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IOSEA6

SCOPING REPORT - APPENDIX C

C.2 BIODIVERSITY, FLORA AND FAUNA

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C.2 BIODIVERSITY, FLORA AND FAUNA

This section describes the baseline, existing environmental sensitivities and potential sensitives of Biodiversity, Flora and Fauna to the Plan. The baseline draws on information from IOSEA4 and IOSEA5, providing updates where applicable.

Ireland complies with the European Union's (EU's) Marine Strategy Framework Directive (MSFD) 2008/56/EC which requires member states to reach Good Environmental Status (GES) in a number of areas classed as descriptors. The assessment process considers 11 qualitative descriptors for determining GES which are under Article 9 of the Directive (Department of Housing, Local Government and Heritage, 2020). Additionally, a Commission Decision (2017/848) sets out 'Primary and Secondary Criteria' across each of the descriptors which provide for a clearer framework (DHLGH, 2020).

Descriptor 1 relates to biodiversity (birds, mammals, reptiles, fish, cephalopods, pelagic habitats. Monitoring is required of each of the MSFD descriptors and the status determined in both Ireland's 'Marine Strategy Part 1' in 2020 and 'Marine Strategy Part 2' in 2021 is that GES for biodiversity has only been partially achieved (DHLGH, 2021b). While much of Irelands marine ecosystem is in generally good condition concerns such as overexploitation, pollution and climate change are leading to biodiversity and habitat loss and ecosystem degradation.

This baseline section covers the following sub-topics:

- Plankton (Section A.1.1)
- Benthos (Section A.1.2)
- Fish and Shellfish (Section A.1.3)
- Marine Mammals (Section A.1.4)
- Birds (Section A.1.5)
- Designated Habitats and Species (Section A.1.6)
- Marine Reptiles (Section A.1.7)
- Invasive Non-Native Species (Section A.1.8)

C.2.1 Plankton

The marine planktonic community consists of microscopic organisms of limited mobility that float in the water column. The majority can be found within the photic zone (the top 20 m of the water column) where light can penetrate allowing photosynthesis to take place. Plankton can be broadly divided into a plant component (phytoplankton) and an animal component (zooplankton). Phytoplankton (comprising primarily diatoms and dinoflagellates, but also including some smaller ciliates) are the primary producers in the marine environment, deriving energy from the sunlight and forming the primary source of nutrition for the marine food web. Nanoplankton comprises all planktonic organisms in the size range of 2 – 20 µm including pymnesiophytes (coccolithophores), prasinophytes, choanoflagellates and cyanobacteria. Zooplankton includes herbivores (feeding on phytoplankton) and carnivores (feeding on other zooplankton elements). It also includes the eggs and larvae of fish and benthic species (Kennington and Rowlands, 2006). These are meroplankton – temporary members of the plankton. The largest zooplankton are jellyfish and the most numerous are copepods; microscopic crustaceans which tend to be herbivores, feeding on the phytoplankton and in turn providing food for organisms higher up the food chain such as fish larvae and juvenile fish. Zooplankton are generally more common where algal production and biomass are greater, and the seasonal cycles of many zooplankton are clearly linked to those of primary production (Tett, 1992).

In general, plankton provide information on the overall ecological status of the ocean as they are a key indicator of change due to their sensitivity to temperature, pH and nutrient availability. However, there is a high level of temporal natural variability associated with phytoplankton assemblages in Irish waters. A review of the distribution of phytoplankton in coastal, shelf and estuarine waters around Ireland, highlighted the relative importance of vertical water column stability, which in turn determines the availability of light and nutrients for phytoplankton growth, and horizontal transport processes in influencing the abundance and composition of phytoplankton. In coastal waters, the seasonal stabilisation and de-stabilisation of the water column accounts for most of the natural variation in phytoplankton species composition and biomass. Much of the remaining natural variability can be explained by the interaction of phytoplankton with a number of oceanographic features and processes such as the presence of tidal and thermohaline fronts, wind and topographically associated coastal upwelling, advection landward of offshore water masses and the flow of coastal and oceanic currents. Additionally, the impact of climate change on phytoplankton dynamics must be considered when assessing the state of the marine environment. A number of studies have indicated that increases in sea temperature and changes in seasonal stratification are already influencing the biogeography, abundance and seasonality of plankton assemblages.

Within the IOSEA6 Study Area plankton is driven by the seasonal change in their vertical stability of the water column (Table C-3). In winter while nutrient concentrations are at the maximum phytoplankton growth is inhibited by light availability (O’Boyle and Silke, 2009).

Within the Celtic Sea, which encompasses the Celtic Sea Basin, there is a diversity of zooplankton species, and it is dominated by copepods (Brophy et al., 2020). There has been a decline in overall copepod abundance since 1958. The cold-water species Calanus finmarchicus and Pseudocalanus spp. have decreased in abundance; however, the warm-water copepod C. helgolandicus has increased (International Council for the Exploration of the Sea , 2018).

The development in the Celtic Sea of the spring bloom and the seasonal cycle of phytoplankton production are closely linked to variations in the physical stability of the water column. The development of fronts and the physical partitioning of the sea into seasonally stratified, permanently mixed and frontal regimes are crucial in determining the environment for primary production. Usually, the spring bloom develops first in mid-April to the south of Ireland in an area of weak tidal streaming. The development of a thermocline and increasing light levels leads to a rapid increase in phytoplankton biomass tracking the spatial development of stratification (O’Boyle & Silke, 2010).

C.2.1.1 Sea Fronts

An important thermohaline frontal boundary separating coastal and oceanic water is present on the west of Ireland called 'Irish Shelf Front' (ISF) (Huang et al., 1991). A thermohaline front consists of a deep-ocean current driven by differences in the water's density, which is controlled by temperature (thermo) and salinity (haline) (National Oceanic and Atmospheric Administration, 2022). The front has been observed to exist all year round and has a length scale of about 500 km (Huang et al., 1991). The ISF is a persistent feature of the circulation in both the Celtic Sea and along the western Irish shelf (Nolan and Lyons, 2006) The Front extends from the north-western coast (including the Slyne-Erris Basin) to the south-western coast where it marks the boundary between the Celtic Sea waters.

This front has been observed to influence the temporal and spatial distribution of planktonic organisms (Raine and McMahon, 1998; O'Boyle and Raine, 2007). Phytoplankton biomass levels were higher on the coastal side of the frontal boundary, as evidenced by chlorophyll concentrations. Diatoms such Leptocylindrus danicus, Guinardia flaccida, and Pseudo-nitzschia cf seriata dominated the phytoplankton species composition inshore of the front (O'Boyle and Raine, 2007). Plankton dynamics vary significantly on either side of the front, with an earlier commencement of the phytoplankton spring bloom and an advanced zooplankton grazing population inshore (McGinty, 2012).

Turbulence caused by the Irish shelf front introduces nutrients from deeper waters to the surface where they promote the growth of phytoplankton. At the edge of the shelf break off the south-west coast of Ireland, enhanced planktonic production occurs in a ~100 km broad band of cold water during the summer. This band of water is 1-2ºC colder than the adjacent neritic and oceanic water in the Celtic Sea and Atlantic and has higher inorganic nitrate levels and chlorophyll concentrations due to physical processes occurring at the edge – namely the slopes, ridges and canyons which cause enhanced mixing particularly due to internal tides and upwelling. This mixing leads to nutrient renewal and phytoplankton growth along the shelf edge. These internal tides are formed when tidal flow across the steep continental slope induces vertical displacements and associated pressure fields. At the Celtic Sea shelf edge for example, large tidal currents (>0.5 m/s) cause large internal tides or vertical displacements of up to 150 m (Huthnance et al., 2001). The resulting upwelling water forms a band of cool nutrient rich water along the shelf edge. In north-western European shelf waters, spring-neap variability has been shown to play a part in the timing of the spring bloom, possibly by briefly interrupting the development of spring stratification (Sharples, 2008 and references therein).

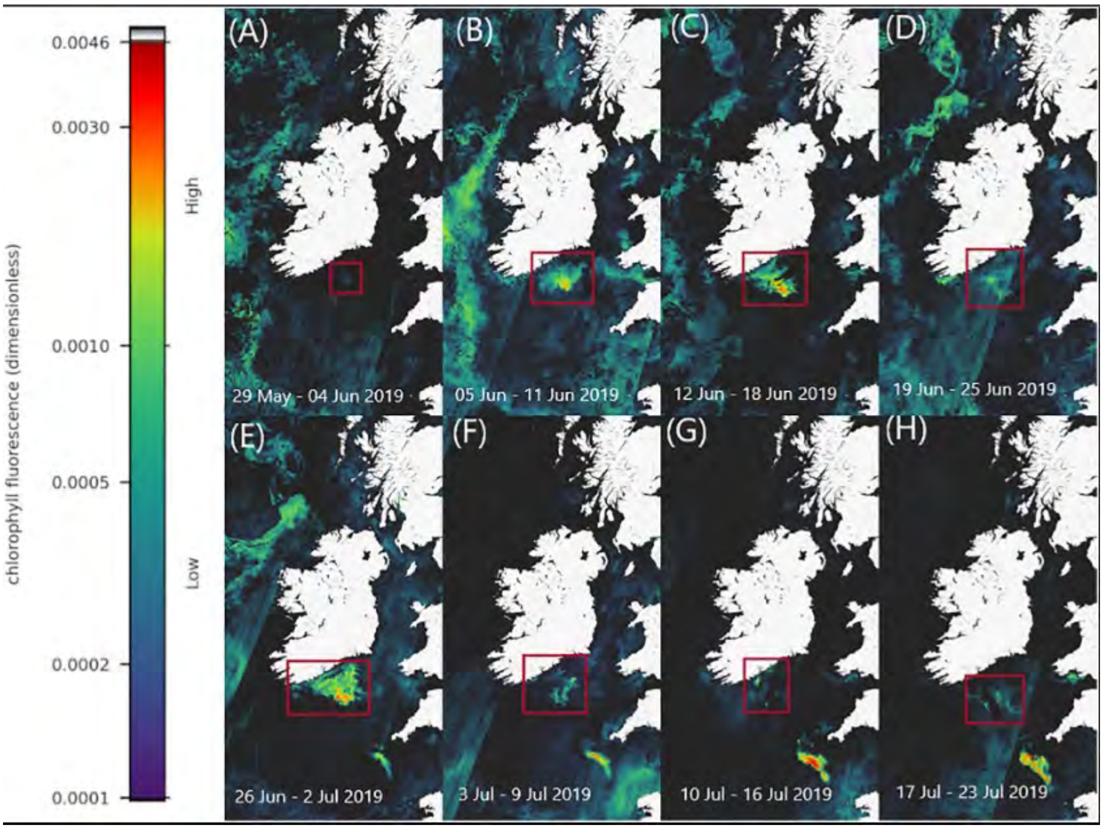
Within the south-east of the IOSEA6 Study Area, another front, the Celtic Sea Front, forms the boundary between stratified waters of the northern Celtic Sea and the tidally mixed waters of the southern Irish Sea (O'Boyle & Silke, 2010). Exceptional blooms of the dinoflagellate Karenia mikimotoi appear to be a characteristic feature of the Celtic Sea Front in summer, especially on the stratified side of the front (Holligan et al., 1980).

C.2.1.2 Harmful Algal Blooms (HABs)

A small number of phytoplankton species are known to be potentially harmful. They can cause fish kills, contaminate seafood with toxins, pose a direct risk to human health and can alter ecosystems. Hallegraeff (1993) reported that the number of toxic events and HABs are increasing in many pelagic environments worldwide. (Note that there has also been an increase in the number of HAB monitoring programmes). While worldwide increases in HABs have been attributed to human-induced water pollution as well as human-induced changes in climate, in Irish waters these toxic events are considered to be primarily natural. In June 2005 a large Karenia mikimotoi bloom occurred along the south-western and western coasts of Ireland and persisted over several months. When this bloom decayed, it caused significant damage to the marine ecosystem all along the west coast of Ireland with mass mortalities of benthic communities (Silke et al., 2005). This species has now been recorded during almost all winter months since 2010 and is known to cause anoxic conditions by the physical bloom itself as well contact with toxins related to the species (Camaro Garcia and Dwyer, 2021; Robin et al., 2013). In 2005 a bloom of this species caused mass mortality of both benthic and pelagic marine organisms along Irelands Atlantic seaboard (O'Boyle et al., 2016).

