodology.

9.9.3.3 The NSER has been prepared in accordance with Advice Note Ten: Habitats Regulations Assessment Relevant to Nationally Significant Infrastructure Projects (PINS, 2016) and will be submitted as part of the Marine Licence and the TCPA application.

9.10 Measures adopted as part of the mWave Project

9.10.1.1 As part of the project design process, a number of designed-in measures have been proposed to reduce the potential for impacts on marine mammals (see Table 9.13). 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 9.11 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.

9.10.1.2 It should be noted that the principles of the JNCC guidance on protection of marine European protected species from injury and disturbance (JNCC, 2010) and of relevant guidelines on minimising the risk of injury to marine mammals will be adopted as necessary (for example, reducing the duration of noise emitting activities).

Table 9.13: Designed-in measures adopted as part of the mWave project.

Measures adopted as part of the mWave project	Justification
Deployment of mWave on seabed with limited vessel activity during installation and operation.	Minimises potential for collision and pollution incidents.
Flat sandy seabed. No requirement for seabed preparation in advance of deployment (section 2.5.2)	Minimises disturbance during installation and potential for increased suspended sediments and noise.
Gravity foundation, simple installation, requires no moorings (Section section 2.5.2).	Minimises potential for collision, disturbance from noise, suspended sediments and entanglement.
No external moving parts which may cause impact to marine life (only the membranes at the top of the device inflating and deflating to move air within the device) (section 2.5.2).	Minimises potential for collision and impact on marine life
Due to design (no moorings which create noise or cavitation noise due to mWave operating in air at subsonic speeds) noise levels are anticipated to be lower than conventional WEC (see Chapter 6, Offshore Noise)	WEC design will minimise potential for noise. In addition gravity foundation with no need for mooring lines reduces noise.
Cable laid on surface and not trenched offshore (Section 2.5.3).	Minimises disturbance during installation and potential for suspended sediments.
No external moving parts which may cause impact to marine life (section 2.5.2).	mWave operated through inflation and deflation of membranes with no elements which may impact on marine life.
Placed on seabed with good clearance for vessels which are likely to be in the area,	Good water coverage, minimises the potential for interaction and thereby 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 (Chapter 2:Project Description 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 (Chapter 2:Project Description 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.

9.11 Assessment of significance

9.11.1.1 The potential impacts of the installation, operation and maintenance, and decommissioning phases of the mWave project have been assessed on marine mammals. The potential impacts arising are listed in Table 9.8 against which each potential impact has been assessed.

9.11.2 Installation phase

Increased anthropogenic underwater sound noise - installation activities

9.11.2.1 Marine mammals, particularly cetaceans, are capable of generating and detecting sound (Au *et al., 1974;* Bailey *et al.,* 2010) and are dependent on sound for many aspects of their lives, i.e. prey-identification; predator avoidance; communication and navigation. Increases in anthropogenic noise may consequently pose a risk within the marine environment (Parsons *et al.,* 2008; Bailey *et al.,* 2010).

9.11.2.2 The impact of exposure to anthropogenic sound on marine mammals, particularly cetaceans has been well documented, and effects may include physical damage, disorientation and impact on navigation; communication masking; and reduced ability to locate prey.

9.11.2.3 It is now recognised that some of the more ubiquitous noise sources, such as ships, can either individually or cumulatively mask communication signals of, and pose a threat to marine mammals (Clark *et al.,* 2009; Ellison *et al.,* 2011; Chen *et al.,* 2017; Simpson *et al.,* 2016, Rolland *et al.,* 2012). The overall increases in oceanic background noise can alter acoustic habitats over large regions in ways which may be detrimental to marine animals that rely on sound for basic life functions (Ellison *et al.,* 2011). It is now emerging that non-injurious effects can accumulate at the population level (Williams *et al.,* 2015).

9.11.2.4 Marine mammals may be grouped according to the peak frequencies of their hearing and vocalising ranges, further information for which may be found in chapter 6: Underwater Noise. These groupings are as follows:

- **Low frequency (LF)** (such as minke whale, with an estimated functional hearing range between 7 Hz and 35 kHz);
- **Mid-frequency (MF) cetaceans** (such as bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, with an estimated functional hearing range between 150 Hz and 160 kHz);
- **High frequency (HF) cetaceans** (such as harbour porpoise, with an estimated functional hearing range between 275 Hz and 160 kHz);
- **Phocid pinnipeds (PW)** (true seals such as grey seal, with an estimated functional hearing range between 50 Hz and 86 kHz); and

9.11.2.5 Richardson and Thompson (1985) defined four zones of noise influence which vary with distance from the source and level:

- Injury/hearing loss;
- Responsiveness;
- Masking; and
- Audibility.

9.11.2.6 Behavioural responses of marine mammals are highly variable, which makes it extremely difficult to predict likely responses to underwater noise and therefore impact assessments only predict the likelihood of responses to underwater noise. JNCC (2010) define disturbance in terms of animals incurring a sustained or chronic disruption of behaviour or undergoing a significant change from their expected distribution.

9.11.2.7 This assessment adopts a conservative approach to behavioural response thresholds and uses NMFS (2005) Level B harassment threshold of 120 dB re 1 µPa (root-mean squared (rms)) for continuous (non-impulsive) sound (vessel noise) for all marine mammal auditory frequency groups (see Table 9.14 and chapter 6 – Underwater Noise). Level B harassment is defined as:

"having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild" (NMFS, 2005).

9.11.2.8 The relevant criteria for marine mammals are summarised in Table 9.14. This includes the thresholds for non-impulsive sound based on the relevant guidelines (NMFS 2018, NMFS 2005). In Table 9.14 the Sound Exposure Levels (SEL) are expressed as dB re 1 µPa2s and RMS sound pressure levels are in dB re 1 µPa (rms).

Table 9.14: Summary of acoustic thresholds for marine mammals for non-impulsive sound.

Hearing group	Parameter	PTS	TTS	Disturbance
Low-frequency (LF) cetaceans	SEL, LF weighted dB re 1 µPa^{2}s	199	179	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
Mid-frequency (MF) cetaceans	SEL, MF weighted dB re 1 µPa^{2}s	198	178	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
High-frequency (HF) cetaceans	SEL, HF weighted dB re 1 µPa^{2}s	173	153	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
Phocid pinnipeds (PW)	SEL, PW weighted dB re 1 µPa^{2}s	201	181	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
	RMS_{T90} dB re 1 µPa (rms)	-	-	120

Magnitude of impact

9.11.2.9 There is potential for installation vessels, cable laying and other equipment to produce noise during installation of mWave. AIS derived vessel density, recorded in 2018 provide baseline data in terms of vessel movement. According to the Chapter 12 Shipping and Navigation, baseline levels of vessel traffic in the East Pickard Bay local study area is 5 –10 vessels (Density Grids (Wales marine planning portal)).

9.11.2.10 The installation and decommissioning phase of the mWave project off East Pickard Bay requires up to three vessels to be involved in the deployment and retrieval of mWave over a 3 day period, and a further one vessel for cable laying. The maximum size of vessels used off East Pickard Bay is 50 m length and 6 m draught for mWave and for cable laying.

9.11.2.11 The noise emissions from the types of vessels that may be used in the mWave project are quantified in Table 9.15, based on a review of publicly available data (see chapter 6: Underwater Noise).

Table 9.15: Source noise data for construction and installation vessels.

Item	Description/assumptions	Data source	Source sound pressure level at 1 m	
			Rms, dB re 1 µPa	SEL(24h), dB re 1 µPa²s
Anchor handling vessel	Tug used as proxy	Richardson (1995)	172	221
Support vessel / tug	Tug used as proxy	Richardson (1995)	172	221
Cable lay vessel	Pipe lay vessel used as proxy	Hannay (2004)	179	229

9.11.2.12 As identified in Table 9.8 chain ballast will also be placed in trays on mWave. There is no readily available underwater noise data for the placement of ballast chain and as such data on the placement of rock and installation of moorings with chain have been reviewed. Nedwell and Edwards (2004), presents noise data from a dedicated rock placement vessel which can accurately place gravel and/or rock material in a controlled manner. Data was collected for both the vessel as it manoeuvred into position and also whilst it was placing rock. A comparison of data concluded that, within the variability of the measurements, there was no evidence that the rock placement was contributing to the noise level, and that the vessel noise was the overriding factor.

9.11.2.13 A study by Side and Beharie (2011) looked into noise disturbance arising from marine renewable developments. In this study data was obtained for the placement of moorings with chain. It was noted that a source, such as chain noise from heavy chains used in mooring systems laid on bedrock may exhibit impulsive noise during installation, as well as continuous jangling during the deployment period from tidal movement. Data for the study indicated chain noise in the range of 173 dB re 1µPa at 1m (peak to peak). In the case of mWave the deployment of chain will be used as ballast and will be placed in trays on the device. As such any noise will be a short term and there will be no additional noise from the chain through tidal movement, as would be experienced with a mooring. As with the study on placement of rock, discussed previously, the noise from the vessel on site will be similar or in the case of cable laying, louder.

9.11.2.14 As stated in chapter 6: Underwater Noise, it is important to understand that baseline noise levels will vary significantly depending on, amongst other factors, seasonal variations and different sea states, meaning that the usefulness of establishing baseline noise levels can be limited. Nevertheless, it can be useful (when undertaking an assessment of underwater noise impacts on ecological receptors, to have an understanding of the range of noise levels likely to be prevailing in the area so that any noise predictions can be placed in the context of the baseline. It is important to note however, that even if an accurate baseline noise level could be determined, there is a paucity of scientific understanding regarding how various receptor species distinguish anthropogenic sound relative to masking noise.

9.11.2.15 Baseline noise measurements were not undertaken for this project. In place of this, a review of baseline noise studies carried out in UK waters for other similar projects was carried out in order to determine the likely magnitude of noise encountered. A review of noise data relating to other marine energy sites in UK waters was undertaken for the Beatrice Wind Farm including a review of baseline underwater noise measurements in UK coastal waters (Brooker *et al.,* 2012). These noise data are summarised in Table 9.16.

Table 9.16: Summary of average background levels of noise around the UK coast (Brooker *et al.*, 2012)

	Overall (Un-Weighted) Average Background Noise Levels, dB re 1 µPa (rms)	
	Sea State 1	Sea State 3
Minimum	92	94
Maximum	126	132
Mean	111	112

9.11.2.16 An assessment of the distance to the potential onset of injury from each vessel category is presented in Table 9.17 based on the SEL cumulative exposure criterion. As noted previously, the potential radii for injury are based on exposure levels over a 24-hour period. Thus, for example, a seal would need to stay within 50m of cable laying operations for a period of 24 hours to experience any injury. This is considered to be an unrealistically pessimistic scenario and therefore it is not thought likely that any marine mammals will be injured as a result of installation activities. Table 9.17 also presents the potential radius of disturbance for marine mammals based on the conservative 120 dB re 1 μPa (rms) criterion. It is important to bear in mind when viewing these potential disturbance radii that the 120 dB re 1 μPa (rms) criterion is very precautionary and that ambient noise levels could well exceed this value, particularly during periods with high tidal flow.

Table 9.17: Calculated effects of continuous vessel / installation noise

Activity / vessel	Radius of potential injury zone (assuming continuous exposure within that radius over 24 hour period)				Radius of potential disturbance
	LF	MF	HF	PW	
Anchor handling vessel	20 m	2 m	46 m	7 m	2 km
Support vessel / tug	20 m	2 m	46 m	7 m	2 km
Cable lay vessel	50 m	0 m	2 m	5 m	7 km

9.11.2.17 In Low Frequency (LF) cetaceans (minke whale VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury (installation phase vessel movement) up to 50m from the cable laying vessel. Whilst three days has been allowed for cable laying it is anticipated that this will be undertaken over one day. It is more likely that low frequency cetaceans may exposed to underwater noise up to 20m (support vessel/tug) from the sound source, which will be onsite for two days.

9.11.2.18 In Medium Frequency (MF) cetaceans (Risso's dolphin VER, bottlenose dolphin VER, short-beaked common dolphin VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury (installation phase vessel movement) up to two metres from the vessel (support vessel/tug).

9.11.2.19 In High Frequency (HF) cetaceans (harbour porpoise VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury (installation phase vessel movement) up to 46m from the sound source (anchor handling vessel or support vessel).

9.11.2.20 In pinnipeds in water (grey seal VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury (installation phase vessel movement) up to 7m from the sounds source.

9.11.2.21 For all cetacean species groups, the maximum radius of potential disturbance is 7km from the cable laying vessel or 2 km (support vessel).

9.11.2.22 Baseline vessel activity in the area is low with larger vessels heading to and from the Waterway passing some 2km to the west. Whilst the largest vessel used for the installation of mWave is 50m length with 6m draught, the zone of potential impact is small. Vessels involved in the installation of mWave and the communication cable will be present within the local study area for a matter of days therefore potential impacts will be of a short-term duration.

Cetacean VERs

9.11.2.23 Low numbers of both harbour porpoise and common dolphin are likely to occur on the south edge of the marine mammal study area (see Figure 9.5). Although sightings data for bottlenose dolphin, Risso's dolphin and minke whale suggest animals may be present in very small numbers within the local study area (Figure 9.5), a precautionary approach would be to assume that individuals have the potential to enter the local study area. However, considering the potential zone of the impact (injury) is very small, and the local/regional density estimates for all cetacean species are very low (9.7.2), few animals are expected to enter the zones of impact (ZOI).

9.11.2.24 Though the potential range for disturbance of cetaceans VERs is higher with the maximum during cable laying (2 - 7 km, Table 9.17), the likelihood of an animal entering the ZOI is very low. Duration of individual vessel movements associated with the installation of mWave or cable laying is predicted to be short-duration, namely up to 3 days, and mWave installation 2 days.

The potential impact for all cetacean VERs is predicted to be of local spatial extent, short duration and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor (adverse).

Grey Seal VER

9.11.2.25 Whilst grey seals are likely to be observed in the local study area (see Figure 9.10), and this population is deemed important in the scale of the MU, the number of animals are relatively low in the local study area when compared to the regional study area (see 9.7.3). Grey seals are only likely to be disturbed up to 2km from the deployment site (Table 9.17), which falls more than 10km outside known grey seal haul out sites, therefore limited numbers of animals are expected to be foraging within potential disturbance ranges (see 9.7.3).

9.11.2.26 In addition, given that seals are not thought to communicate underwater, the impact will not mask communication and any disturbance impact which does occur will be of short duration.

9.11.2.27 The potential impact for grey seal VER is predicted to be of local spatial extent, short duration and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor (adverse).

Sensitivity of the receptor

Cetacean VERs

9.11.2.28 Odontocete species such as common dolphins may exhibit behavioural response to vessel noise, however given that there is some shipping which passes along the coast to get to the Waterway (see 9.11.2.9), it is highly likely that there may be some habituation of animals in this area (Nowacek *et al.,* 2007). Marine mammals can both be attracted to, and avoid, vessels. Harbour porpoise are particularly sensitive to high frequency noise and are more likely to avoid vessels (Heinanen and Skov, 2015). Other species such as common dolphin are regularly sighted near vessels and may also approach vessels (e.g. bow-riding). However, dolphins are also known to show aversion behaviours to vessel presence, including increased swimming speed, avoidance, increased group cohesion and longer dive duration (Miller *et al.,* 2008). Sensitivity to vessel noise is most likely related to the marine mammal activity at the time of disturbance (ICW, 2006, Senior *et al*., 2008). For example, resting dolphins are likely to avoid vessels, foraging dolphins will ignore them and socialising dolphins may approach vessels (Richardson *et al*., 1995).

9.11.2.29 Based on information provided in chapter 6: Underwater Noise, the disturbance ranges of cetaceans and pinnipeds is up to 7km (Table 9.17). The potential zones of injury for vessel activities likely to be involved in this project, given in Table 9.17, range from 2m to 50m, however this assumes that animals would remain within these ranges continuously for 24 hours, and as such it is highly likely that animals would be disturbed, resulting in them moving away from the noise impact.

9.11.2.30 The harbour porpoise VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.31 The bottlenose dolphin VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.32 The common dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.33 The Risso's dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.34 The minke whale VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

Grey seal VER

9.11.2.35 Whilst pinnipeds do not critically rely on hearing to survive, they are highly vocally active under water and can use sounds passively to forage (Chen *et al.,* 2017). Their repertoires extend across a wide range of frequencies, usually from 0.1 kHz to 3 kHz, but upsweeps can go up to 4.7 kHz (Chen *et al.,* 2017). Their hearing ranges from very low frequencies (~ 100 Hz) to high frequencies (~ 30 kHz) and it is therefore likely that shipping noise is within the hearing range of grey seals (Chen *et al.,* 2017).

9.11.2.36 Grey seals are likely to exhibit avoidance behaviour in response to vessel noise (Anderwald *et al.,* 2013) and are likely to exhibit behavioural responses to vessel noise.

9.11.2.37 The grey seal VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

Harbour porpoise VER

9.11.2.38 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.

Bottlenose dolphin VER

9.11.2.39 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.

Short-beaked common dolphin VER

9.11.2.40 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.

Risso's dolphin VER

9.11.2.41 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.

Grey seal VER

9.11.2.42 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.

9.11.2.43 The overall significance of the effect for all VERS has been assessed. The sensitivity of the VERs is considered to be negligible – 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.

Further mitigation and residual effect

9.11.2.44 No further mitigation is suggested.

Increased collisions risk with vessels

9.11.2.45 Increased vessel traffic during the installation phase presents an increased risk of marine mammals colliding with vessels. Wilson *et al*., (2007) identifies the main drivers in influencing the number and severity of strikes as a result of shipping as:

- Vessel type and speed;
- High levels of ambient noise resulting in difficulty in detection of approaching vessels;
- Weather conditions and time of navigation affecting the ability of crew to locate marine mammals; and
- Marine mammal behaviour, which is species-specific (but appears to affect juveniles and sick individuals more often than animals in good health as juveniles are inexperienced in how to respond to ship presence and sick animals may be unable to remove themselves from an impact situation and may be less able to recover).

9.11.2.46 Marine mammal collision (ship strike) is well documented, particularly in busy ports and harbours, and collision is a known cause of injury and mortality in marine mammals (Laist *et al*., 2001).

9.11.2.47 There are different potential outcomes of vessel collision with marine mammals; both fatal injuries and non-fatal injuries have been documented. Fatal collisions can be seen through carcasses washing up on beaches; carcasses draped on vessel bows; and floating carcasses which have evidence of propeller strike. There will be a number of ship strike fatalities which of course cannot be identified and animals which have survived ship strikes but which have no discernible injury. Animals which survive propeller strikes have also been widely documented.

9.11.2.48 Guidance provided by NOAA have defined serious injury to marine mammals as '*any injury that will likely result in mortality*' (50 CFR 229.2). NMFS clarified its definition of 'serious injury' (SI) in 2012 and stated their interpretation of the regulatory definition of serious injury as any injury that is 'more likely than not' to result in mortality, or any injury that presents a greater than 50% chance of death to the marine mammal (77 Federal Register 3233, 23 January 2012; NMFS 2012a)." (Helker *et al.,* 2017).

9.11.2.49 Non-serious injury is likely to result in short-term impacts and may also have long-term effects on health and lifespan.

Magnitude of impact

9.11.2.50 As described in section 9.11.2.10, there is relatively low existing vessel traffic offshore of East Pickard Bay.

9.11.2.51 The installation and decommissioning phase of the mWave project requires three vessels to be involved in activities (including a guard boat) and one vessel for cable laying. The maximum size of vessel for installation of mWave and cable laying is 50 m length and 6 m draught. An additional 18 trips over 4 days would be required to install ballast chain on the device.

9.11.2.52 Vessels travelling at 7m/s or faster are those most likely to cause death or serious injury to marine mammals (Wilson *et al.,* 2007). Vessels involved in the installation phase are likely to be travelling considerably slower than this, in particular as the vessels will either be towing mWave to site and or engaged in cable laying activities. As such the collision risk is expected to be lower than that posed by commercial shipping activity.

9.11.2.53 In addition to this larger vessels are less likely to be involved in vessel collisions, based on their predictable movements and larger volume of noise produced, making them more detectable to marine mammals than smaller vessels.

9.11.2.54 Vessels involved in the installation of the mWave device and marine cable will be present within the local study area for a matter of days therefore potential impacts will be of short-term duration.