A study conducted in 2019 highlighted a bloom of K. mikimotoi off the south-east of Ireland (Figure C-5). The study was conducted in May, June, July and August and over the four weeks of June an extensive localised surface K.mikimotoi phytoplankton bloom formed in the Celtic Sea (Jordan et al., 2021)

Figure C-5 *K.mikimotoi* bloom progression between 29th May 2019 and 23rd July 2019 (A–H). Colours indicate relative fluorescence, with warmer colours representing higher fluorescence indicative of higher bloom concentration (Image taken from Jordan et al., 2021)



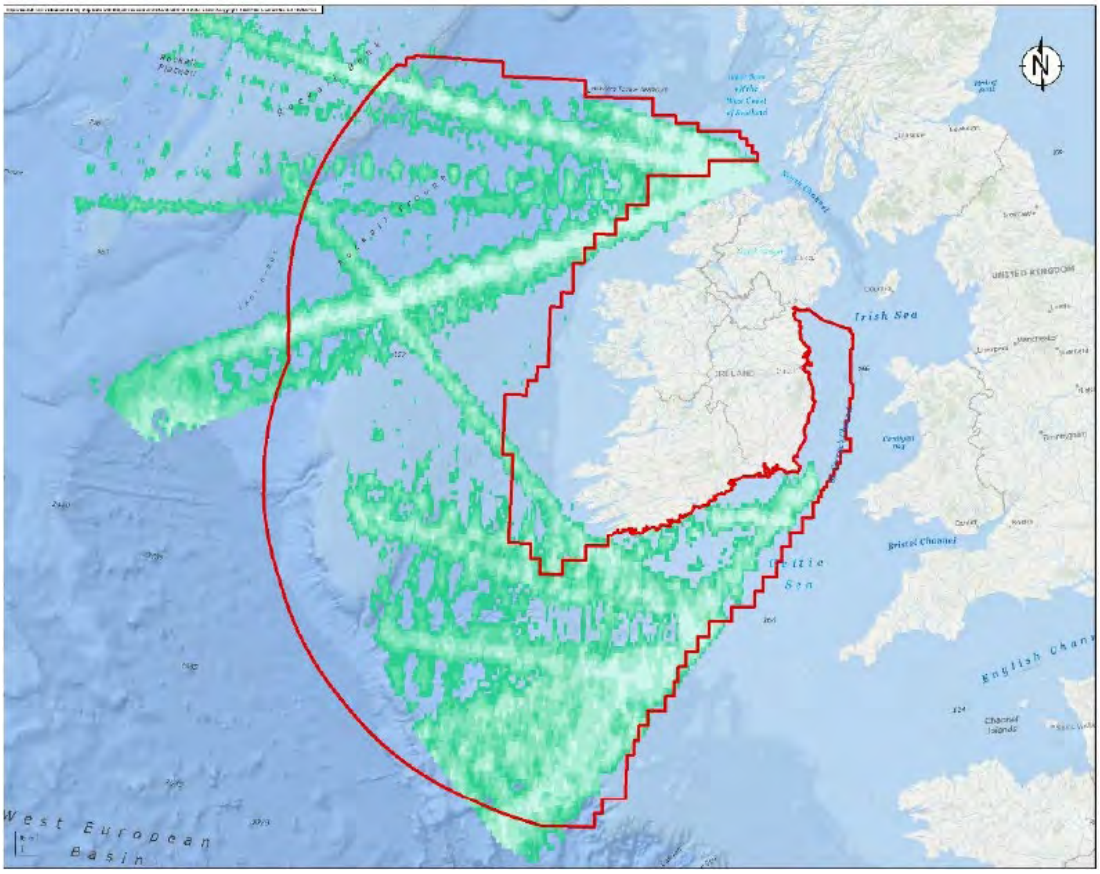
The Marine Institute has developed a harmful agal bloom alert system to prevent toxin related aquaculture farm closures (Copernicus Marine Service, 2022). Weekly bulletins are produced to monitor the occurrence of harmful agal blooms. These bulletins allow for weekly updates providing information on likely transport pathways of HABs and the potential problematic species which may cause issues (MI, 2022). The most recent (at the time of writing this report) weekly bulletin Week 40 gives a summary of the water column; Warmer water moving away from Southern areas. Decreasing light levels and increasing water turbulence in general. High mixed diatom and dinoflagellates dominance in most coastal areas. Localised temporary blooms becoming less likely. These reports can be used to update the most current bloom likelihood in localised areas.

Plankton Monitoring Programmes

The main dataset that is used for ongoing Plankton monitoring is the Continuous Plankton Recorder Survey (CPRS) which has been continuously developed and updated by the Sir Alistar Hardy Foundation for Ocean Sciences (SAHFOS) and in 2018 was incorporated into the Marine Biological

Association (MBA, 2022). The survey has been ongoing since 1958 and the methodology has remained the same. The last annual report by SAHFOS was published for the year 2017-2018 the dataset online currently is updated for the period from 1958-2018, however the most recent CPRS was carried out from 2020-2021. Figure C-6 displays distributions of phytoplankton in Irish Waters.

Figure C-6 CPR sampling intensity in the region from 1958 – 2018 (Source: Modified from SAHFOS for IOSEA5 which encompasses the IOSEA6 Study Area)



C.2.1.3 MSFD Descriptor 4: Marine Food Webs

Descriptor 4 of the MSFD assesses plankton communities following methods set out by OSPAR Common Indicators PH1/FW5 and PH2. The OSPAR plankton indicators are used as they can provide information on ecosystem structure and energy flow (OSPAR, 2018). The assessment was carried out for the "Celtic Seas ecoregion" (defined by the International Council for the Exploration of the Sea (ICES)) GES for descriptor 4 is assessed as being achieved when "all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity" (DHLGH, 2021b).

The assessment was carried out against two primary criteria D4C1 (assessment was completed for fish) and D4C2 (EC, 2017). D4C2 was assessed for phytoplankton and zooplankton:

- D4C2 - The balance of total abundance between the trophic guilds is not adversely affected due to anthropogenic pressures.

The assessment found that phytoplankton populations have increased while zooplankton counts (especially small copepods) have decreased in recent years (DHLGH, 2021b). Phytoplankton biomass in the Celtic Seas demonstrated year-to-year variation, with an increase since the mid-1980s. The biomass of zooplankton, on the other hand, has been declining over time, especially since the late 1980s. Although this was only a preliminary assessment based on these criteria, it revealed that changes had occurred, emphasising potential difficulties or consequences for the larger marine ecosystem (DHLGH, 2021b). The MSFD assessment also reported significant changes in plankton community structure and energy flows (DHLGH, 2021b). Small and large copepods, as well as non-carnivorous and carnivorous zooplankton, showed the most variation, indicating food web structure and energy exchange between trophic groups (DHLGH, 2021b). The holo-plankton (plankton for their entire lives) and mero-plankton (plankton for only part of their lives (usually the larval stage) lifeform pair has also undergone significant change, suggesting changes in linkage between the benthic and pelagic components of the ecosystem (Marine Science Center, 2012; DHLGH, 2021b). The only nonsignificant change noted in the assessment was in diatoms and dinoflagellates that cause toxic algal blooms, however the report recommended that further research is needed to refine this comparison.

Table C-3 Summary of the main seasonal features of the phytoplankton ecology of coastal and shelf waters around Ireland (source O'Boyle & Silke, 2010)

Winter	Spring	Summer	Autumn
In winter, phytoplankton growth is limited by light availability in all waters with the exception of some inshore shallow waters where chlorophyll levels in late February–early March can exceed winter background levels (Pybus, 2007). At this time, cryophytes and other flagellates can be numerically dominant but diatoms provide the larger contribution to chlorophyll concentration and total volume of phytoplankton (Pybus, 2007).	Increasing day length leads to an outburst in net primary production, which often occurs first in shallower inshore water and then further offshore in deeper water following the onset of seasonal stratification (Falsham et al., 1983). The spring bloom consists mainly of diatom species such as *Thalassiosira* spp., *Skeletonema* spp., *Asterionopsis glacialis*, and *Chaetoceros* spp. With species such as *Pseudo-nitzschia* spp., *Rhizosolenia* spp., *Cerataulina pelagica* becoming more common later in spring and early summer (Dooley, 1973; Pybus, 1996). *Phaeocystis* often forms a significant component of the plankton flora in the period after the diatom dominated spring bloom and may in some areas remain an important part of the phytoplankton community throughout the summer (e.g. mixed waters of the western Irish Sea). Inshore, chlorophyll concentration can vary with the spring-neap tidal cycle with higher chlorophyll levels being observed at neap spring tides and at spring tides in early summer (Roden, 1994). At the boundary between mixed and stratified water tidal mixing can fuel additional phytoplankton growth. Higher biomass levels are usually found on the stratified side of the front, while on the mixed side, chlorophyll levels are lower as phytoplankton populations are mixed out of the euphotic zone (Simpson et al., 1979). In shallower water, blooms can occur on the mixed side of	In early summer, as stratification intensifies diatom numbers decline and a noticeable increase in dinoflagellate species occurs. In mid-summer, the flora is often composed of both diatoms and dinoflagellates including *Pseudo-nitzshia* spp, *Chaetoceros* spp, *Rhizosolenia* spp, *Leptocylindrus* spp, *Gonyaulax* spp, Scrippsiella and *Prorocentrum micans*. Also common at this time is the coccolithophorid *Emiliania huxleyi* which often forms massive blooms to the west of Ireland. From mid-summer onwards dinoflagellates, particularly *Ceratium* spp, and to a lesser extent *Protoperidinium* spp. and *Dinophysis* spp. become the dominant component of the flora in fully stratified waters, although diatom species such as *P. alata* and *L. mediterraneus* are also common. Diatoms can remain numerically dominant inshore where the water column remains vertically mixed due to tidal stirring. Offshore, the presence of stratification inhibits the diffusion of nutrients from below the pycnocline and surface mixed-layer biomass levels decline. At the base of the thermocline diffusion of nutrients from below promotes the development of large monospecific dinoflagellate populations (e.g. *Karenia mikimotoi*). Also common are surface blooms of the heterotrophic dinoflagellate *N. scintillans*. Exceptional dinoflagellate blooms can occur in coastal bays following the advection	In autumn surface cooling and increased wind-stress leads to the destabilization of the water column. Advection of nutrients into the euphotic zone fuels a short-lived autumnal bloom often consisting of diatom species. Occasional blooms in late autumn such as the large bloom of *Ceratium tripos*, which was observed off the coast of Connemara (Roden & Raine, 1994) reported occasionally.

Winter	Spring	Summer	Autumn
	coastal fronts as phytoplankton cells spend most of their time in the euphotic zone (Roden & Raine, 1994). In spring and summer, the presence of the Irish Shelf Front to the west of Ireland has a strong influence on the distribution of phytoplankton (McMahon et al., 1995; Raine & McMahon, 1998; Gribble et al., 2007; O'Boyle & Raine, 2007).	inshore of established offshore populations (Raine et al., 1993b). In summer, the formation of bottom density fronts inshore generates strong density-driven coastal flows that can carry phytoplankton populations northwards along the west coast of Ireland. Episodic coastal upwelling off south-western Ireland results in a shift in phytoplankton composition from one dominated by dinoflagellates (e.g. *Ceratium*) to one dominated by diatoms (Raine et al., 1993c).	