Cetacean VERS

9.11.2.55 Considering local/regional density estimates for all cetacean species (see section 9.7.2), regardless of size of vessel, few animals are expected to enter the zones of impact and thus, few, if any, will be affected by potential increased collision risk associated with increased vessel movement from the mWave project.

9.11.2.56 The impact is 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 (adverse).

Grey Seal VER

9.11.2.57 Vessel strike in seals is likely related to a combination of increased vessel speed and size (Moore *et al.,* 2013). Whilst grey seals are likely to be observed in the local study area (see Figure 9.10), and this population is deemed important in the scale of the MU, the number of animals are relatively low in the local study area when compared to the regional study area (see 9.7.3). In addition, whilst there will be only be limited vessels involved in installation activities over a few days, it is highly likely that grey seals, if present, will be aware of the vessels due to increase noise, and will therefore likely exhibit vessel avoidance.

9.11.2.58 The impact is 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 (adverse).

Sensitivity of the receptor

Cetacean VERs

9.11.2.59 As stated in section 9.11.2.28 a likely response of odontocete species to vessels is to move away. Small, fast moving odontocetes are less likely to be struck by large commercial vessels producing loud noise and moving in predictable directions. Odontocetes are more likely to be struck by smaller, fast moving vessels, due to unpredictability of direction of movement, and engine noise which is masked by ambient noise.

9.11.2.60 Mysticetes, such as minke whale are more likely to be struck by fast moving larger vessels

9.11.2.61 Whilst a limited range of vessels size will be used during the installation phase, the slow speed of all vessels used in installation operations means that vessel strike is unlikely. Individual animals which enter the local study area are likely to exhibit some habituation to levels of traffic in the area, in particular around the busier area from the mouth of Milford Haven Waterway. Although animals which are found near to East Pickard Bay may be less habituated to vessel traffic due to the lower levels of existing vessel movement, the likely ambient noise in this area will be lower and therefore individual vessels will be more acoustically discernible. As such the potential increase in vessel collision risk associated with increased vessel movements associated with the short installation phase of the mWave Project, are considered unlikely to significantly increase potential for vessel strike.

9.11.2.62 Although the presence of vessels is during installation will be of short-duration the impact of vessel collision would be permanent in nature, and irreversible.

9.11.2.63 The harbour porpoise VER is deemed to be of medium vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

9.11.2.64 The bottlenose dolphin VER is deemed to be of medium vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

9.11.2.65 The common dolphin VER is deemed to be of medium vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

9.11.2.66 The Risso's dolphin VER is deemed to be of medium vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be medium.

9.11.2.67 The minke whale VER is deemed to be of medium vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be medium.

Grey seal VER

9.11.2.68 Collisions between vessels and pinnipeds can have adverse effects on health of individual animals; the severity and type of trauma depends on a number of factors including vessel speed and size (Moore *et al.,* 2013).

9.11.2.69 The vessels involved in the installation phase of the mWave project are described in Table 9.8 and have not been reiterated here.

9.11.2.70 The grey seal VER is deemed to be of medium vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of the effect

Harbour porpoise VER

9.11.2.71 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.

Bottlenose dolphin VER

9.11.2.72 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.

Short-beaked common dolphin VER

9.11.2.73 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.

Risso's dolphin VER

9.11.2.74 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.

Grey seal VER

9.11.2.75 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.

9.11.2.76 Overall, the sensitivity of the VERs 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.

Further mitigation and residual effect

9.11.2.77 No further mitigation is suggested.

Increases in suspended sediment concentration (SSC)

9.11.2.78 Marine mammals use vision to navigate in their environment, detect prey and avoid obstacles. Increases in SSC arising from construction activities may affect marine mammals through visual impairment.

Magnitude of impact

9.11.2.79 The substrate at mWave deployment site offshore of East Pickard Bay is sand (chapter 7: Benthic Subtidal and Intertidal Ecology). The marine cable which will be laid on the seabed from the device to shore initially crosses sand before being laid across rocky substrate into the intertidal zone. Installation activities on the sandy areas have the potential for temporary increases in suspended sediments due to the proposed project.

9.11.2.80 The main activities that will contribute to increases in suspended sediments include the placement of mWave on the seabed, placement of navigational marker buoys (if needed) and ADCP/SUTU, and installation of the communications cable (<1900m^2). Vessel movements may also lead to very short-term increases in suspended sediment due to vessel manoeuvring/anchoring.

All activities are of a temporary nature with mWave and ancillary equipment such as ADCP, placed in the marine environment for a maximum of 18 months. The installation of the marine part of the communications cable will occur over a maximum of three days, therefore is of very short duration. The cable will be laid on the surface of the seabed, with three rock bags used as weights to maintain position within sandy sediment, and therefore there will be no requirement for trenching, and sediment disturbance will be minimised. Seabed disturbance and associated temporary increases in suspended sediments due to placement of the mWave device and cable is therefore considered to be of very short-duration and very limited in extent.

9.11.2.81 Due to the high energy environment off East Pickard Bay, it can be expected that any suspended sediments will quickly dissipate and disperse according to the sites' hydrological regimes (chapter 5: Coastal Processes). 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.

9.11.2.82 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. As such even with an intrusive method of advanced works, the potential impact of temporary increases in suspended sediment would be of local spatial extent, short-term duration and reversible due to the small footprint of the device. It is predicted that the impact will affect the receptor directly.

9.11.2.83 As mentioned previously no site clearance is required, with mWave being lowered to the seabed and the cable also being placed on the seabed. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor

9.11.2.84 Marine mammals regularly occur in turbid environments and therefore are adapted to finding prey in such conditions. Marine mammals forage through the diel cycle and can therefore successfully forage in low light conditions, including at night. Most marine mammals rely on vision to some extent: the large forward pointing eyes of seals gives them binocular vision and suggests that this is an important sense for detecting prey.

9.11.2.85 The use of echolocation by odontocetes enables these species to locate prey that is out of sight. Prey capture may be more difficult for non-echolocating species, such as seals, in turbid environments. Most marine mammals, however, have an acute sense of touch. Seals possess sensitive muzzles with vibrissae or sensory whiskers that these species use to detect prey items either through direct contact or due to receiving vibrations in the water column (Denhardt *et al.*, 2001). Minke whale also use vibrissae to sense their prey and olfactory receptors may also be important in detecting prey. These senses are also used to navigate in the marine environment, allowing animals to avoid obstacles if undetected using their visual sense.

Cetacean VERs

9.11.2.86 The harbour porpoise VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.87 The bottlenose dolphin VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.88 The common dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.89 The Risso's dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.90 The minke whale VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

Grey seal VER

9.11.2.91 The grey seal VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

Harbour porpoise VER

9.11.2.92 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.

Bottlenose dolphin VER

9.11.2.93 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.

Short-beaked common dolphin VER

9.11.2.94 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.

Risso's dolphin VER

9.11.2.95 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.

Grey seal VER

9.11.2.96 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.

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

Further mitigation and residual effect

9.11.2.98 No further mitigation is suggested.

Changes in fish and shellfish communities

9.11.2.99 Fish and shellfish receptors are vulnerable to a number of impacts during construction including temporary habitat loss and increased SSC during installation works (Chapter 8: Fish and Shellfish Ecology).

9.11.2.100 The nature of mWave means that from installation through to decommissioning, it will occupy an area of seabed, resulting in a reduction of water-column availability as well as loss of habitat or compaction of sediment under the footprint of the device, the ADCP monitoring device, SUTU and the marine cable. There would also be some effects during the consented period (18 months) from temporary moorings resulting in temporary disturbance to or loss of seabed habitat. These changes have the potential to reduce the availability of marine habitat, including spawning, nursery of feeding habitats. As such these changes may result in a temporary reduction in fish and shellfish species abundance or diversity with affected areas, though demersal fish and shellfish species and demersal spawning species are likely to be affected to the greatest extent. Substratum loss will only directly affect species utilising the seabed, including shellfish and demersal species listed in Table 8.10 and 8.11 of Chapter 8: Fish and Shellfish, and a temporary reduction in sections of water column will only directly affect pelagic species.

9.11.2.101 The key prey species for marine mammals include a number of clupeids (e.g. herring), gadoids (e.g. cod, whiting), flatfish and sandeels. These species have been identified as important components of the fish community within the wider project area. As such negative effects on the fish assemblages identified in Chapter 8 impact assessment may have indirect negative effects on marine mammal receptors.

Magnitude of impact

9.11.2.102 The magnitude of the impact on fish and shellfish receptors was assessed as being minor (Chapter 8: Fish and shellfish section 8.10) and the sensitivity of fish and shellfish receptors ranged from negligible to medium (Chapter 8: Fish and Shellfish section 8.10.2.7 *et seq.*); consequently, the effects of temporary habitat loss was assessed as negligible to minor adverse significance (Chapter 8: Fish and Shellfish section 8.10.2.21 *et seq.*)

9.11.2.103 Overall no significant adverse effects are predicted to occur to fish and shellfish as a result of the installation of the mWave project; therefore, the magnitude of the impact on marine mammals is deemed to be minor.

Sensitivity of the receptor

9.11.2.104 Marine mammals exploit a suite of different prey items and can travel great distances to forage. It is likely that the effects described for fish and shellfish (Chapter 8) will occur over a similar, or lesser, extent and duration as those for marine mammals. For example, avoidance behaviour of fish during the installation phase will lead to displacement over potentially smaller ranges than those given for most marine mammals. In addition, as prey moves out of the areas of potential impact, so marine mammals are likely to follow in order to exploit these resources.

9.11.2.105 The communities found within the wider fish and shellfish study area were characteristic of the fish and shellfish assemblages in the regional study area. Whilst the mWave project is located within and/or close to spawning and nursery grounds (e.g. sole) (see Chapter 8: Fish and Shellfish, paragraph 8.7.3.24) and these could be potentially adversely affected by localised impacts such as increased SSC, or loss of habitat, due to the highly mobile nature of marine mammals, it is likely that these animals will be able to exploit similar resources elsewhere. There could, however, be an energetic cost if animals have to travel further to an alternative foraging grounds.

Harbour porpoise VER

9.11.2.106 The harbour porpoise VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

Bottlenose dolphin VER

9.11.2.107 The bottlenose dolphin VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

Short-beaked common dolphin VER

9.11.2.108 The short-beaked common dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

Risso's dolphin VER

9.11.2.109 The Risso's dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

Minke whale VER

9.11.2.110 The minke whale VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

Grey seal VER

9.11.2.111 The grey seal is VER deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

Harbour porpoise VER

9.11.2.112 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.