C.2.2 Benthos

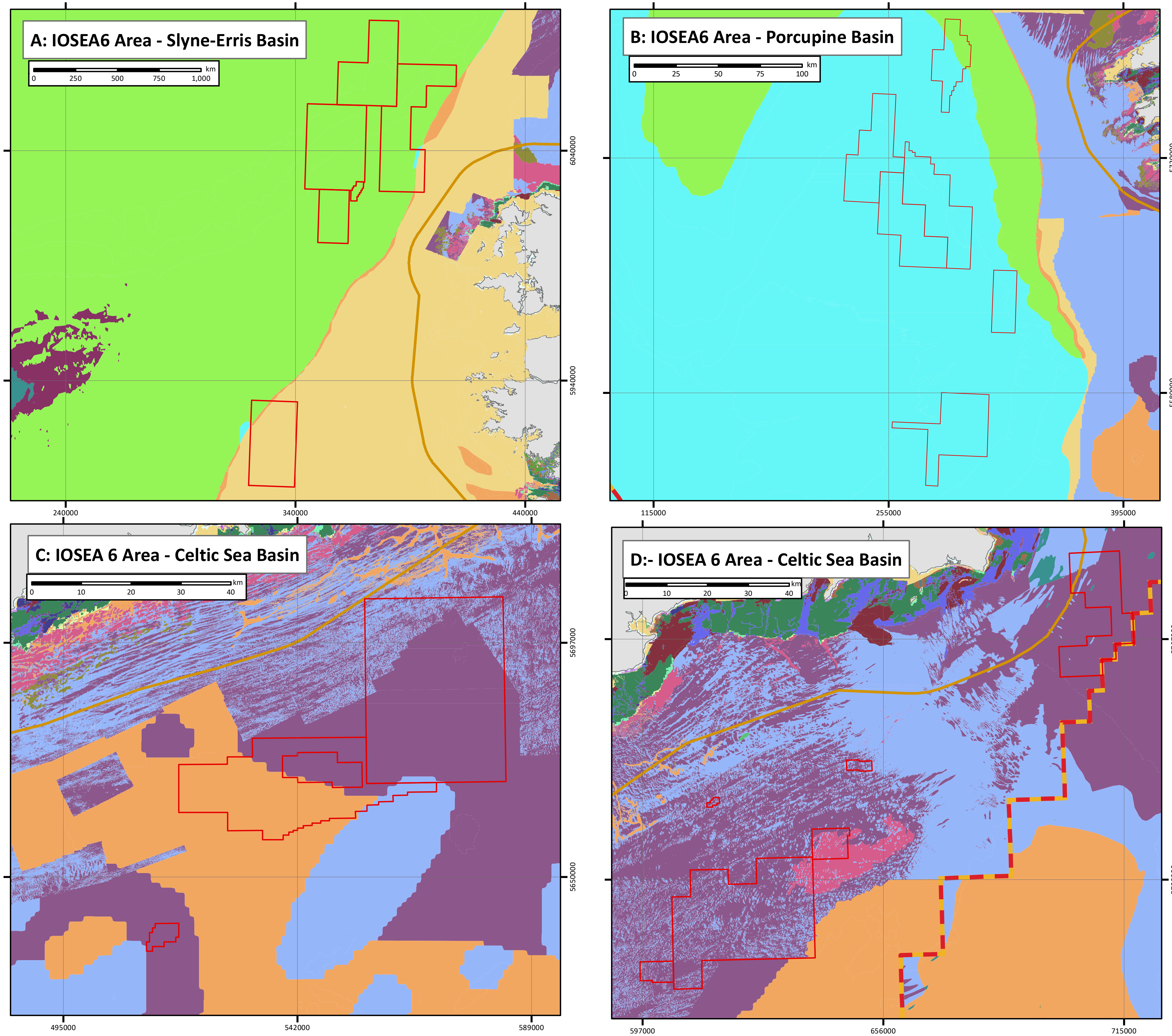
Intertidal and benthic ecology comprises the habitats and species (flora and fauna) present in (infauna), on (epifauna) or closely associated with the seabed. Benthic communities include those found on the sea floor from the intertidal zone to the deepest parts of the marine environment. The structure of benthic communities varies temporally and spatially depending on a wide range of physical factors of which water depth, light penetration, sediment type, particle size and supply of organic matter are key variables.

The seabed within the Irish and Celtic Seas comprises a broad range of sediment types which vary from mud, sand, gravel to rock. Shelf areas to the west are categorised by muds, sands and mixed sediments. There is a however, a lack of empirical biological data on a large scale. Benthic habitat mapping therefore relies predictive modelling which uses the relationship between benthic communities and their physical environment (e.g. sediment type and water depth) to predict the biotopes present. The accuracy of these predictions is dependent on the quality and quantity of the input data available.

Various European habitat modelling projects have been undertaken in recent years to address the limited amount of information available on benthic communities within the IOSEA6 Study Area. These include 'Mapping European Seabed Habitats' (MESH), the Irish Sea Pilot (Vincent et al., 2004), UKSeaMap (Connor et al., 2006) and HABMAP (HABitat MAPping for conservation and management of the southern Irish Sea) project (Robinson et al., 2009a, b, 2010).

IOSEA5 utilised information from MESH, however, this has now been archived and updated onto the newer European Marine Observation and Data Network (EMODNet). EMODNet is the permanent seabed habitats portal for European waters providing a broad scale map accessible as the EUSeaMap with focus on the European Nature Information Systems (EUNIS)habitat classification and the MSFD Benthic Broad Habitat types classifications (EMODnet, 2022).

EMODnet data has been used to provide information on the benthic habitats within each of the three basins, Slyne-Erris, Celtic and Porcupine, describing the IOSEA6 Study Area (Figure C-7 (Drawing Reference: P2510-HAB-001), Tables C-4, C-5 and C-6 display the predicted modelled data of the benthic habitats of each basin).



IOSEA6 - ENVIRONMENTAL REPORT

Biodiversity, Flora and Fauna

EMODNET Habitats

Drawing No: P2510-HAB-001	B

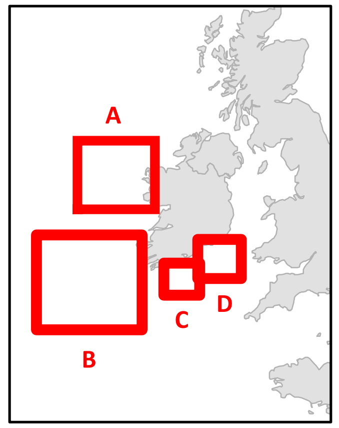
Legend

- IOSEA6 Area
- EEZ Boundary
- 12 NM Limit

EUNIS Habitats

A3.1	A5.14
A3.2	A5.15
A3.3	A5.23 or A5.24
A3	A5.25 or A5.26
A4.12	A5.27
A4.1	A5.33
A4.27	A5.35
A4.2	A5.37
A4.33	A5.43
A4.3	A5.44
A4	A5.45
A5.13	A5.6
	A6.2
	A6.5
	A6
	A6.3
	Na

N W E S



NOTE: Not to be used for Navigation

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Projection	Transverse Mercator
Datum	European 1950
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File Reference	J:\P2510\Mxd\07_HAB\ P2510-HAB-001.mxd
Created By	Emma Kilbane
Reviewed By	Lewis Castle
Approved By	Emma Langley

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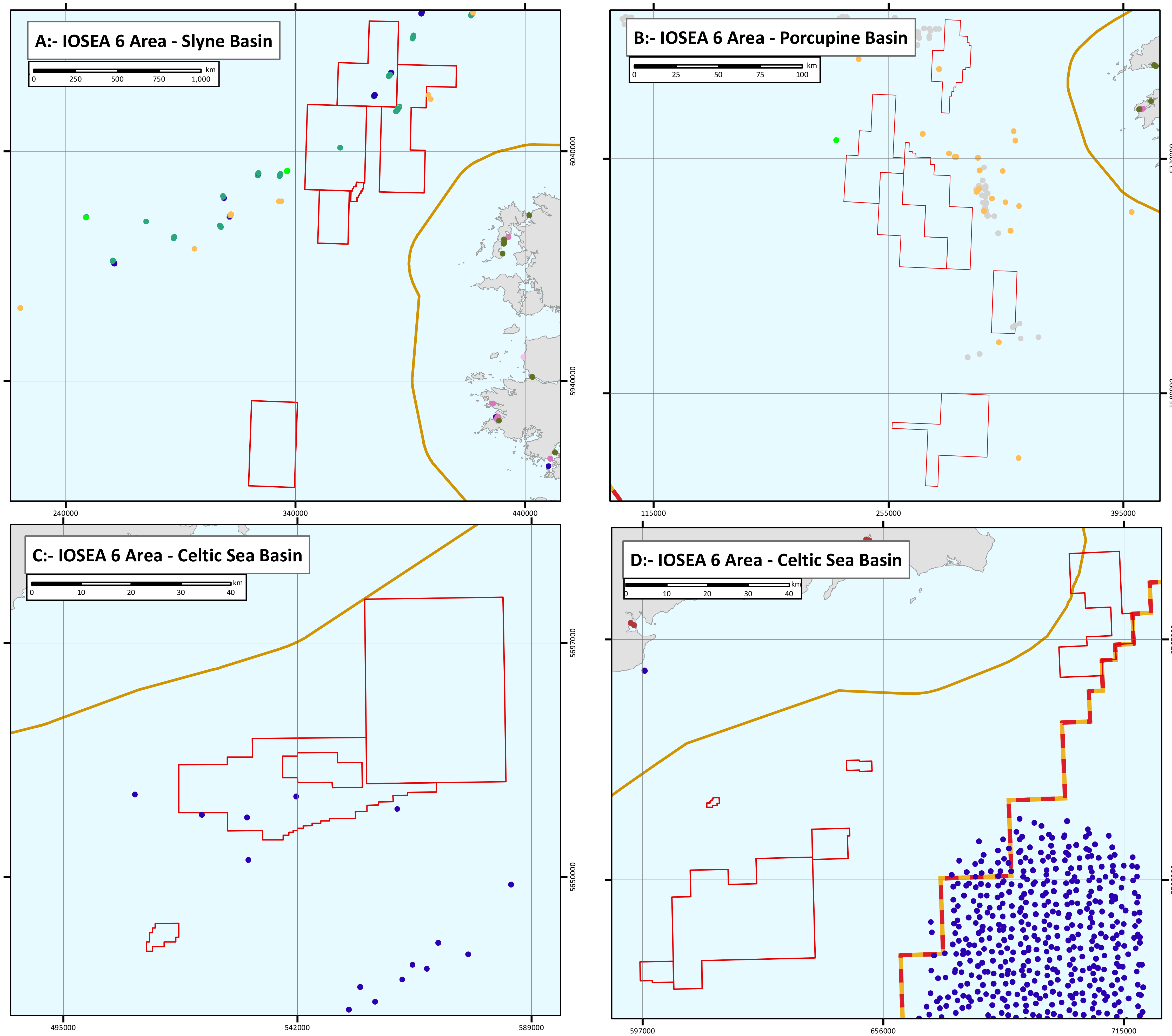


IOSEA6 - ENVIRONMENTAL REPORT

BIODIVERSITY, FLORA AND FAUNA OSPAR classified habitats found in the IOSEA6 Area

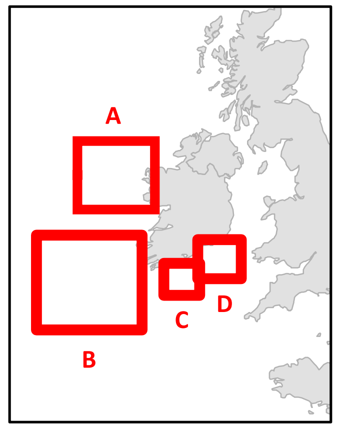
Drawing No: P2510-HAB-004	B

Legend

- IOSEA6 Area
- EEZ Boundary
- 12 NM Limit

OSPAR Threatened and/or Declining Habitat

- Carbonate mounds
- Coral gardens
- Deep-sea sponge aggregations
- Intertidal mudflats
- Littoral chalk communities
- Lophelia pertusa reefs
- Maerl beds
- Sea-pen and burrowing megafauna communities
- Zostera beds



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Created By	Lewis Castle
Reviewed By	Emma Kilbane
Approved By	Emma Langley

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C.2.2.2 Slyne-Erris Basin

Benthic Sediments

The Slyne-Erris Basin is located on the North-West coast of Ireland. An overview of the EMODnet predictive EUNIS classified habitats found in the Slyne-Erris Basin are provided in Table C-4. Within this basin the dominant EUNIS habitat is A6.5 Deep-sea mud. This is defined as low energy with a mostly sandy mud substrate and is made up of bathyal and abyssal benthic habitats. Bathyal and abyssal sediments are not well characterised because of their depth, remoteness and great extent. There is also a very small area within the Slyne-Erris Basin which is classed as EUNIS habitat A5.37 Deep circalittoral mud. Depending on silt and clay levels of this habitat type different faunal communities can develop, however the habitat is mostly dominated by polychaetes and bivalves (Figure C-7, Drawing Reference: P2510-HAB-001). There are also areas of unclassified EUNIS habitat within the basin, however, INFOMAR classes the sediment in this area as sandy Mud/Muddy Sand.