Bottlenose dolphin VER

9.11.2.113 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.

Short-beaked common dolphin VER

9.11.2.114 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.

Risso's dolphin VER

9.11.2.115 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.

Grey seal VER

9.11.2.116 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.

Accidental pollution

9.11.2.117 Although marine mammals are all highly mobile with the ability to detect and thus avoid pollutants in the marine environment, general concerns with regards to accidental spills are:

- Ingestion of contaminated prey;
- Potential irritation of skin and eyes;
- Inhalation of toxic fumes; and
- Abandonment of polluted feeding habitat (Clapham *et al.,* 1999).

Magnitude of impact

9.11.2.118 This assessment focuses on the worst case potential accidental pollution scenario, which is considered to be the release of a large inventory of fuel oil from a vessel. The impacts and potential consequences of other significantly smaller inventories of polluting substances will be managed through the Marine Pollution Contingency Plan (MCPC) which will form part of the EMP (see Table 9.13).

9.11.2.119 As stated in Table 9.8, during the installation phase, the maximum size of vessels used at the mWave site off East Pickard Bay is 50 m length and 6 m draught. The magnitude of impact on VERs is likely to be affected by a number of factors, including the volume and type of oil released as well as the sea and weather conditions at the time of the spill. However, with the limited amount of existing vessel activity offshore of East Pickard Bay, the limited number of vessels involved in installation/decommissioning and the slow moving nature of the activity, the potential of an accidental pollution event occurring is considered to be highly unlikely.

9.11.2.120 As stated in 9.11.2.23, given that numbers of cetaceans are relatively low in the local study area when compared to the regional study area, few animals are expected to enter the zone of impact and thus, few, if any, would be negatively impacted in the event of an accidental release of pollutants.

9.11.2.121 Given that haul out sites within the Skomer MCZ support important numbers of grey seal, with approximately 5% of UK grey seal pups being born on the coasts of SW Wales and SW England each year (Duck, 1995; Baines *et al*., 1995; SCOS, 2017), any pollutant accumulating at haul out sites could have major impacts on this breeding colony. Although it is important to note that the mWave deployment site is remote (approximately 15km) from Skomer MCZ.

9.11.2.122 The likelihood of a spill occurring is deemed to be extremely rare based on the information provided above, the fact that works will only take place during good sea conditions, and the management measures which will be in place through various legislation, and specifically to this project in the MPCP.

9.11.2.123 The impact is predicted to be of local spatial extent, short-term duration and reversible and it is predicted that the impact would affect the receptor directly. The likelihood of an accidental pollution event occurring is considered unlikely. The magnitude is therefore considered to be minor.

Sensitivity of the receptor

9.11.2.124 Marine mammals are highly mobile species and are likely to be able to detect pollutants and as a result are expected to avoid areas where there has been an accidental release of pollutants.

9.11.2.125 The most likely impact will be where a pollutant washes up and accumulates on seal haul out sites. Seals may be displaced from preferred haul out sites, which would be more of a concern during grey seal pupping season, since juveniles do not initially have a waterproof coat and movement from a haulout site could negatively impact on pup survival rates.

9.11.2.126 As stated in section 9.7.3, known haul-out site for grey seals exist at Ramsey Island, extending southwards to Skomer Island and northwards to southern Ceredigion (see Figure 9.9) (Baines and Evans, 2009). The nearest grey seal haul-out sites to the mWave project occur within the Skomer MCZ, on the Marloes Peninsula and Skomer Island, with 47.2% of pup production on Skomer Island occurring on the western tip of the Marloes peninsula which is some 15km from the deployment site. The total pup production at haulout sites within the Skomer MCZ from 1992 to 2008 (Lock *et al.,* 2017) remained fairly consistent with expected fluctuation across the period. The average pup production per year was 208, with a steady increase since 2009; average pup production between 2012 and 2016 was 345. Pup births occur mainly from August to November although there are occasional records of pups born outside of this period.

9.11.2.127 Marine mammals may also be indirectly affected if prey species (fish and shellfish) are adversely affected by accidental release of contaminants. Section 8.10.2.35 *et seq.* of Chapter 8: Fish and Shellfish however concludes that the magnitude of the potential impact of accidental release of pollutants is negligible, the sensitivity of receptors is negligible to medium and the significance of the effect for VERs will be of negligible or minor (adverse) significance.

Harbour porpoise VER

9.11.2.128 The harbour porpoise VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

Short-beaked common dolphin VER

9.11.2.129 The short-beaked common dolphin VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Bottlenose dolphin VER

9.11.2.130 The bottlenose dolphin VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Risso's dolphin VER

9.11.2.131 The Risso's dolphin VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Minke whale VER

9.11.2.132 The minke whale VER is deemed to be of medium vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

Grey seal VER

9.11.2.133 The grey seal VER is deemed to be of high vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

Harbour porpoise VER

9.11.2.134 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** significance, which is not significant in EIA terms.

Bottlenose dolphin VER

9.11.2.135 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** significance, which is not significant in EIA terms.

Short-beaked common dolphin VER

9.11.2.136 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** significance, which is not significant in EIA terms.

Risso's dolphin VER

9.11.2.137 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** significance, which is not significant in EIA terms.

9.11.2.138 Minke whale VER

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** significance, which is not significant in EIA terms.

Grey seal VER

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

Further mitigation and residual effect

9.11.2.140 No further mitigation is suggested.

Future monitoring

9.11.2.141 No marine mammal, monitoring to test the predictions made within the installation phase impact assessment is considered necessary.

9.11.3 Operational and maintenance phase

9.11.3.1 The impacts of the operation and maintenance of the mWave project have been assessed on marine mammals. The environmental impacts arising from the operation and maintenance of the mWave Project are listed in Table 9.7 against which each operation and maintenance phase impact has been assessed.

Increased anthropogenic underwater noise – vessels

9.11.3.2 The previous sections assessing the installation phase provides an overview of the relationship between underwater vessel noise and marine mammals.

Magnitude of the impact

9.11.3.3 The operation and maintenance phase of the mWave project requires up to three vessels visiting once a month for up to two days, over the 6-12-month testing period, resulting in a maximum of 76 vessel visits. The maximum size of vessels used will be 50 m length and 6m draught. Whilst not anticipated to be required, if needed scour protection would be deployed at some point over the operation period using up to 10 vessels over a 5 day period. As such in terms of average monthly activity the levels of vessels on site in any one month will be less than that during the short term installation phase. During operation a source sound pressure level at 1 m = 172 dB re 1 μPa (rms) / 221 SEL (24h) dB re 1 μPa^{2}s, for a support vessel has been used.

9.11.3.4 The magnitude of impact of the operation and maintenance phase therefore, anticipated to be less than that from the installation phase. A review of likely baseline noise levels, assessment of distance to onset of injury assessment and radius of potential disturbance is given in section 9.11.2.9 *et seq.* and is not reiterated here.

9.11.3.5 In accordance with the magnitude of impact of the installation phase, the impact is predicted to be of local spatial extent, short-term duration (6-12 months), and intermittent (2 days in every month) and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor (adverse).

Sensitivity of the receptor

9.11.3.6 The sensitivity of the receptor in the operational and maintenance phase is not expected to differ from the sensitivity of receptor of the installation phase. An assessment of sensitivity and behavioural response is given in sections 9.11.2.28 *et seq* and as such is not reiterated here.

Significance of the effect

9.11.3.7 The significance of the effect of the operation and maintenance phase is not expected to differ from the significance of the effect of the installation phase. The overall significance of the effect for all VERS has been assessed. The sensitivity of the VERs 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.

Further mitigation and residual effect

9.11.3.8 No further mitigation is suggested.

Increased anthropogenic underwater noise – mWave operation

9.11.3.9 The effect of exposure to anthropogenic sound from installation activities (vessels) on marine mammals has been described in section 9.11.2.1 *et seq.* and has not been reiterated here.

9.11.3.10 This assessment adopts a conservative approach to behavioural response thresholds and uses NMFS (2005) Level B harassment threshold of 120 dB re 1 µPa (root-mean squared (rms)) for continuous (non-impulsive) sound (marine device operation) for all marine mammal auditory frequency groups (see Table 9.18: Summary of acoustic thresholds for marine mammals for non-impulsive sound. and chapter 6 – Underwater Noise). Level B harassment is defined as:

“having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild” (NMFS, 2005).

9.11.3.11 The relevant criteria for marine mammals are summarised in Table 9.18: Summary of acoustic thresholds for marine mammals for non-impulsive sound. This includes the thresholds for non-impulsive sound based on the relevant guidelines (NMFS 2018, NMFS 2005). In Table 9.14 the Sound Exposure Levels (SEL) are expressed as dB re 1 µPa2s and RMS sound pressure levels are in dB re 1 µPa (rms).

Table 9.18: Summary of acoustic thresholds for marine mammals for non-impulsive sound.

Hearing group	Parameter	PTS	TTS	Disturbance
Low-frequency (LF) cetaceans	SEL, LF weighted dB re 1 µPa^{2}s	199	179	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
Mid-frequency (MF) cetaceans	SEL, MF weighted dB re 1 µPa^{2}s	198	178	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
High-frequency (HF) cetaceans	SEL, HF weighted dB re 1 µPa^{2}s	173	153	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
Phocid pinnipeds (PW)	SEL, PW weighted dB re 1 µPa^{2}s	201	181	-
	RMS_{T90} dB re 1 µPa (rms)	-	-	120
	RMS_{T90} dB re 1 µPa (rms)	-	-	120

Magnitude of the impact

9.11.3.12 As identified in Chapter 2 Project Description, mWave is a full scale WEC prototype that sits on the seabed and it comprises multiple seafloor-mounted, air-filled cells covered by flexible rubber membranes.. As a wave passes overhead the device uses the change in water pressure to displace air in the membrane covered cells , the membranes inflate and deflate to move air within the device. At any instant, those cells with a higher pressure supply air to a high-pressure duct in the pneumatic circuit, via a set of non-return cell outlet valves. This high-pressure air flows through the enclosed turbine and returns to low pressure cells, via a low-pressure manifold and non-return inlet valves. The turbine is enclosed so that no water gets into the enclosed pressurised air system. Through the air being pushed through the turbine by change in water pressure, electricity can be generated by the turbine. As such whilst mWave is a WEC it is not of the conventional type, using the movement of air within the device to generate electricity.