Table C-4 Habitats Present within the Slyne-Erris Basin (EMODnet, 2022; EUNIS, 2022)

EUNIS code	EUNIS name	Typical fauna
A5.37	Deep circalittoral mud	In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.
A6	Deep-sea bed	The seabed beyond the continental shelf break. The shelf break occurs at variable depth, but is generally over 200 m. The upper limit of the deep-sea zone is marked by the edge of the shelf. Includes areas of the Mediterranean Sea which are deeper than 200 m but not of the Baltic Sea which is a shelf sea. Excludes caves in the deep sea which are classified in A4.71 irrespective of depth.
A6.5	Deep-sea mud	Bathyal and abyssal benthic habitats with substrates predominantly of yellowish or blue-grey mud, relatively consistent, whose population is extremely sparse. This biocoenosis is characterised by constant homothermy and an almost total absence of light.

OSPAR Threatened and Declining List of Species

In addition to the EUNIS and INFOMAR habitat types, there are also instances of OSPAR Threatened and Declining benthic species identified within the Slyne-Erris basin (Figure C-8, Drawing Reference: P2510-004) (OSPAR, 2008b). The cold-water coral *Lophelia pertusa* has been recorded in scattered localities within the basin, usually occurring at depths of 200 m to 700 m, where it is likely that the steady current associated with the upper slope of the Rockall Trough provides suitable feeding conditions for them. Additionally, coral gardens defined as relatively dense aggregation of colonies or individuals of one or more coral species and sea-pen and burrowing megafauna communities have also been shown to be found within the IOSEA6 Slyne-Erris basin (OSPAR, 2008a). Sea pen and burrowing megafauna are included on the OSPAR Threatened and Declining List of Species.

C.2.2.3 Porcupine Basin

EMODNet Benthic Sediments

The Porcupine Basin is located offshore south-west of Ireland. An overview of the EMODnet predictive EUNIS classified habitats found in the Porcupine Basin are provided in Table C-5. The main habitat within the basin is A6 'Deep-sea Bed', the area also includes mud and cohesive sandy mud in the offshore circalittoral zone.

OSPAR Threatened and Declining List of Species

OSPAR lists species and habitats which have been classified as threatened and/or declining (OSPAR, 2017). Within the Porcupine Basin, OSPAR data identifies carbonate mounds displayed in Figure C-8, (Drawing Reference: P2510-HAB-004). There has been three major coral provinces within the Porcupine Basin; namely, the Hovland Mounds, Magellan mound, and the Belgica Mound Province (Ola et al., 2002; Mol et al., 2007). The Belgica Mound Province is located approximately 1km away from the IOSEA6 Porcupine Basin. The geological Porcupine basin benthic ecosystem consists of carbonate mounds at depths between 550 and 1060 m, with good examples of cold-water coral reefs formed by *Lophelia pertusa* and *Madrepora oculata* (Mol et al., 2007). The seabed in this area is characterised by cold-water coral reefs which support a highly diverse community (MPAs Europe, 2022). The Belgica Mound Province has been identified as one of the most prolific places in the world with over fifty giant coral mounds and 300 smaller coral reefs (Marine Institute, 2022).

While the OSPAR recorded data of threatened and declining species does not place carbonate mounds within the IOSEA6 Porcupine Basin, due to the occurrence of carbonate mounds surrounding the area it cannot be ruled out they will not be present with the IOSEA6 blocks.

Other species which occur on the OSPAR threated and declining species list have also been recorded in the Porcupine Basin. The eight underwater TV survey (UWTV) of the 'Porcupine Bank Nephrops ground' conducted by the Marine Institute in 2020. In this survey four species of sea-pen were observed ; *Virgularia mirabilis*, *Funiculina quadrangularis*, *Pennatula phosphorea* and the deepwater seapen *Kophobelemnon stelliferum* (Aristegui et al., 2020). All three species of sea pen which occur on mud habitat around Ireland are found on the Porcupine Bank. Sea pen and burrowing megafauna are included on the OSPAR threatened and/ or declining species and habitats.

Table C-5 Habitats Present within the Porcupine Basin (EMODnet, 2022; EUNIS, 2022)

EUNIS code	EUNIS name	Typical fauna
A6	Deep-sea bed	The seabed beyond the continental shelf break. The shelf break occurs at variable depth, but is generally over 200 m. The upper limit of the deep-sea zone is marked by the edge of the shelf. Includes areas of the Mediterranean Sea which are deeper than 200 m but not of the Baltic Sea which is a shelf sea. Excludes caves in the deep sea which are classified in A4.71 irrespective of depth.
A6.5	Deep-sea mud	Bathyal and abyssal benthic habitats with substrates predominantly of yellowish or blue-grey mud, relatively consistent, whose population is extremely sparse. This biocoenosis is characterised by constant homothermy and an almost total absence of light.

C.2.2.4 Celtic Sea Basin

EMODNet Benthic Sediments

The seabed of the Celtic Seas Basin is primarily comprised of mixed sediments. In the northern section of the IOSEA6 Celtic Sea basin there are coarse and sandy to muddy areas and, coarse and mixed sediments with some muddy patches. Within the southern part of the IOSEA6 Celtic Sea basin the sediment is classed as coarse, rocky, and sandy to muddy sands in the Celtic Sea. An overview of the EMODnet predictive EUNIS classified habitats found in the Porcupine Basin are provided in Table C-6. The main seabed types categorised under the EUNIS classification are A5.15 'Deep circalittoral coarse sediment', A5.27 'Deep circalittoral sand' and A5.37 'Deep circalittoral mud'. A5.15 habitat type is quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. The A5.37 habitat type has similar communities to A5.15 and is typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.

The fauna within the area consists of burrowing megafauna including sea pens and commercially important species (e.g. *Nephrops norvegicus*). Nephrops communities can be found in areas with muddy sediment such as the Celtic Deep, i.e. areas of deep circalittoral mud habitat (A5.37). The fauna is also characterised by macrobenthos such as deposit-feeding polychaetes. The BIOMÔR 1 study (Mackie et al., 1995) reported the bivalves *Abra alba*, *Abra nitida*, the polychaete *Levinsenia* sp. and Nemertea as the most abundant fauna with the Dublin Bay prawn (or Norway lobster) *Nephrops norvegicus* and the cumacean *Diastylis lucifera* as exclusive species to this habitat. Commercially important shellfish species, e.g. *Pecten maximus* and *Aequipecten opercularis* are associated with the coarser sediments in the area.

The nearshore rocky habitats are characterised by algae and epifauna; however, some areas of rocky habitat in deep waters in the northern part of the region are characterised by hydroids, bryozoans, and cnidarians such as *Eunicella verrucosa* and *Swiftia pallida*. Hard substratum communities occur in areas of particularly high-water movements; notably off headlands such as Carnsore Point and around Tuskar Rock (Keegan et al., 1987). These localities are stony, bedrock is often exposed, and the fauna is commonly dominated by attached sessile epifaunal species. Sensitive species and habitats within the basin include the. burrowing megafauna, maerl *Phymatolithon calcareum* (unattached coralline algae), brittle star beds *Ophiuroidea*, *Modiolus modiolus* beds, and *Atrina fragilis*.(ICES, 2018).

Table C-6 Habitats Present within the Celtic Sea Basin (EMODnet, 2022; EUNIS, 2022)

EUNIS code	EUNIS name	Typical fauna
A4.27	Faunal communities on deep moderate energy circalittoral rock	These communities populate hard substrata with low hydrodynamics and strong sedimentation.
A5	Sublittoral sediment	Sediment habitats in the sublittoral near shore zone (i.e. covering the infralittoral and circalittoral zones), typically extending from the extreme lower shore down to the edge of the bathyal zone (200 m). Sediment ranges from boulders and cobbles, through pebbles and shingle, coarse sands, sands, fine sands, muds, and mixed sediments. Those communities found in or on sediment are described within this broad habitat type.
A5.15	Deep circalittoral coarse sediment	Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little quantitative data available. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus*. In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt leading to the development of the biotope A5.6.2. The EUSeaMap highlights potential *Modiolous modiolus* beds. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A5.27	Deep circalittoral sand	Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.
A5.37	Deep circalittoral mud	In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.

EUNIS code	EUNIS name	Typical fauna
A5.45	Deep circalittoral mixed sediments	Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore gravels and coarse sands and in some areas populations of the horse mussel *Modiolus modiolus* may develop in these habitats (see A5.622)

OSPAR Threatened and Declining List of Species

Threatened and declining benthic species identified within the Slyne-Erris basin (Figure C-8, Drawing Reference: P2510-HAB-004) (OSPAR, 2008b). The cold-water coral *Lophelia pertusa* has been recorded in scattered localities within the basin, usually occurring at depths of 200 m to 700 m, where it is likely that the steady current associated with the upper slope of the Rockall Trough provides suitable feeding conditions for them. Additionally, coral gardens defined as relatively dense aggregation of colonies or individuals of one or more coral species and sea-pen and burrowing megafauna communities have also been shown to be found within the IOSEA6 Slyne-Erris basin (OSPAR, 2008a).

C.2.2.5 Other basins within the IOSEA6 Study Area

An overview of the EMODnet predictive EUNIS classified habitats found partially within or adjacent to the IOSEA6 Study Areas are provided in Table C-7 to C-9.

Table C-7 Habitats Present within the Rockall Basin

EUNIS code	EUNIS name	Typical fauna
A6	Deep-sea bed	The seabed beyond the continental shelf break. The shelf break occurs at variable depth, but is generally over 200 m. The upper limit of the deep-sea zone is marked by the edge of the shelf. Includes areas of the Mediterranean Sea which are deeper than 200 m but not of the Baltic Sea which is a shelf sea. Excludes caves in the deep sea which are classified in A4.71 irrespective of depth.
A6.5	Deep-sea mud	Bathyal and abyssal benthic habitats with substrates predominantly of yellowish or blue-grey mud, relatively consistent, whose population is extremely sparse. This biocoenosis is characterised by constant homothermy and an almost total absence of light.
A6.11	Deep-sea bedrock	There is no description available for A6.11 on the EUNIS website however A6.1 is described as: Deep-sea benthic habitats with substrates predominantly of bedrock, immobile boulders or artificial hard substrates.

Table C-8 Habitats Present within the Mayo Basin

EUNIS code	EUNIS name	Typical fauna
A3	Atlantic and Mediterranean high energy infralittoral rock	Rocky habitats in the infralittoral zone subject to exposed to extremely exposed wave action or strong tidal streams. Typically, the rock supports a community of kelp *Laminaria hyperborea* with foliose seaweeds and animals, the latter tending to become more prominent in areas of strongest water movement. The depth to which the kelp extends varies according to water clarity, exceptionally (e.g. St Kilda) reaching 45 m. The sublittoral fringe is characterised by dabberlocks *Alaria esculenta.*
A3.1	Atlantic and Mediterranean	Rocky habitats in the infralittoral zone subject to exposed to extremely exposed wave action or strong tidal streams. Typically, the rock supports a community of kelp *Laminaria hyperborea* with foliose seaweeds and animals,

EUNIS code	EUNIS name	Typical fauna
	high energy infralittoral rock	the latter tending to become more prominent in areas of strongest water movement. The depth to which the kelp extends varies according to water clarity, exceptionally (e.g. St Kilda) reaching 45 m. The sublittoral fringe is characterised by dabberlocks *Alaria esculenta*.
A3.2	Atlantic and Mediterranean moderate energy infralittoral rock	Predominantly moderately wave-exposed bedrock and boulders, subject to moderately strong to weak tidal streams. On the bedrock and stable boulders there is typically a narrow band of kelp *Laminaria digitata* in the sublittoral fringe which lies above a *Laminaria hyperborea* forest and park. Associated with the kelp are communities of seaweeds, predominantly reds and including a greater variety of more delicate filamentous types than found on more exposed coasts (cf. A3.11).
A3.3	Atlantic and Mediterranean low energy infralittoral rock	Infralittoral rock in wave and tide-sheltered conditions, supporting silty communities with *Laminaria hyperborea* and/or *Laminaria saccharina* (A3.31). Associated seaweeds are typically silt-tolerant and include a high proportion of delicate filamentous types. In turbid-water estuarine areas, the kelp and seaweeds (A3.32) may be replaced by animal-dominated communities (A3.36) whilst stable hard substrata in lagoons support distinctive communities (A3.34).
A4	Atlantic and Mediterranean high energy circalittoral rock	Occurs on extremely wave-exposed to exposed circalittoral bedrock and boulders subject to tidal streams ranging from strong to very strong. Typically found in tidal straits and narrows. The high energy levels found within this habitat complex are reflected in the fauna recorded. Sponges such as *Pachymatisma johnstonia, Halichondria panicea, Esperiopsis fucorum* and Myxilla incrustans may all be recorded. Characteristic of this habitat complex is the dense 'carpet' of the hydroid Tubularia indivisa. The barnacle *Balanus crenatus* is recorded in high abundance on the rocky substrata. On rocky outcrops, Alcyonium digitatum is often present.
A4.1	Atlantic and Mediterranean high energy circalittoral rock	Occurs on extremely wave-exposed to exposed circalittoral bedrock and boulders subject to tidal streams ranging from strong to very strong. Typically found in tidal straits and narrows. The high energy levels found within this habitat complex are reflected in the fauna recorded. Sponges such as *Pachymatisma johnstonia, Halichondria panicea, Esperiopsis fucorum* and *Myxilla incrustans* may all be recorded. Characteristic of this habitat complex is the dense 'carpet' of the hydroid *Tubularia indivisa*. The barnacle *Balanus crenatus* is recorded in high abundance on the rocky substrata. On rocky outcrops, *Alcyonium digitatum* is often present. In EUSeaMap broad-scale predictive mapping this habitat is classified as 'circalittoral rock and biogenic reef'. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A4.2	Atlantic and Mediterranean moderate energy circalittoral rock	Mainly occurs on exposed to moderately wave-exposed circalittoral bedrock and boulders, subject to moderately strong and weak tidal streams. This habitat type contains a broad range of biological subtypes, from echinoderms and crustose communities (A4.21) to *Sabellaria* reefs (A4.22) and circalittoral mussel beds (A4.24). The EUSeaMap identifies"*Sabellaria* reef" and "circalittoral mussel beds" as potentially present. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A4.27	Faunal communities on deep moderate energy circalittoral rock	These communities populate hard substrata with low hydrodynamics and strong sedimentation.
A4.3	Atlantic and Mediterranean low energy circalittoral rock	Occurs on wave-sheltered circalittoral bedrock and boulders subject to mainly weak/very weak tidal streams. The biotopes identified within this habitat type are often dominated by encrusting red algae, brachiopods (*Neocrania anomala*) and ascidians (*Ciona intestinalis* and *Ascidia mentula*).

EUNIS code	EUNIS name	Typical fauna
A4.33	Faunal communities on deep low energy circalittoral rock	There is no description of A4.33 on the EUNIS website however A4.3 is described as: Occurs on wave-sheltered circalittoral bedrock and boulders subject to mainly weak/very weak tidal streams. The biotopes identified within this habitat type are often dominated by encrusting red algae, brachiopods (*Neocrania anomala*) and ascidians (*Ciona intestinalis* and *Ascidia mentula*).
A5.13	Infralittoral coarse sediment	Moderately exposed habitats with coarse sand, gravelly sand, shingle and gravel in the infralittoral, are subject to disturbance by tidal steams and wave action. Such habitats found on the open coast or in tide-swept marine inlets are characterised by a robust fauna of infaunal polychaetes such as *Chaetozone setosa* and *Lanice conchilega*, cumacean crustacea such as *Iphinoe trispinosa* and *Diastylis bradyi*, and venerid bivalves. Habitats with the lancelet *Branchiostoma lanceolatum* may also occur.
A5.14	Circalittoral coarse sediment	Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum*.
A5.15	Deep circalittoral coarse sediment	Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little quantitative data available. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus*. In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt leading to the development of the biotope A5.6.2. The EUSeaMap highlights potential *Modiolous modiolus* beds. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A5.23 or A5.24	Infralittoral fine sand or Infralittoral muddy sand	A5.23 - Clean sands which occur in shallow water, either on the open coast or in tide-swept channels of marine inlets. The habitat typically lacks a significant seaweed component and is characterised by robust fauna, particularly amphipods (*Bathyporeia*) and robust polychaetes including *Nephtys cirrosa* and *Lanice conchilega*. A5.24 - Non-cohesive muddy sand (with 5% to 20% silt/clay) in the infralittoral zone, extending from the extreme lower shore down to more stable circalittoral zone at about 15-20 m. The habitat supports a variety of animal-dominated communities, particularly polychaetes (*Magelona mirabilis*, *Spiophanes bombyx* and *Chaetozone setosa*), bivalves (*Fabulina fibula* and *Chamelea gallina*) and the urchin *Echinocardium cordatum*.
A5.25 or A5.26	Circalittoral fine sand or Circalittoral muddy sand	A5.25 - Clean fine sands with less than 5% silt/clay in deeper water, either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20 m. The habitat may also extend offshore and is characterised by a wide range of echinoderms (in some areas including the sea urchin (*Echinocyamus pusillus*), polychaetes and bivalves. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community. A5.26 - Circalittoral non-cohesive muddy sands with the silt content of the substratum typically ranging from 5% to 20%. This habitat is generally found in water depths of over 15-20m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves such as *Abra alba* and *Nucula nitidosa*, and echinoderms such as *Amphiura* spp and *Ophiura* spp., and *Astropecten irregularis*. These circalittoral habitats tend to be more

EUNIS code	EUNIS name	Typical fauna
		stable than their infralittoral counterparts and as such support a richer infaunal community.
A5.27	Deep circalittoral sand	Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.
A5.35	Circalittoral sandy mud	Circalittoral, cohesive sandy mud, typically with over 20% silt/clay, generally in water depths of over 10 m, with weak or very weak tidal streams. This habitat is generally found in deeper areas of bays and marine inlets or offshore from less wave exposed coasts. Sea pens such as Virgularia mirabilis and brittlestars such as *Amphiura* spp. are particularly characteristic of this habitat whilst infaunal species include the tube building polychaetes *Lagis koreni* and *Owenia fusiformis*, and deposit feeding bivalves such as *Mysella bidentata* and *Abra* spp.
A5.37	Deep circalittoral mud	In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.
A5.43	Infralittoral mixed sediments	Shallow mixed (heterogeneous) sediments in fully marine or near fully marine conditions, supporting various animal-dominated communities, with relatively low proportions of seaweeds. This habitat may include well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in mud, sand or gravel. Due to the quite variable nature of the sediment type, a widely variable array of communities may be found, including those characterised by bivalves (A5.433, A5.431, and A5.435), polychaetes (A5.432) and file shells (A5.434). This has resulted in many species being described as characteristic of this habitat type all contributing only a small percentage to the overall similarity (see below). This habitat type may also include a newly proposed *Chaetopterus* biotope (Rees pers com.) recently found in the eastern English Channel. This biotope is characterised by an undescribed *Chaetopterus* sp. and small *Lanice conchilega*. Further sampling is need in order to assess and fully characterise this potential biotope. As a result, the *Chaetopterus* biotope has not been included in this revision. Infaunal data for this habitat type are limited to that described in the biotope A5.433 and so are not representative of the infaunal component of the whole habitat type.
A5.44	Circalittoral mixed sediments	Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20 m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as *Cerianthus lloydii* are often present in such habitat and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as *Nemertesia* spp and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities. Coarser mixed sediment communities may show a strong resemblance, in terms of infauna, to biotopes within the A5.1. However, infaunal data for this habitat type is limited to that described under the biotope A5.443, and so are not representative of the infaunal component of this habitat type.
A5.45	Deep circalittoral mixed sediments	Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore gravels and coarse sands and in some areas populations of the horse mussel *Modiolus modiolus* may develop in these habitats (see A5.622)

EUNIS code	EUNIS name	Typical fauna
A6	Deep-sea bed	The seabed beyond the continental shelf break. The shelf break occurs at variable depth, but is generally over 200 m. The upper limit of the deep-sea zone is marked by the edge of the shelf. Includes areas of the Mediterranean Sea which are deeper than 200 m but not of the Baltic Sea which is a shelf sea. Excludes caves in the deep sea which are classified in A4.71 irrespective of depth.
A6.5	Deep-sea mud	Bathyal and abyssal benthic habitats with substrates predominantly of yellowish or blue-grey mud, relatively consistent, whose population is extremely sparse. This biocoenosis is characterised by constant homothermy and an almost total absence of light.