9.11.3.13 No noise data is available for mWave, but data will be collected through its testing period which will be 6 - 12 months. Due to the lack of available data, as stated in chapter 6: Underwater Noise, the noise modelling for this study has been undertaken based on noise measurements of an OpenHydro tidal turbine at the EMEC facility in Orkney (Parvin and Brooker 2008) and the Pelamis P2 (a surface WEC) measured at Billia Croo (Lepper and Robinson 2016). Data for both tidal and wave devices have been used to give an indication of noise from marine renewable devices in the absence of device specific data. As such, it is considered that the range of source noise levels modelled (162 to 180 dB re 1 µPa at 1 m) is representative, if not worst case, of the potential noise output from mWave. The noise source data used in the modelling is summarised in Table 9.19.

Table 9.19: Source noise data for example operational devices.

Item	Description/assumptions	Data source	Source sound pressure level at 1 m	
			Rms, dB re 1 µPa	SEL(24h), dB re 1 µPa2s
OpenHydro tidal turbine	EMEC facility in Orkney	Parvin and Brooker (2008)	162	212
Pelamis P2 WEC	EMEC facility in Orkney	Lepper *et al.* (2012)	180	229

9.11.3.14 As stated in chapter 6: Underwater Noise, it is important to understand that baseline noise levels will vary significantly depending on, amongst other factors, seasonal variations and different sea states, meaning that the usefulness of establishing baseline noise levels can be limited. Nevertheless, it can be useful (when undertaking an assessment of underwater noise impacts on ecological receptors), to have an understanding of the range of noise levels likely to be prevailing in the area so that any noise predictions can be placed in the context of the baseline. It is important to note however, that even if an accurate baseline noise level could be determined, there is a paucity of scientific understanding regarding how various receptor species distinguish anthropogenic sound relative to masking noise.

9.11.3.15 As previously, baseline noise measurements were not undertaken for this project. In place of this, a review of baseline noise studies carried out in UK waters for other similar projects was carried out in order to determine the likely magnitude of noise encountered. A review of noise data relating to other marine energy sites in UK waters was undertaken for the Beatrice Wind Farm including a review of baseline underwater noise measurements in UK coastal waters (Brooker et al., 2012). These noise data are summarised in Table 9.16.

9.11.3.16 An assessment of the distance to onset of injury from each operational device is presented in Table 9.20 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.

Table 9.20: Calculated effects of continuous operational device noise.

Activity / vessel	Radius of potential injury zone (assuming continuous exposure within that radius over 24-hour period)					Radius of potential disturbance
	LF	MF	HF	PW	OW	
OpenHydro tidal turbine	3 m	0 m	2 m	0 m	0 m	0.5 km
Pelamis P2 WEC	76 m	1 m	18 m	23 m	2 m	7 km

9.11.3.17 The Pelamis 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 within mWaves underwater membrane covered cells. In addition to this monitoring of noise from Pelamis suggests a significant component from moorings (rattling, clanking, banging) which are not required for mWave (Chapter 6, Section 6.7.2). Likewise the OpenHydro has hydrofoils which means there is a possibility of cavitation. Cavitation is a significant noise source. The rotational speed and deployment depth of the OpenHydro device limits the likelihood of cavitation occurring. The mWave turbine operates in air at subsonic speeds meaning there is no equivalent noise source for the mWave. Whilst the operational device noise data above is of value to provide an assessment of potential impact it is likely to be conservative.

9.11.3.18 In Low Frequency (LF) cetaceans (minke whale VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury up to (maximum scenario) 76m from the Pelamis P2 WEC, whilst the effect from the OpenHydro tidal turbine was up to 3m. As discussed above, as mWave has limited mechanical moving parts, with air being used to generate electricity, the above assessment is likely to be conservative.

9.11.3.19 In Medium Frequency (MF) cetaceans (Risso's dolphin VER, bottlenose dolphin VER, short-beaked common dolphin VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury up to one metre from the sound source (Pelamis P2 WEC) and 0m (OpenHydro tidal turbine).

9.11.3.20 In High Frequency (HF) cetaceans (harbour porpoise VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury up to 18m from the sound source (Pelamis P2 WEC). It is more likely that high frequency cetaceans may be exposed to underwater noise up to 2m (OpenHydro tidal turbine) from the sound source, as a conservative estimate.

9.11.3.21 In pinnipeds in water (grey seal VER), a conservative assessment estimates that animals may be exposed to underwater noise that has the potential to result in the onset of injury (tidal turbine operation) up to 23 m from the sound source (Pelamis P2 WEC). As stated in 9.11.3.14 , it is more likely that pinnipeds may be exposed to underwater noise up to 2 m OpenHydro tidal turbine) from the sound source, as a conservative estimate.

9.11.3.22 For all cetacean species groups, the maximum radius of potential disturbance is 7 km (Pelamis P2 WEC), and the most likely is 0.5 km (based on OpenHydro tidal turbine).

9.11.3.23 On the basis of the above and taking into account the very low likelihood of an animal being exposed to noise from a device within the injury radii over a 24-hour period, it is considered highly unlikely that injury would occur to any marine mammal as a result of operational noise from mWave.

Cetacean VERs

9.11.3.24 Although sightings data for bottlenose dolphin, Risso's dolphin and minke whale suggest animals may be present in very small numbers within the local study area (Figure 9.5), a precautionary approach would be to assume that individuals have the potential to enter the local study area. Considering the potential zone of the impact (injury) is very small, and the local/regional density estimates for all cetacean species are very low (section 9.7.2), few animals are expected to enter the zones of impact (ZoI) for injury.

9.11.3.25 Though the potential range for disturbance of cetaceans VERs is higher (0.5 - 7 km, Table 9.20), based on sightings data (see Figure 9.5) the likelihood of an animal entering the ZoI is very low.

The potential impact for all cetacean VERs is predicted to be of local spatial extent, short - term duration (6-12 months), and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor (adverse).

Grey Seal VER

9.11.3.26 Whilst grey seals are likely to be observed in the local study area (see Figure 9.10), and this population is deemed important in the scale of the MU, the number of animals are relatively low in the local study area when compared to the regional study area (see 9.7.3). For the worst case scenario, grey seals are only likely to be disturbed up to 7 km from the mWave (Table 9.20), which falls more than 18 km out with known grey seal haul out sites. Whilst some avoidance behaviour may occur up to 7 km from a full-scale WEC, limited numbers of animals are expected to be foraging within potential disturbance ranges (see 9.7.3 and Figure 9.10), and potential disturbance distances are considered highly likely to be significantly smaller given the nature of proposed mWave device.

9.11.3.27 In addition, given that seals are not thought to communicate underwater, the impact will not mask communication. Any disturbance impact which does occur individually be of short duration (6-12 months).

9.11.3.28 The potential impact for grey seal VER is 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 (adverse).

Sensitivity of the receptor

Cetacean VERs

9.11.3.29 Based on information provided in chapter 6: Underwater Noise, the disturbance ranges of cetaceans and pinnipeds is up to 7km (Table 9.20). The potential zones of injury for marine renewable device noise, given in Table 9.20, range from 0 m to 76 m, however this assumes that animals would remain within these ranges continuously for 24 hours, and as such it is highly likely that animals would be disturbed, resulting in them moving away from the noise impact.

9.11.3.30 The harbour porpoise VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.3.31 The bottlenose dolphin VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.3.32 The common dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.3.33 The Risso's dolphin VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

9.11.3.34 The minke whale VER is deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be low.

Grey seal VER

9.11.3.35 Whilst pinnipeds do not critically rely on hearing to survive, they are highly vocally active under water and can use sounds passively to forage (Chen *et al.,* 2017). Their repertoires extend across a wide range of frequencies, usually from 0.1 kHz to 3 kHz, but upsweeps can go up to 4.7 kHz (Chen *et al.,* 2017). Their hearing ranges from very low frequencies (~ 100 Hz) to high frequencies (~ 30 kHz) and it is therefore likely that marine energy device noise is within the hearing range of grey seals (Chen *et al.,* 2017).

9.11.3.36 A study carried out on Harbour seals in 2017 (Hastie *et al.,* 2017) which measured behavioural responses to simulated tidal turbine sound, showed that there was a localised impact, whereby tagged seals exhibited significant spatial avoidance of the sound, which resulted in a reduction in the usage by seals of between 11% and 41% at the playback location. The significant decline in usage extended to 500 m from the playback location at which usage decreased by between 1% and 9% during playback. As such, grey seals are expected to exhibit avoidance behaviour, and as such (as stated in paragraph 9.11.3.29 it is highly unlikely that that animals would remain within the 0 – 23m range (given in Table 9.20) continuously for 24 hours.

9.11.3.37 The grey seal VER is deemed to be of low vulnerability, high recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

Harbour porpoise VER

9.11.3.38 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.

Bottlenose dolphin VER

9.11.3.39 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.

Short-beaked common dolphin VER

9.11.3.40 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.

Risso's dolphin VER

9.11.3.41 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.

Grey seal VER

9.11.3.42 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.

Further mitigation and residual effect

9.11.3.43 No further mitigation is suggested.

Increased collision risk with vessels

Magnitude of the impact

9.11.3.44 The vessel movements during the operational and maintenance phase on a monthly basis (3 vessels for 2 days) will be less than that of the installation phase (mWave installation 3 days, up to 3 vessels and cable laying up to 1 vessels in up to 3 days).There may be a one-off requirement to deploy scour protection which would take up to 5 days. The magnitude of impact of the operation and maintenance phase therefore, is expected to be less than the installation phase. An overview of the likely magnitude of impact of increased collision risk with vessels is given in section 9.11.2.50 to 9.11.2.54.

9.11.3.45 In accordance with the installation phase the impact is predicted to be of local spatial extent, short- term duration (6-12 month), but intermittent (once per month) and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor (adverse).

Sensitivity of the receptor

9.11.3.46 The sensitivity of the receptor of the operational phase is not expected to differ from the sensitivity of the installation phase (see sections 9.11.2.59 *et seq*).