Table C-9 Habitats Present within the Clare Basin

EUNIS code	EUNIS name	Typical fauna
A4	Atlantic and Mediterranean high energy circalittoral rock	Occurs on extremely wave-exposed to exposed circalittoral bedrock and boulders subject to tidal streams ranging from strong to very strong. Typically found in tidal straits and narrows. The high energy levels found within this habitat complex are reflected in the fauna recorded. Sponges such as *Pachymatisma johnstonia, Halichondria panicea, Esperiopsis fucorum* and *Myxilla incrustans* may all be recorded. Characteristic of this habitat complex is the dense 'carpet' of the hydroid *Tubularia indivisa*. The barnacle *Balanus crenatus* is recorded in high abundance on the rocky substrata. On rocky outcrops, *Alcyonium digitatum* is often present.
A4.1	Atlantic and Mediterranean high energy circalittoral rock	Occurs on extremely wave-exposed to exposed circalittoral bedrock and boulders subject to tidal streams ranging from strong to very strong. Typically found in tidal straits and narrows. The high energy levels found within this habitat complex are reflected in the fauna recorded. Sponges such as *Pachymatisma johnstonia, Halichondria panicea, Esperiopsis fucorum* and *Myxilla incrustans* may all be recorded. Characteristic of this habitat complex is the dense 'carpet' of the hydroid *Tubularia indivisa*. The barnacle *Balanus crenatus* is recorded in high abundance on the rocky substrata. On rocky outcrops, *Alcyonium digitatum* is often present. In EUSeaMap broad-scale predictive mapping this habitat is classified as 'circalittoral rock and biogenic reef'. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A4.2	Atlantic and Mediterranean moderate energy circalittoral rock	Mainly occurs on exposed to moderately wave-exposed circalittoral bedrock and boulders, subject to moderately strong and weak tidal streams. This habitat type contains a broad range of biological subtypes, from echinoderms and crustose communities (A4.21) to *Sabellaria* reefs (A4.22) and circalittoral mussel beds (A4.24). The EUSeaMap identifies "*Sabellaria* reef" and "circalittoral mussel beds" as potentially present. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A4.27	Faunal communities on deep moderate energy circalittoral rock	These communities populate hard substrata with low hydrodynamics and strong sedimentation.
A4.3	Atlantic and Mediterranean low energy circalittoral rock	Occurs on wave-sheltered circalittoral bedrock and boulders subject to mainly weak/very weak tidal streams. The biotopes identified within this habitat type are often dominated by encrusting red algae, brachiopods (*Neocrania anomala*) and ascidians (*Ciona intestinalis* and *Ascidia mentula*).
A4.33	Faunal communities on	There is no description of A4.33 on the EUNIS website, however, A4.3 is described as:

EUNIS code	EUNIS name	Typical fauna
	deep low energy circalittoral rock	Occurs on wave-sheltered circalittoral bedrock and boulders subject to mainly weak/very weak tidal streams. The biotopes identified within this habitat type are often dominated by encrusting red algae, brachiopods (*Neocrania anomala)* and ascidians (*Ciona intestinalis* and *Ascidia mentula*).
A5.14	Circalittoral coarse sediment	Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum*.
A5.15	Deep circalittoral coarse sediment	Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little quantitative data available. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus*. In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt leading to the development of the biotope A5.6.2. The EUSeaMap highlights potential *Modiolous modiolus* beds. It is therefore possible that the EC Habitats Directive Annex I listed habitat 'biogenic reef' maybe observed in these areas.
A5.25 or A5.26	Circalittoral fine sand or Circalittoral muddy sand	A5.25 - Clean fine sands with less than 5% silt/clay in deeper water, either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20 m. The habitat may also extend offshore and is characterised by a wide range of echinoderms (in some areas including the sea urchin (*Echinocyamus pusillus*), polychaetes and bivalves. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community. A5.26 - Circalittoral non-cohesive muddy sands with the silt content of the substratum typically ranging from 5% to 20%. This habitat is generally found in water depths of over 15-20m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves such as *Abra alba* and *Nucula nitidosa*, and echinoderms such as *Amphiura* spp and *Ophiura* spp., and *Astropecten irregularis*. These circalittoral habitats tend to be more stable than their infralittoral counterparts and as such support a richer infaunal community.
A5.27	Deep circalittoral sand	Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.
A5.35	Circalittoral sandy mud	Circalittoral, cohesive sandy mud, typically with over 20% silt/clay, generally in water depths of over 10 m, with weak or very weak tidal streams. This habitat is generally found in deeper areas of bays and marine inlets or offshore from less wave exposed coasts. Sea pens such as *Virgularia mirabilis* and brittlestars such as *Amphiura* spp. are particularly characteristic of this habitat whilst infaunal species include the tube building polychaetes *Lagis koreni* and *Owenia fusiformis*, and deposit feeding bivalves such as *Mysella bidentata* and *Abra* spp.
A5.37	Deep circalittoral mud	In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.

EUNIS code	EUNIS name	Typical fauna
A5.44	Circalittoral mixed sediments	Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20 m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as *Cerianthus lloydii* are often present in such habitat and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as *Nemertesia* spp and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities. Coarser mixed sediment communities may show a strong resemblance, in terms of infauna, to biotopes within the A5.1. However, infaunal data for this habitat type is limited to that described under the biotope A5.443, and so are not representative of the infaunal component of this habitat type.
A6.5	Deep-sea mud	Bathyal and abyssal benthic habitats with substrates predominantly of yellowish or blue-grey mud, relatively consistent, whose population is extremely sparse. This biocoenosis is characterised by constant homothermy and an almost total absence of light.

C.2.2.6 GSI Offshore Reef Survey

The Geological Society of Ireland (GSI) and the Marine Institute jointly run INFOMAR the national seabed-mapping programme (2006-2026 inclusive), which aims to map the physical, chemical, and biological features of Ireland’s seabed.

In addition to general seabed habitat mapping, INFOMAR coordinated an extensive offshore reef survey of Irelands north-west continental margin (2017-2019) (Picton et al., 2021). This study was conducted to implement the European Maritime and Fisheries Fund (EMFF) Marine Biodiversity Scheme 'Fisheries Natura'. The aim of this project was to map the offshore reef habitat to better inform management of fishing pressures and to ultimately avoid deterioration of protected habitats (EPA, 2020). Findings of this project identified multiple areas of cold-water coral aggregations that could potentially be found within the IOSEA6 Study Area, including the deepest known aggregations (>1600m) at the Belgica Mound Province within the Porcupine basin.

This survey data is not yet available to the public to analyse exactly what reefs occur within the IOSEA6 Study Areas, however there is overlap of the OSPAR Threatened Species. If the data is available for this SEA’s assessment it will be used to further the benthic baseline of the IOSEA6 Study Area.

Maps from the INFOMAR sensitive ecosystem assessment report map vulnerable marine ecosystems are shown in Figures C-9 and C-10.

Figure C-9 Vulnerable marine ecosystems (VME's) mapped during the sensitive ecosystem assessment and ROV exploration of offshore reef. VME categories are nested and some sites have multiple VMEs so map is only to show overall pattern of occurrence and a full list of VMEs and cannot be interpreted as presence or absence of specific VMEs. (Source: Picton et al., 2021)

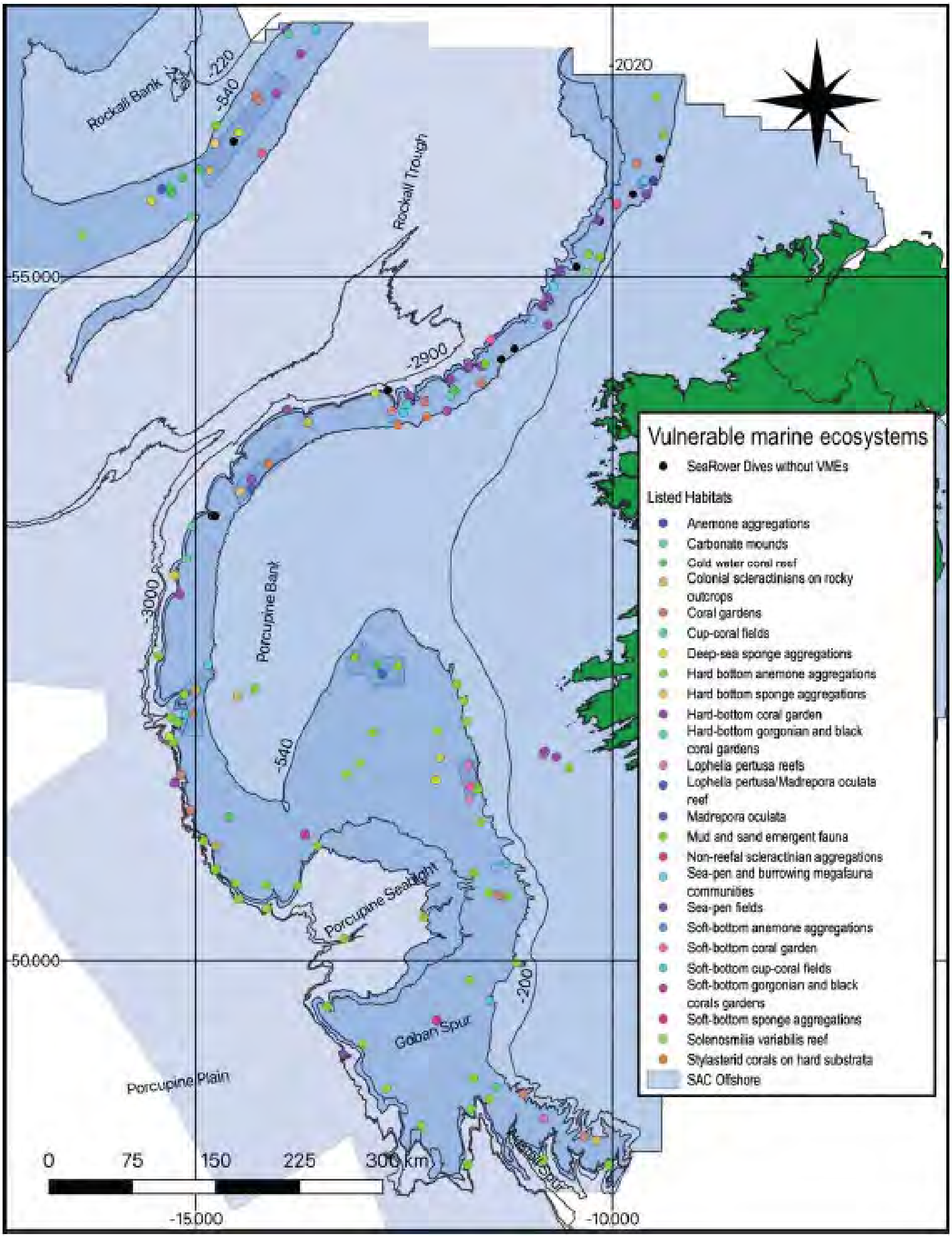
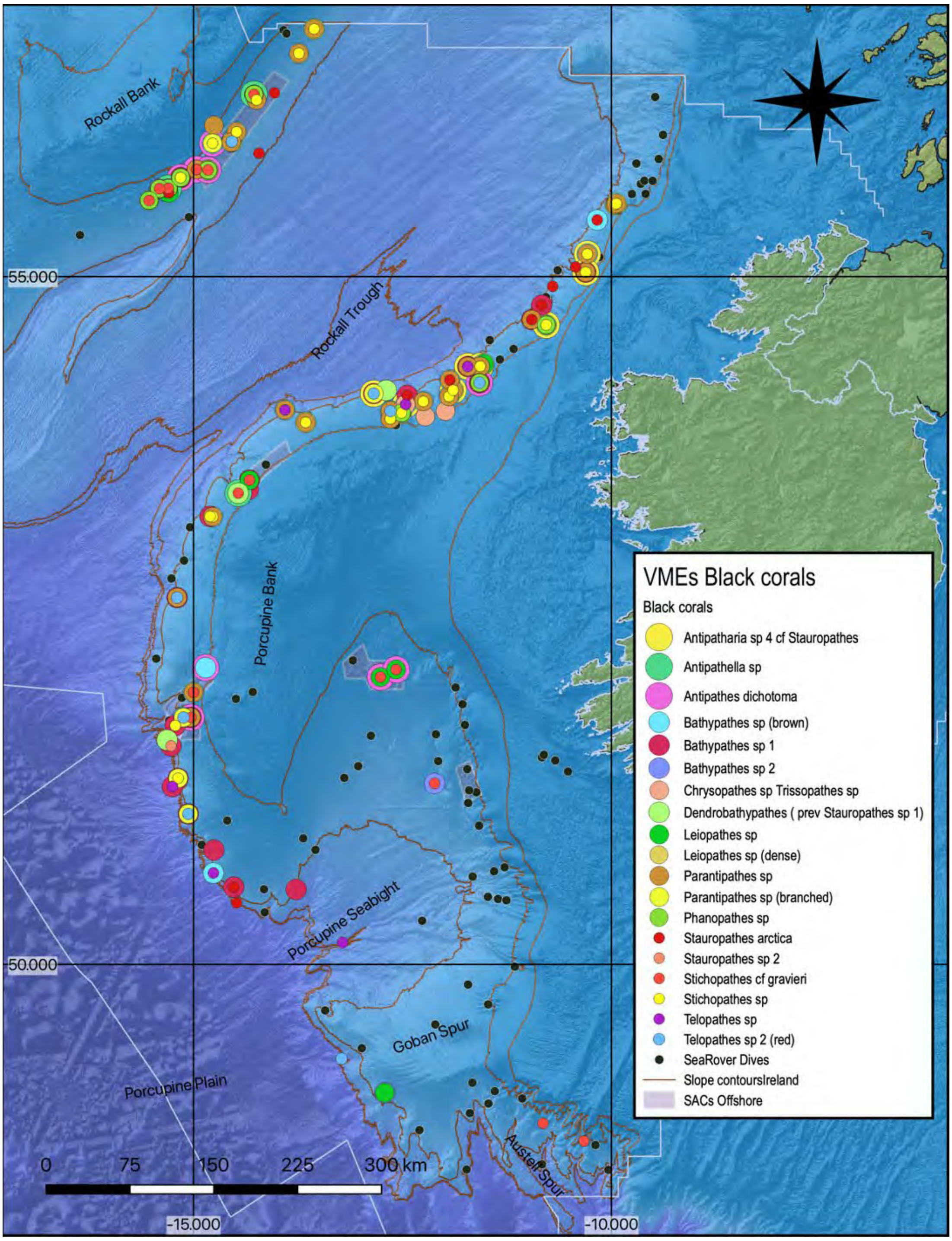


Figure C-10 Vulnerable marine ecosystems (VME's) Black coral mapped during the sensitive ecosystem assessment and ROV exploration of offshore reef. VME categories are nested and some sites have multiple VMEs so map is only to show overall pattern of occurrence and a full list of VMEs and cannot be interpreted as presence or absence of specific VMEs. (Source: Picton et al., 2021)



C.2.3 Fish and Shellfish

Irish waters support a wide variety of fish and shellfish species, including many commercially important species and others of strong conservation interest. Marine Institute (2013) reported that approximately 250 fish species have been caught in Irish fish surveys over the last eight years. The diversity of species and communities present in the IOSEA6 Study Area reflects the scale of the area and range of habitats present, from coastal waters with strong tidal currents through deeper continental shelf and slope waters to depths more than 2,000 m.

The range of species caught in the waters of the continental shelf (up to 200 m depth). Shelf-edge species include hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), monkfish (*Lophius piscatorius*) and megrim (*Lepidorhombus whiffiagonis*), saithe (pollack) (*Pollachius virens*), whiting (*Merlangius merlangus*), plaice (*Pleuronectes platessa*), ling (*Molva molva*) and black sole (*Solea solea*) typically targeted at maximum depths of 600 m. There are spawning grounds off the coast for all the above species and the spawning period for many species is between late winter and spring (Stafford, 2018).

Fish communities in the Celtic and Irish Sea areas are generally well described with distinct assemblages associated with different seabed substrata. Sandy inshore areas support large numbers of juvenile flatfish and sand eels (*Ammodytes tobianus*), with seasonal populations of sprat (*Sprattus sprattus*), herring (*Clupea harengus*) and juvenile gadoids (*Gadidae*). Rockier areas are dominated by small species such as wrasse (*Labridae*), gobies (*Gobiidae*) and blennies (*Blenniiformes*), as well as juvenile pollock (*Pollachius*) and saithe (*Pollachius viren*). Pelagic fish such as mackerel (*Scomber scombrus*) horse mackerel (*Trachurus trachurus*) and boarfish (*Capros aper*), and herring (*C. harengus*) range widely within the region, migrating between summer feeding grounds, spawning grounds and overwintering grounds. In gravelly, tidally dynamic (shallower) areas, such as the north coast of Ireland, the fish communities are dominated by larger species, including small sharks, gurnard (*Chelidonichthys cuculus*), cod (*Gadus morhua*), whiting (*Merlangius merlangus*), and only a few species of flatfish with populations of scallops (*Pectinidae*) and queen scallops (*Aequipecten opercularis*) also present in such areas. Muddy sediments have a higher incidence of gadoids and lower densities of plaice (*Pleuronectes platessa*) and dab (*Limanda limanda*) than found in shallower sandy areas. Soft-muddy sediments provide a habitat for burrowing crustacean, particularly *Nephrops*, which support important commercial fisheries. Other species more prevalent on soft sediments include long rough dab, witch and burrowing fish species such as sandeels which live in close association with the sandy sediments.

The offshore shelf regions, made up of large areas of sand or muddy sand, interspersed with patches of gravel or mud, support fisheries for cod, haddock, whiting, saithe, sole and plaice over much of the shelf with hake, anglerfish and megrim often also associated with the shelf edge. The distributions of many of these species are dynamic with feeding, spawning or migratory movements between coastal waters, the shelf and upper parts of the continental slope. Squid are also present in continental shelf waters.

Species present in deeper waters include the morid cod (*Moridae*), chimaeras (*Chimaeriformes*), greater forkbeard (*Phycis blennoides*), silvery pout (*Gadiculus argenteus*), Argentine (*Argentinidae*), blue whiting (*Micromesistius poutassou*) and roundnose grenadier (*Coryphaenoides rupestris*) of upper slope areas, through orange roughy (*Hoplostethus atlanticus*), black scabbardfish (*Aphanopus carbo*), blue ling (*Molva dypterygia)* and squalid sharks of the mid slope, to various eel forms, Mediterranean grenadier (*Coryphaenoides mediterraneus*), blue hake (*Merluccius merluccius*), Agassiz smoothhead (*Leptochilichthys agassizii*), lizardfish (*Synodontidae*), and blunt-snout smoothhead (*Xenodermichthys copei)* of the deepest areas.

The IOSEA6 Study Area has a wide variety of fish and shellfish, both commercially important and of conservation interest.

The most abundant species within the Celtic Sea are haddock, whiting, and pout Trisopterus spp. Common flatfish species in the ecoregion include dab *Limanda limanda*, plaice *Pleuronectes platessa*, and several species of sole and megrim. Pelagic fish species along the shelf edge are boarfish, blue whiting, mackerel, and horse mackerel while Mueller's pearlside *Maurolicus muelleri*, glacial lantern fish *Benthosema glaciale*, and lancet fish *Alepisauridae* are the dominant mesopelagic species. These pelagic and mesopelagic species are important parts of the foodweb in this ecoregion and changes in their abundance can have significant consequences for the marine food chain (ICES, 2018).

A study conducted on along the Porcupine Seabright and Abyssal Plain (to the south-west of the IOSEA6 Study Area) identified 108 deep-sea demersal fish species (Priede et al., 2010).

The International Beam Trawl Survey (IBTS) reports on species of fish that can be found around the Irish coast. These include Atlantic Cod (*Gadus morhua*), Haddock (*Melanogrammus aeglefinus*), herring (*Clupea harengus*), European hake, (*Merluccius merluccius*), horse mackerel (*Trachurus trachurus*), and Mackerel *Scomber scombrus*), monkfish, (*Lophius piscatorius*), plaice, (*Pleuronectes platessa*), whiting, (*Merlangius merlangus*), blue whiting (*Micromesistius poutassou*), Norway pout (*Trisopterus esmarkii*) (ICES, 2018).

C.2.3.1 Migratory Species

Atlantic salmon (*Salmo salar*) is an anadromous species i.e. individuals live mostly in the ocean but breed in freshwater. They spawn far upstream in freshwater, usually from November and December. The eggs are laid on a nest (redd) hollowed out in the gravel bed by the female and hatch out from April to May. In Ireland and the British Isles, the parr can spend from one to, exceptionally, five years in this river before migrating to the sea (Shelton et al., 1997). After three to four years (although in some cases only one to two years) the salmon return to their spawning rivers. Many die after spawning, but some will survive the downstream journey to spawn a second or third time (Wheeler, 1978). The migration path for Irish salmon appears to be northward along the west coast and then towards Greenland and the Norwegian Sea via the Faroe-Shetland Channel (Shelton et al., 1997; Hansen & Jacobsen, 2003; White et al., 2002). Salmon are native to rivers right around the Irish coast. The Salmon is listed as a protected species under Annex II of the Habitats Directive.

Trout (*Salmo trutta*) shares many of the biological features of its close relative the salmon but forms two basic types, the migratory sea-trout and the non-migratory brown trout. Trout spawn in winter from October to January. The eggs are shed in redds cut by the female in the river gravel, usually in upstream reaches, although many spawn in the gravel below weirs. Most sea trout tend to remain in coastal waters once they leave the freshwater systems (Kallio-Nyberg et al., 2002).

The European eel (*Anguilla anguilla*) is common in Ireland, occurring throughout the country. They spawn in the Sargasso Sea, after which the larvae drift back towards Europe on the North Atlantic Current (Arai et al., 2006). Approximately 6-8 months after hatching these glass eels (elvers) arrive on the Irish coast during December, increasing in numbers during spring (Moriarty, 1999). Some will remain in estuarine habitats where they continue to grow to maturity while others will continue their migration into freshwater. The number of individual elvers moving upstream can be in the order of millions. After a number of years in fresh water, mature adults will migrate downstream to the sea in the autumn and may continue through to late spring. From here they will continue their migration back to the Sargasso Sea where they mate and die.

Sea lamprey (*Petromyzon marinus*) is considered an indigenous species having been widely recorded in the rivers of Ireland (Kurz & Costello, 1999). Sea lampreys spawn mainly in June and July in freshwater brooks and rivers. Juveniles remain in freshwater for 3-6 years before returning to the sea. It is an Annex II species. The sea lamprey's overall conservation status was described in the Irish Red Data Book as Near Threatened stating barriers to upstream migration are considered a major issue to achieved good conservation status as they limit access to spawning and juvenile beds (King et al., 2011). The overall status of sea lamprey was assessed as 'Bad' in 2019 by NPWSs when conducted the assessment of the status of EU protected habitats and species in Ireland, this overall status has remained the same since 2013 (NPWS, 2019). The river lamprey (*Lampetra fluviatilis*) is also an Annex II species and despite its name occurs in fresh and saltwater. The Red Data Book classes the river lamprey as of 'Least concern' (King et al., 2011). The most recent assessment (2019) carried out by NPWS states the overall status of the species is 'Unknown'(NPWS, 2019). This assessment was due to the inability to distinguish between river lamprey and brook lamprey larvae and challenges associated with sampling adult river lamprey (NPWS, 2019).

The European sturgeon (*Acipenser sturio*) is listed as a priority species in Annex II of the EU Habitats Directive. It is a migratory species reproducing in fresh water and then moving into the sea until ready to spawn again (OSPAR, 2009b). This species was once common throughout the North Sea, the shelf region of the eastern North Atlantic, the Mediterranean, and the Black Sea. Following a rapid decline at the end of the 19th century in central Europe, the species was extirpated in the second half of the last century throughout Europe (e.g. Almaça, 1988: Elvira et al., 1991; Elvira & Almodovar, 1993). The European sturgeon is now extinct in a number of its former spawning rivers including the Elbe and the Rhine. It is limited in its distribution to a population centred on the River Gironde in France. A second possible population in the River Rioni in Georgia, which drains into the Black Sea, has been unconfirmed since 1991. The species remains in the Gironde estuary for the first seven years of its life cycle, following which fish have mainly been caught along the coastal waters of the Western Gulf of Biscay and along the British Channel (Castelnaud et al., 1990). Individuals of this population have occasionally been described to stray around the British Isles into the North Sea and to Norway (Trondheim).