Significance of the effect

9.11.3.47 Overall, the sensitivity of the VERs 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.

Further mitigation and residual effect

9.11.3.48 The further mitigation is suggested.

Entanglement risk

9.11.3.49 Incidental mortality of marine mammals caught in ropes, lines and fishing gear, is recognised as a significant conservation problem (Benjamins *et al*., 2014). Whilst less is known about the likelihood of marine mammal entanglement in offshore renewable mooring lines, particularly those which attach to floating devices, the potential for this impact is becoming widely recognised (Benjamins *et al.,* 2014; Harnois *et al.,* 2015).

Magnitude of impact

9.11.3.50 For mWave it will maintain its position on the seabed through its gravity foundation. A surface navigational marker buoy may be required to mark its location.

9.11.3.51 A number of factors including the visibility, dimensions, how important the location is for feeding or breeding and the extent of close-range evasion all interact to determine the likelihood of entanglement.

9.11.3.52 Cetaceans and grey seal are likely to forage offshore of East Pickard Bay. As stated in 9.11.2.23, given that numbers of animals are relatively low in the local study area when compared to the regional study area, few animals are expected to enter the ZoIs and thus, few, if any, will be negatively impacted.

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

Sensitivity of the receptor

9.11.3.54 The potential outcomes of entanglement in slack lines for a marine mammal can include low level injury such as abrasions, to long-term severe injury and even mortality. Worldwide, fatal entanglement in fishing gear is a source of anthropogenically induced mortality in cetaceans, pinnipeds and elasmobranchs (Cassoff *et al.,* 2011), however much less is known of the potential risks for incidental mortality associated with marine renewable energy developments.

9.11.3.55 Baleen whales appear to be particularly vulnerable to entanglement due to their size. Fewer comparable records exist of entanglements involving small cetaceans (e.g. dolphins), which are more vulnerable to bycatch in nets than to rope entanglement due to their smaller size. In addition, scarring in baleen whales has shown that some individuals are able to disentangle themselves, however long-term injury is a likely outcome regardless.

9.11.3.56 Rope entanglement has been reported to be the cause of many incidental mortalities of pinnipeds worldwide (Harnois *et al.,* 2015). Allen *et al.* (2012) report rope as one of several types of marine debris found on grey seals at a haul-out site in Cornwall, suggesting that this problem could occur elsewhere in UK waters.

Harbour porpoise VER

9.11.3.57 The harbour porpoise VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

Short-beaked common dolphin VER

9.11.3.58 The short-beaked common dolphin VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Bottlenose dolphin VER

9.11.3.59 The bottlenose dolphin VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Risso's dolphin VER

9.11.3.60 The Risso's dolphin VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Minke whale VER

9.11.3.61 The minke whale VER is deemed to be of medium vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be medium.

Grey seal VER

9.11.3.62 The grey seal VER is deemed to be of low vulnerability, low recoverability and very high value. The sensitivity of the receptor is therefore, considered to be low to medium.

Significance of the effect

Harbour porpoise VER

9.11.3.63 The sensitivity of the receptor is considered to be low to 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.

Bottlenose dolphin VER

9.11.3.64 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.

Short-beaked common dolphin VER

9.11.3.65 The sensitivity of the receptor is considered to be low to 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.

Risso's dolphin VER

9.11.3.66 The sensitivity of the receptor is considered to be low to 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.

Minke whale VER

9.11.3.67 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.

Grey seal VER

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

Further mitigation and residual effect

9.11.3.69 No future mitigation is suggested.

Accidental pollution

Magnitude of impact

9.11.3.70 During operation the maximum size of vessels used for O&M activities at East Pickard Bay is 50m length and 6m draught.

9.11.3.71 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. There may be a one-off requirement to deploy scour protection which would take up to 5 days. As such the potential for accidental pollution incident is reduced compared to the installation phase.

9.11.3.72 A review of the likely oil inventory to be involved in a spill, and the likely impact on marine mammal receptors is outlined for installation and is not reiterated here.

9.11.3.73 In accordance with the magnitude of impact of the installation phase, in the event a large spill does occur, the impact is predicted to be of local spatial extent, short-term duration and reversible. The likelihood of an accidental pollution event occurring is considered unlikely and it is predicted that the impact would affect the receptor directly. The magnitude is therefore, considered to be minor.

Sensitivity of the receptor

9.11.3.74 The sensitivity of the receptors in the operational and maintenance phase is not expected to differ from the sensitivity of receptors of the installation phase. An assessment of sensitivity and behavioural response is given in section 9.11.2.128 *et seq.* and as such is not reiterated here.

Significance of the effect

9.11.3.75 The significance of the effect of the operation and maintenance phase is not expected to differ from the significance of the effect of the installation phase (see section 9.11.2.134 *et seq.*).

Further mitigation and residual effect

9.11.3.76 No further mitigation is suggested.

Future monitoring

9.11.3.77 No marine mammal monitoring to test the predictions made within the operational phase impact assessment is considered necessary.

9.11.4 Decommissioning phase

9.11.4.1 The impacts of the decommissioning of the mWave project have been assessed on marine mammals. The environmental effects arising from the decommissioning of the mWave project are listed in Table 9.8 against which each decommissioning phase impact has been assessed. The impacts during the decommissioning phase are expected to be of the same nature and magnitude as those predicted from the installation phase of the mWave project, therefore the assessment of potential impacts on marine mammals presented within Sections 9.11.2.1 to 9.11.2.141 have been assumed for the decommissioning phase and are not reiterated here.

9.12 Cumulative Impact Assessment methodology

9.12.1 Methodology

9.12.2 Screening of other projects and plans into the Cumulative Effect Assessment

9.12.2.1 The Cumulative Impact Assessment (CIA) takes into account the impacts 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 and are presented in Table 9.21. 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.

9.12.2.2 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).

Table 9.21: 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 2019. No further consideration.
Installation/ Operation and Maintenance	Neyland Yacht Haven Ltd - CML1658	11.5	No spatial 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

Project phase	Developer - Reference	Approx. distance to mWave (km)	Spatial/ temporal overlap with the mWave project	Details	Date of Construction	Further Consideration required?	Justification
			No temporal overlap.				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.
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	Jan 2019 – Q4 2020 (possible renewal of	no	Whilst there is potential for temporal overlap with the mWave project, it is distant and therefore highly unlikely to

Project phase	Developer - Reference	Approx. distance to mWave (km)	Spatial/ temporal overlap with the mWave project	Details	Date of Construction	Further Consideration required?	Justification
				for growing scallops and mix species of native algae. The farm will be serviced by vessels and divers	licence)		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.

9.12.2.3 The potential impacts identified for assessment as part of the marine mammal cumulative impact assessment (CIA) are:

- Increased underwater noise emissions;
- Vessel collision;
- Increase in SSC; and
- Changes to fish and shellfish communities.

9.12.2.4 Considering the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, those that are considered to have the potential to result in cumulative impacts have been assessed further.

9.12.2.5 The nature of the possible cumulative impact will depend on the nature of the development; for example, there will be no cumulative operational effects with cable projects. However, the potential for cumulative impact exists in the installation phase with all other project types. The scope for such cumulative impact will however be limited to projects for which the installation schedule is similar to that of the mWave project.

9.13 Cumulative Impact Assessment

9.13.1.1 A description of the significance of cumulative impacts upon marine mammal receptors arising from each identified impact is given below.

Increased underwater noise emissions

9.13.1.2 Increased underwater noise emissions may occur as a result of cumulative impacts arising from projects that spatially or temporally overlapping with the mWave project, as listed in Table 9.21. These include the installation, operation and decommissioning of wave energy devices at the offshore META site 8. Research activities are not considered likely to result in potential for cumulative noise impacts. Installation of the Greenlink Interconnector may result in very short-duration increases in underwater noise in proximity to mWave. Also in relation to mWave, MOD activities are on-going and considered to constitute part of the baseline..

9.13.1.3 The potential impacts of increased underwater noise from vessels have been outlined in Section 9.11.2.1 and are not re-iterated here.

Magnitude of impact

9.13.1.4 As mentioned previously mWave was originally intended to be the first deployment at META site 8. Within the Environmental Statement in support of the consents for the META project the most likely scenario is for one wave device to be present at a time. Notwithstanding this the assessment allowed for the installation through to decommissioning of an onshore (mWave site) and offshore device. The cumulative impacts were assessed to be minor adverse due to the short duration of each of the activities. In terms of the installation of the Greenlink Interconnector, this may result in very short-duration increases in underwater noise in proximity to mWave. The potential for temporal overlap of installation is very unlikely as the mWave project is short term, with very short installation and decommissioning phases (few days). As such, since the noise from installation/decommissioning vessels for other projects are likely to be of a similar scale as predicted for the mWave project, the potential to cause injury or disturbance from increase in noise emissions is therefore expected to be low.

9.13.1.5 The significance of increased underwater vessel noise for the mWave project was predicted to be of minor (adverse) effect.

9.13.1.6 The potential cumulative impact of the two projects (META Site 8 and Greenlink Interconnector) might make a slightly larger proportion of suitable habitat unavailable for a particular marine mammal species due to increased underwater noise. As described previously, the local/regional density estimates for all marine mammal species are very low. The geographic ranges of marine mammals using the local study area are much larger. As a result it is unlikely that cumulative impacts of temporary increased disturbance due to increased underwater noise will result in detectable changes in spatial or temporal disturbance to marine mammal receptor species.

9.13.1.7 The impact is predicted to be of local spatial extent, short-term duration (18 months), and intermittent (short-duration of vessel movements) and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor (adverse).

Sensitivity of receptor

9.13.1.8 As summarised in Table 9.17, the potential for behavioural disturbance as a result of vessel noise activity of the mWave project is likely to extend out to a maximum of 2 km. Whilst this will overlap with noise emissions resulting in behavioural disturbance from the other two projects, the sensitivity of marine mammal VERs is not expected to increase from the predicted negligible to low, as reported for installation.

Significance of effect

9.13.1.9 Overall, it is predicted that the sensitivity of the receptor is considered to be **negligible** to **low** and the magnitude is deemed to be **minor**. The significance of the effect will, therefore, be of **minor** (adverse) significance, which is not significant in EIA terms.

Further mitigation and residual effect

9.13.1.10 No further mitigation is suggested.

Increased vessel collision risk – vessels

9.13.1.11 A cumulative increased risk of collision with vessels may occur as a result of interactions with projects that spatially or temporally overlapping with the mWave project, as listed in Table 9.22. The potential impacts of increased vessel collision risk have been outlined in Section 9.11.2.45 and are not re-iterated here.

Magnitude of impact

The vessels associated with the project will use the Waterway as a base and so will transit to site and back. The number of vessels for the mWave project is minimal. There is significant vessel movement in the Waterway (Chapter 12: Shipping and Navigation) and the increase in vessels as a result of the project in combination with META Site 8 and Greenlink Interconnector are unlikely to be significant especially as vessels are unlikely to be all transiting in the Waterway at the same time.

9.13.1.12 Off the coastal waters of East Pickard Bay, traffic numbers are lower, however the number of vessels used for the various stages of the projects will be low and limited in extent. As such whilst there will be only be limited vessels involved in offshore activities, it is highly likely that marine mammals, if present, will be aware of the vessels due to increase noise. In addition, local/regional density estimates for all marine mammals are low and therefore the impact on marine mammals is predicted to be of local spatial extent, short-term duration (18 months), intermittent (short-duration of vessel movements) and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be minor (adverse)

Sensitivity of receptor

9.13.1.13 The sensitivity of marine mammal VERs to vessel collision risk is not expected to change from assessment of sensitivity described in sections 9.11.2.45 et seq. The overall sensitivity of the receptors is medium.

Significance of effect

9.13.1.14 Overall, it is predicted that the sensitivity of the receptors is considered to be **medium** and the magnitude is deemed to be **minor**. The significance of the effect will, therefore, be of **minor** (adverse) significance, which is not significant in EIA terms.

Changes to fish and shellfish communities

9.13.1.15 For potential effects on fish and shellfish as prey items for marine mammals the extent of the cumulative assessment was based upon the screening and CIA undertaken for Chapter 8: Fish and Shellfish.

Magnitude of impact

9.13.1.16 The cumulative impacts on temporary changes to fish and shellfish habitat, and temporary increases in suspended sediments are discussed in Chapter 8: Fish and Shellfish (section 8.10.2) and are not re-iterated here.

9.13.1.17 Both projects (META Site 8 and Greenlink Interconnector) are offshore of East Pickard Bay and Freshwater West Beach, and as such any temporary effects will be localised. The sediments at mWave and in the surrounding area are sand which will settle within relatively short distances (Chapter 5: Coastal Processes). The magnitude of impact of temporary increases in SSC in the Fish and Shellfish CIA is reported to be negligible to minor. In terms of habitat, as discussed in Chapter 8, section 8.10.2 the communities associated with sandy/coarse gravel sediments are well adapted to rapid recolonisation with 'optimistic/pioneering' species establishing initially and later longer-lived and slow-growing organism. As such the magnitude of impact of temporary changes to fish and shellfish habitat for the three projects off East Pickard Bay is anticipated to be minor.

9.13.1.18 As such no significant adverse effects are predicted to occur to fish and shellfish as a result of cumulative effects; therefore, the magnitude of the impact on marine mammals is deemed to be minor.

Sensitivity of receptor

9.13.1.19 The sensitivity of marine mammal VERs to changes to fish and shellfish communities is not expected to change from the assessment of sensitivity described in sections 9.11.2.104 *et seq*. The overall sensitivity of the receptors is low.

Significance of effect

9.13.1.20 Overall, it is predicted that the sensitivity of the receptors is considered to be **low** and the magnitude is deemed to be **minor**. The significance of the effect will, therefore, be of **minor** (adverse) significance, which is not significant in EIA terms.

Increase in suspended sediment concentration

9.13.1.21 Increased suspended sediments may occur as a result of cumulative impacts arising from projects that spatially or temporally overlap with the mWave project, as listed in Table 9.21. The potential impacts of an increase in SSC have been outlined in Sections 9.11.2.79 to *et seq.* and are not re-iterated here.

Magnitude of impact

9.13.1.22 Cabling works associated with the Greenlink interconnector and installation of an offshore device at META Site 8 may lead to temporary increases of suspended sediment offshore at East Pickard bay and in close proximity to mWave.

9.13.1.23 As discussed previously, and as reported in Chapter 5 Coastal Processes, the East Pickard Bay area is characterised by sandy sediments which would result in any disturbed sediment a plume of up to 70mg/l, but which will settle within a short time (approx 1 hour) and distance. As such whilst there are two projects which could lead to increases in suspended sediment within the vicinity of mWave, potential increases in suspended sediment are not predicted to be extensive or long-term.

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

<u>Sensitivity of the receptor</u>

9.13.1.25 The mWave project assessment of sensitivity for marine mammal VERs are assessed as low (see sections 9.11.2.86 *et seq*), and it is assumed that this is the same for the CIA.

<u>Significance of the effect</u>

9.13.1.26 The overall sensitivity of the receptors 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.

Future monitoring

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

9.14 Transboundary effects

9.14.1.1 A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regards to marine mammals from the mWave project upon the interests of other EEA States.

9.15 Inter-related effects

9.15.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor.

9.15.1.2 There are not considered to be any potential marine mammal inter-related effects.

9.16 Conclusion and summary

9.16.1.1 Table 9.22 summarises the assessment of impacts on marine mammals associated with the installation, operation and maintenance, and decommissioning phases of the mWave project, alone and cumulatively with other plans or projects.

Table 9.22: Summary of potential environment effects, mitigation and monitoring at the mWave project.

Description of impact	Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Installation Phase							
Increased anthropogenic underwater noise– installation activities	EMP and EMMP	Minor	Low	Minor (not significant in EIA terms)	None	n/a	None
Increased collision risk with vessels	EMP and EMMP	Minor	Medium	Minor (not significant in EIA terms)	None	n/a	None
Increases in SSC	EMP and EMMP	Negligible	Low	Negligible or Minor (not significant in EIA terms)	None	n/a	None
Changes in fish and shellfish communities	EMP and EMMP	Minor	Low	Minor (not significant in EIA terms)	None	n/a	None
Accidental pollution	EMP and EMMP	Minor	Low to Medium	Minor (not significant in EIA terms)	None	n/a	None
Operational Phase							
Increased anthropogenic underwater noise– vessels	EMP and EMMP	Minor	Low	Minor (not significant in EIA terms)	None	n/a	None
Increased anthropogenic underwater noise – mWave operation	EMP and EMMP	Minor	Low	Minor (not significant in EIA terms)	None	n/a	None
Increased collision risk with vessels	EMP and EMMP	Minor	Medium	Minor (not significant in EIA terms)	None	n/a	None
Entanglement risk	EMP and EMMP	Negligible - Minor	Low to Medium	Negligible to Minor (not significant in EIA terms)	None	n/a	None
Accidental pollution	EMP and EMMP	Minor	Low - Medium	Minor (not significant in EIA terms)	None	n/a	None
Decommissioning Phase							
Increased anthropogenic underwater noise – decommissioning phase	EMP and EMMP	Minor	Low	Minor (not significant in EIA terms)	None	n/a	None
Increased collision risk with vessels	EMP and EMMP	Minor	Medium	Minor (not significant in EIA terms)	None	n/a	None
Increases in SSC	EMP and EMMP	Negligible	Low	Minor (not significant in EIA terms)	None	n/a	None
Changes in fish and shellfish communities	EMP and EMMP	Minor	Low	Minor (not significant in EIA terms)	None	n/a	None
Accidental pollution	EMP and EMMP	Major	Low - Medium	Minor (not significant in EIA terms)	None	n/a	None

9.17 References

Anderwald, P., Brandecker, A., Coleman, M., Collins C., Denniston H., Haberlin, M. D., O'Donovan, M., Pinfield, R., Visser, F., and Walshe, L. (2013) Displacement responses of a mysticete, an odontocete, and a phocid seal to construction related vessel traffic. *Endangered Species Research,* 21, 231–240.

Anderwald, P. and P.G.H. Evans (2007) Minke Whale Populations in the North Atlantic – an Overview with Special Reference to UK waters, in Robinson, K.P., Stevick, P.T. & MacLeod, C.D. (Eds) *An Integrated Approach to Non-lethal Research on Minke Whales in European Waters*. European Cetacean Society Spec. Public. Series 47: 8-13.

Aquatic Survey and Monitoring Ltd. (2019). Drop-down video survey of East Pickard Bay, Freshwater West, March 2019 A report for Bombora WavePower Ltd.

Au, W.W.L., Floyd, R.W., Penner, R.H., and Murchison, A.E. (1974) Measurement of echolocation signals of the Atlantic bottlenose dolphin, *Tursiops truncatus* Montagu, in open waters. *Journal of the Acoustical Society of America,* 56, 1280– 1290.

Bailey, H., Senior, B., SimmonS, D., Rusin, J., Picken, J., and Thompson, P. M. (2009) Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. *Marine Pollution Bulletin,* 60, 888–897.

Baines, M. E. and P. G. H. Evans (2012) Atlas of the Marine Mammals of Wales. CCW Monitoring Report No. 68. 2nd Edition. 139pp.

Battersby, J. (2005) UK Mammals: Species Status and Population Trends. First Report by the Tracking Mammals Partnership, JNCC, *pp. 116*

Büche, B & Stubbings, E (2018) Grey Seal Breeding Census, Skomer Island 2017. NRW Evidence Report number 195. The Wildlife Trust of South and West Wales.

Benjamins, S., Harnois, V., Smith, H.C.M., Johanning, L., Greenhill, L., Carter, C. and Wilson, B. (2014) Understanding the potential for marine megafauna entanglement risk from renewable marine energy developments. Scottish Natural Heritage Commissioned Report No. 791.

Büche, B. and Stubbings, E. (2017) Grey Seal Breeding Census Skomer Island 2017. The Wildlife Trust of South and West Wales NRW Evidence Report 252

Benjamins, S., Dale, A., van Geel, N. and B. Wilson (2016) Riding the tide: use of a moving tidal-stream habitat by harbour porpoises, *Marine Ecology Progress Series,* 549 275-288.

Brooker, A., R. Barham, and T. Mason. 2012. "Underwater Noise Modelling Technical Report." E287R0919. Subacoustech Ltd.

Casper, B., M., Halvorsen, M., B., and Popper A.N. (2012) Are Sharks Even Bothered by a Noisy Environment?. In: Popper, A., N., and Hawkins, A. (eds) The Effects of Noise on Aquatic Life. *Advances in Experimental Medicine and Biology*, 730, 93-97.

Cassoff, R. M., Moore, K. M., McLellan, W. A., Barco, S. G., Rotstein, D. S., and Moore, M. J. (2011) Lethal entanglement in baleen whales. *Diseases of Aquatic Organisms*, 96, 175–185.

Chen, F., Shapiro, G. I., Bennett, K. A., Ingram, S. N., Thompson, D., Vincent, C., Russell, D., and Embling, C. B. (2017) Shipping noise in a dynamic sea: a case study of grey seals in the Celtic Sea. *Marine Pollution Bulletin*, 114 (1), 372-383.

Doherty, P. D., Baxter, J. M., Gell, F. R., Godley, B. J., Graham, R. T., Hall, G., Hall, J., Hawkes, L. A., Henderson, L. A., Johnson, L., Speedie, C. and Witt, M. J. (2017) Long-term satellite tracking reveals variable seasonal migration strategies of basking sharks in the north-east Atlantic. *Scientific Reports,* 7: 42837.

Dunn, P. (2002) Is that a !*!*ing shark? *All at sea*, 48.

Evans, P.G.H., Pierce, G.J., Panigada, S. (2010) Climate change and marine mammals. *Journal of the Marine Biological Association of the United Kingdom*, 90, 1483 - 1487.

Feingold, D. and Evans, P.G.H. (2014) *Bottlenose Dolphin and Harbour Porpoise Monitoring in Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation 2011-2013*. Natural Resources Wales Evidence Report Series No. 4. 124pp

Fowler, S.L. 2009. Cetorhinus maximus. The IUCN Red List of Threatened Species 2009: e.T4292A10763893. http://dx.doi.org/10.2305/IUCN.UK.2005.RLTS.T4292A10763893.en. Downloaded on 8 February 2019.

Gore, M. A., Frey, P. H., Ormond, R. F., Allan, H. and Gilkes, G. (2016) Use of photo-identification and mark-recapture methodology to assess basking shark (*Cetorhinus maximus*) populations. *PLoS One,* 11(3): e0150160.

Halvorsen, M. B., Brandon M., Casper, Frazer Matthews, Carlson, T. J. and Popper, A. N. (2012) Effects of exposure to pile-driving sounds on the lake sturgeon, Nile tilapia and hogchoker Proc Biol Sci. 2012 Dec 7; 279(1748): 4705–4714.

Harnoisa, V, Smitha, H. C. M., Benjamins, S., and Johannin, L. (2015) Assessment of entanglement risk to marine megafauna due to offshore renewable energy mooring systems. International Journal of Marine Energy, 11, 27-49

Heinänen, S. & Skov, H. (2015) The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area, JNCC Report No.544 JNCC, Peterborough.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K.Wilkinson, and J. Jannot. 2017. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2011-2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-354,112 p.

Hoegh-Guldberg, O. and Bruno, J.F. (2010). The impact of climate change on the world's marine ecosystems. Science 328: 1523 - 1528.

Hoegh-Guldberg, O. and Bruno, J.F. (2010). The impact of climate change on the world's marine ecosystems. Science 328: 1523 - 1528.

McFarlane, G, King, J., Leask, J. and L.B. Christensen (2008) Assessment of information used to develop a Recovery Potential assessment for basking shark *Cetorhinus maximus* (Pacific population) in Canada. Canadian Science Advisory Secretariat Research Document 2008/071.

Hung, N. and C. J. (2016) *Lutra lutra. Species*, 48, 940, 109–122.

IAMMWG (2015). Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, March 2015, 42 pp.

IAMMWG (2013). Management Units for marine mammals in UK waters. JNCC, June 2013.

IAMMWG (2015) The use of harbour porpoise sightings data to inform the development of Special Areas of Conservation in UK waters (December 2015). JNCC Report No. 565, December 2015, 33 pp.

JNCC (2007) Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. & Podesta, M. (2001). Collisions between ships and whales. Marine Mammal Science. 17, 35 - 75.

Lock K, Newman P, Burton M & Jones J, 2017, Skomer MCZ Grey Seal Survey, Marloes Peninsula 1992 – 2016. NRW Evidence Report 195.

Lohrengel, K., Evans, P.G.H., Lindenbaum C.P., Morris C.W. and T.B. Stringell (2018) Bottlenose Dolphin Monitoring in Cardigan Bay, 2014 – 2016, NRW Evidence Report No: 191, 162 pp, Natural Resources Wales, Bangor.

Mann, J., Conner, R. C., Tyack, P. L. and Whitehead, H. (2000) Cetacean Societies: Field Studies of Dolphins and Whales. The University of Chicago Press, Chicago and London

Murphy , S., Pinn, E. H. and Jepson, P. D. (2013) The short -beaked common dolphin (*Delphinus delphis*) in the north-east Atlantic: distribution, ecology, management and conservation status, Oceanogrpahy and Marine Biology: An Annual Review, 2013, 51, 193-280.

National Marine Fisheries Service (NMFS) (2018). Revision: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (V 2.0) Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59

National Marine Fisheries Service (NMFS) (2016). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 pp.

NMFS. (2005). Scoping Report for NMFS EIS for the National Acoustic Guidelines on Marine Mammals. National Marine Fisheries Service.

Parsons, E.C.M., Dolman, S.J., Wright, A.J., Rose, N.A., Burns, W.C.G. (2008) Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Marine Pollution Bulletin 56, 1248–1257.

Pereira, J. N. D. S. G. (2008) Field Notes on Risso's Dolphin (Grampus griseus) Distribution, Social Ecology, Behaviour, and Occurrence in the Azores (2008) Aquatic Mammals, 34, 426-435.

Pierpoint, C (2008) Harbour porpoise (*Phocoena phocoena*) foraging strategy at a high energy, near-shore site in south-west Wales, UK, *Journal of the Marine Biological Association of the United Kingdom,* 88 (6) 1167-1173.

Robinson, S. P., and P. A. Lepper. 2013. "Pentland Firth and Orkney Waters Enabling Actions Report - Review of Current Knowledge of Underwater Noise Emissions from Wave and Tidal Stream Energy Devices." The Crown Estate.

Roos, A., Loy, A., de Silva, P., Hajkova, P. & Zemanová, B. 2015. *Lutra lutra*. *The IUCN Red List of Threatened Species* 2015: e.T12419A21935287. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T12419A21935287.en. Downloaded on 26 January 2019.

V. Senigaglia, F. Christiansen, L. Bejder, D. Gendron, D. Lundquist, D. P. Noren, A. Schaffar, J.C. Smith, R. Williams, E. Martinez, K. Stockin, D. Lusseau (2019) Meta-analyses of whalewatching impact studies: comparisons of cetacean responses to disturbance Marine Ecology Progress Series Vol. 542: 251–263, 2016

Sims, D.W. et al. (2003). Effects of zooplankton density and diel period on surface-swimming duration of basking sharks. *Journal of the Marine Biological Association of the UK*, 83, 643- 646.

Priede, I.G. & Miller, P.I. (2009) A basking shark (*Cetorhinus maximus*) tracked by satellite together with simultaneous remote sensing II: New analysis reveals orientation to a thermal front. *Fisheries Research,*, 95, 370-372.

SCOS (2017) Scientific Advice on Matters Related to the Management of Seal Populations

SCOS (2015) IAMMWG Management Units for marine mammals in UK Waters (January 2015). JNCC Report No: 547, JNCC Peterborough

SCOS (2013) IAMMWG Management Units for marine mammals in UK Waters (June 2013), JNCC Peterborough

Sparling, C., Lonergan, M. and McConnell. B. (2017) Harbour seals (*Phoca vitulina*) around an operational tidal turbine in Strangford Narrows: No barrier effect but small changes in transit behaviour. Aquatic Conservation, 28, 194-204.

Speedie, C.D., Johnson, L. A., Witt, M.J. (2009). *Basking Shark Hotspots on the West Coast of Scotland: Key sites, threats and implications for conservation of the species. Commissioned Report No.339*

Speedie, C.D. & Johnson, L.A. (2008) The basking shark (*Cetorhinus maximus*) in West Cornwall. Key sites, anthropogenic threats and their implications for conservation of the species. *Natural England Research Report NERR 0018.*

Strong P.G., Lerwill J., Morris S.R. & Stringell, T.B. (2006). Pembrokeshire marine SAC grey seal monitoring 2005. CCW Marine Monitoring Report No: 26; redacted version. 51pp.

Thompson, D. (2012) Assessment of Risk to Marine Mammals from Underwater Marine Renewable Devices in Welsh waters (on behalf of the Welsh Government) Phase 2: Studies of Marine Mammals in Welsh High Tidal Waters Annex 1 Movements and Diving Behaviour of Juvenile Grey Seals in Areas of High Tidal Energy

Titan Environmental Services Ltd (2018) Bombora Hydrographic - Metocean Survey Geophysical & Oceanographic. June 2018. Project Number: CS0535

Thompson, D., Bexton, S., Brownlow, A., Wood, D., Patterson, T., Pye, K., Lonergan, M. & Milne, R. (2010) Report on recent seal mortalities in UK waters caused by extensive lacerations. Report by SMRU, St Andrews. Available online at http://www.smru.st-and.ac.uk/documents/366.pdf

Nowacek, D. P., Thorne, L., Johnston, D. W. and P. L. Tyack (2007) Responses of cetaceans to anthropogenic noise. *Mammal Review*, 37, 2, 81–115.

Vincent, C., Ridoux, V., Fedak, M. A., McConnell, B. J., Sparling, C. E., Leaute, J.-P., Jouma'a, J. and J. Spitz (2016) Foraging behaviour and prey consumption by grey seals (*Halichoerus grypus*)- spatial and trophic overlaps with fisheries in a marine protected area, ICES *Journal of Marine Science,* 73 (10) 2653 – 2665.

Wilson, B., Batty, R. S., Daunt, F. and Carter, C. (2007) Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban.

Williams, R., Wright, A.J., Ashe, E., Blight, L.K., Bruintjes, R., Canessa, R., Clark, C.W. Cullis-Suzuki, S., Dakin, D.T., Erbe, C., Hammond, P.S., Merchant, N.D., Hara, P.D.O, Purser, J., Radford, A.N., Simpson, S.D., Thomas, L. and M.A.Wale (2015) Impacts of anthropogenic noise on marine life: Publication patterns, new discoveries, and future directions in research and management. Ocean & Coastal Management, 115, 17-24.

Yachting World (2008). The fox, the jackal and the whale. July 2008