Also, of relevance to the IOSEA6 Study Area are the twaite shad (*Alosa fallax*) and allis shad (*Alosa alosa*). Both of these species move between coastal, estuarine and freshwater environments and are listed on Annex II of the Habitats Directive. High sensitivity hearing species such as clupeids (e.g. herring, sprat, twaite shad and allis shad) have specialisations of the auditory apparatus where the swim bladder and inner ear are intimately connected. These species can detect sound pressure as well as particle motion and are able to detect frequencies up to 3kHz; with optimum sensitivity between 300Hz-1kHz (Nedwell et al. 2007). Clupeids of the shad family (*Alosinae*) in particular, have shown sensitivity to a range of frequencies that can extend to >100 kHz. (Mann et al., 2001). Teague & Clough (2011) recorded positive significant reactions in juvenile twaite shad to sound frequencies of between 30 and 60 kHz with a peak at 45kHz. Behavioural studies of the responses of American shad to ultrasound (Mann et al., 2001; Popper et al., 2004). Twaite shad have known spawning grounds at the upper tidal reaches in the River Barrow and River Nore SAC. Spawning fish move to these areas in shoals to spawn annually in late May – early June. Telemetry investigations by Inland Fisheries Ireland indicate that the fish do not move in a single event to spawning areas but make a series of up- and down river migrations, dropping far down into the Waterford Harbour area, at least, prior to settling for a short period in the spawning areas (IFI, 2021). The telemetry work and sampling in the near-shore marine areas indicate that the adult shads migrate in and out of the estuarine areas and open sea, presumed to be feeding movements. The telemetry study has also shown movements from one estuary to another, one fish moving from the Munster Blackwater to Waterford Harbour over the course of two to three days immediately after spawning.

C.2.3.2 Spawning and nursery grounds

Irish waters contain very important spawning and nursery grounds for commercially important fish species which also indicates what type of fish can be found utilising the IOSEA6 Study Areas. Shelf and coastal areas support important spawning and nursery grounds for a range of demersal and pelagic species.

The Fisheries Ecosystem Assessment Services (FEAS), a team within the Marine Institute, are responsible for meeting Ireland's obligations under the EU Data Collection Framework. As part of this work FEAS carry out Groundfish Trawl Surveys, Acoustic Surveys, Plankton Surveys and Underwater Television surveys (Marine Institute, 2020).

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) provide information on spawning grounds (the location where eggs are laid) and nursery areas (the location where juveniles are common) for fish stock in Irish coastal waters in the form of fisheries sensitivity maps (Coull et al. 1998, Ellis et al. 2012, Marine Institute 2018).

A summary of the spawning and nursery periods of commercially important fish species which can be found in the IOSEA6 Study Area are outlined in Table C-10. Spawning and nursery areas are not rigidly fixed in terms of their boundaries, and these maps are only a representation of the spawning grounds given current knowledge and should not be taken as rigid unchanging descriptions of presence or absence.

Table C-10 Summary of spawning and nursery periods for commercially important fish species which can be found (but not limited to) within the IOSEA6 Study Area

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anglerfish (N)	N	N	N	N	N	N	N	N				
Atlantic Cod (S)(N)	SN	S*N	S*N	SN	N	N						
Atlantic Herring (S)(N)	SN	S*N	S*N	SN	N	N			S*	S	S	S
Atlantic mackerel (N)		N	N	N	N	N	N	N				
Blue Whiting (N)				N	N	N	N	N				
Common Ling (N)		N	N	N	N	N	N					
European hake (N)	N	N	N	N	N	N	N	N				
Haddock (S)(N)		SN	SN	SN	SN	N	N					
Horse mackerel (N)		N	N	N	N	N	N	N	N	N		
Lemon Sole (SN)				SN	SN	SN	SN	SN	SN	N	N	
Nephrops (SN)	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN
Plaice (S)	S*	S*	S									S
Sandeel (N)	N	N	N	N							N	N
Sprat (S)					S*	S*	S	S				
Sole (S)			S	S*	S							
Whiting (S) (N)		SN	SN	SN	SN	SN	N	N				

S = Spawning, N = Nursery, SN = Spawning and Nursery, Blank = No Data, *peak spawning, -=unavailable.

Source: Coull et al. 1998; Ellis et al. 2012.

Demersal Species

The spawning and nursery species most likely to be affected by the activities within the IOSEA6 Study Areas are those with demersal (bottom dwelling) life stages, e.g. species which lay their eggs on specific seabed types, such as herring, larval or juvenile ages, or species that live in contact with the seabed e.g. sandeel and skates and rays. Sandeel are of particular importance as they are an important component to food webs. Skates and rays are particularly vulnerable to seabed disturbance because they lay their eggs on the seabed, live on the seabed and exhibit slow growth rates, late maturity, low fecundity and productivity which limits their capacity to recover from population declines.

The IOSEA6 Celtic Sea basin is adjacent to the coastal herring spawning site, referred to as the Dunmore East herring spawning grounds. These grounds are the largest spawning grounds in the Celtic Sea (approximately 36 km^2) (O'Sullivan et al., 2013). Atlantic herring is an important commercial fish in Irish waters. In coastal waters spawning takes place mostly between September and February in high energy environments, usually at the mouth and bays of estuaries where tidal currents are strong (O'Sullivan et al. 2013). Which is corroborated by Scientific, Technical and Economic Committee for Fisheries (STECF) landings data for ICES Rectangles 32E3, 32E4 and 33E3. Local knowledge indicates that for Dunmore East the peak season is usually around October/November and December/January (O'Sullivan et al. 2013), corroborated by peak landings in Quarter 4 for ICES Rectangles 32E3, 32E4 and 33E3 (Marine Space, 2018).

Herring are benthic spawners and are reliant on specific benthic spawning habitats with particular substrate types such as gravel and rock (O'Sullivan et al., 2013). The dependency of herring on these specific substrates makes the species potentially susceptible to disturbance.

According to the CEFAS sensitivity maps sandeel nursery grounds could be found within the IOSEA6 Study Areas. Sandeels have a high level of habitat specialisation and studies show preference to medium/coarse grained sands with sandeel absent from sediments with silt contents (Wright, Jensen and Tuck, 2000; Holland et al., 2005; Green, 2017). Sandeels display burrowing behaviour which is thought to help avoid displacement by underwater currents to less suitable areas, to aid with avoiding predation, and to conserve energy (Green, 2017). Additionally, sandeels like herring, are demersal spawners and lay their eggs directly onto the substrate (Wright et al., 2018, 2019). Planktonic larvae are then transported by currents and settle back into the sand as juveniles (Wright et al., 2018, 2019). The presence of sandeel eggs and burrowing sandeels of different life stages, make these habitats susceptible to disturbance. Sandeel are known for their patchy distribution. There are indications that sandeels have a high level of site fidelity and are not successful re-colonisers (Jensen et al. 2011), although some research (Haynes and Robinson 2011) indicates that patch fidelity amongst young sandeel in particular, may be short term.

C.2.3.3 Shellfish

Important Norway lobster (*Nephrops norvegicus*) grounds occur on soft-muddy sediments within the Celtic and Irish Seas. Brown, or edible, crabs are distributed throughout the continental shelf area to the north and west of Ireland and the rocky areas of the Irish and Celtic Sea. Populations of scallops and queen scallops may also occur in areas of gravelly sediments (DCENR 2015). Fisheries data from the Marine Management Organisation (MMO) and STECF fisheries (landings and activity) has found that the Celtic Sea is important for lobster, *Nephrops*, shrimp, crabs, scallops, razor clams and whelks (STECF, 2018; Elliott and Holden, 2018; Marine Space, 2018).

C.2.3.4 Elasmobranchs (sharks, rays and skates)

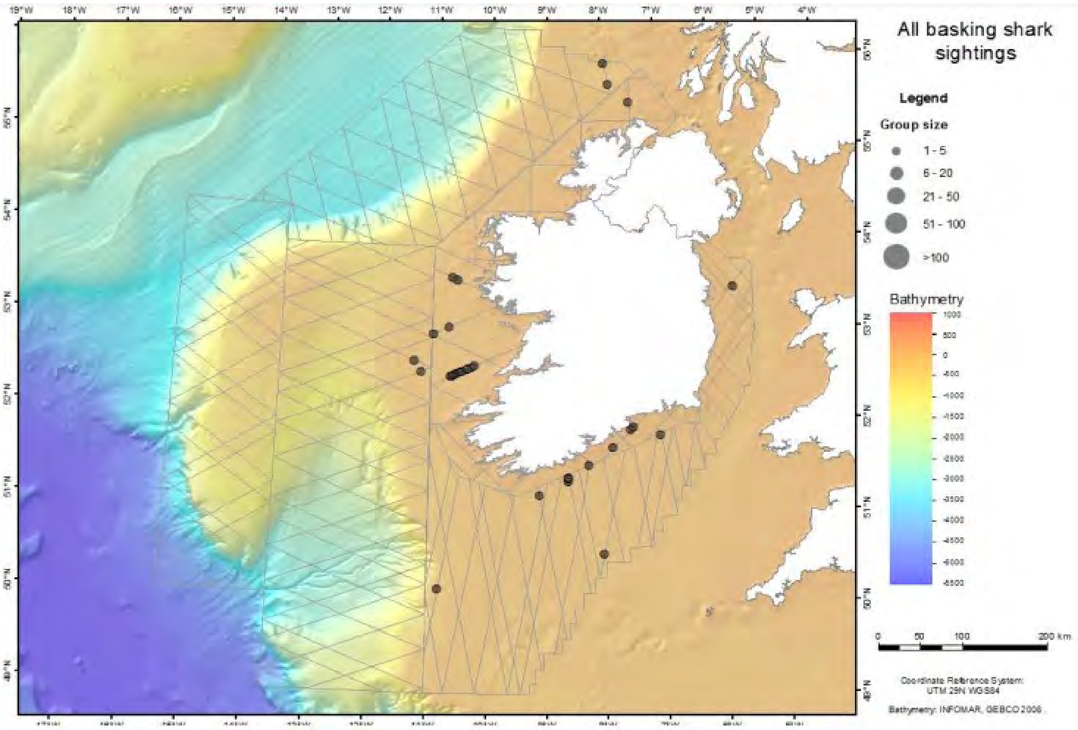
The Irish Elasmobranch Group (IEG) reports that there are 28 species of shark currently known in Ireland (IEG, 2018). The IBTS reports catches of different elasmobranch species such as spotted dogfish (*Scyliorhinus canicular*), cuckoo ray, (*Leucoraja naevus*), spurdog (*Squalus acanthias*), tope (*Galeorhinus galeus),* smooth-hound (*Mustelus mustelus*), thornback ray (*Raja clavate*), spotted ray (*Raja montagui*), nurse hound (*Scyliorhinus stellaris*) (ICES, 2018). Dedman et al., (2015) modelled abundance hotspots for rays in the Irish Sea and the study results predicted the abundance of species such as Cuckoo Ray (*Leucoraja naevus*), Thornback Ray (*Raja clavate*), Blonde Ray (*Raja brachyura*), Spotted Ray (*Aetobatus narinari*) could be found within the Irish Sea which therefore gives potential for these species to be found within the IOSEA6 Study Areas (Dedman et al., 2015; Dedman et al., 2017).

The Flapper (Common) Skate (*Dipturus batis*) is another ray species which previously was a common fish species in the north-east Atlantic however due to overexploitation in fisheries and habitat degradation it is now listed as 'Critically Endangered' on the International Union for Conservation of Nature IUCN Red List of Threatened Species. The species range is now localised to small populations in north-west Scotland, the west of Ireland and deeper waters of the Celtic Sea (ICES, 2008; NatureScot, 2022). Sightings of flapper skate have been recorded on the west coast of Ireland and on the south-east coast indicating that they can occur in the IOSEA6 Study Area (NBDC, 2022)

The basking shark (*Cetorhinus maximus*) is the largest fish in the North Atlantic and the second largest in the world. Results from the ObSERVE project (a three-year aerial survey programme aimed to collect data on the distribution of cetaceans, seabirds and other marine megafauna in Irish offshore waters) have recorded the basking shark in low numbers around St Georges Channel (Figure C-11) (Berrow and Heardman 1994; Solandt and Chassin 2014; Rogan et al. 2018). Most sightings occur in summer months, but it is less clear where they spend the winter. Basking sharks are listed on the OSPAR list of threatened and/or declining species and receive further protection through the Bonn Convention.

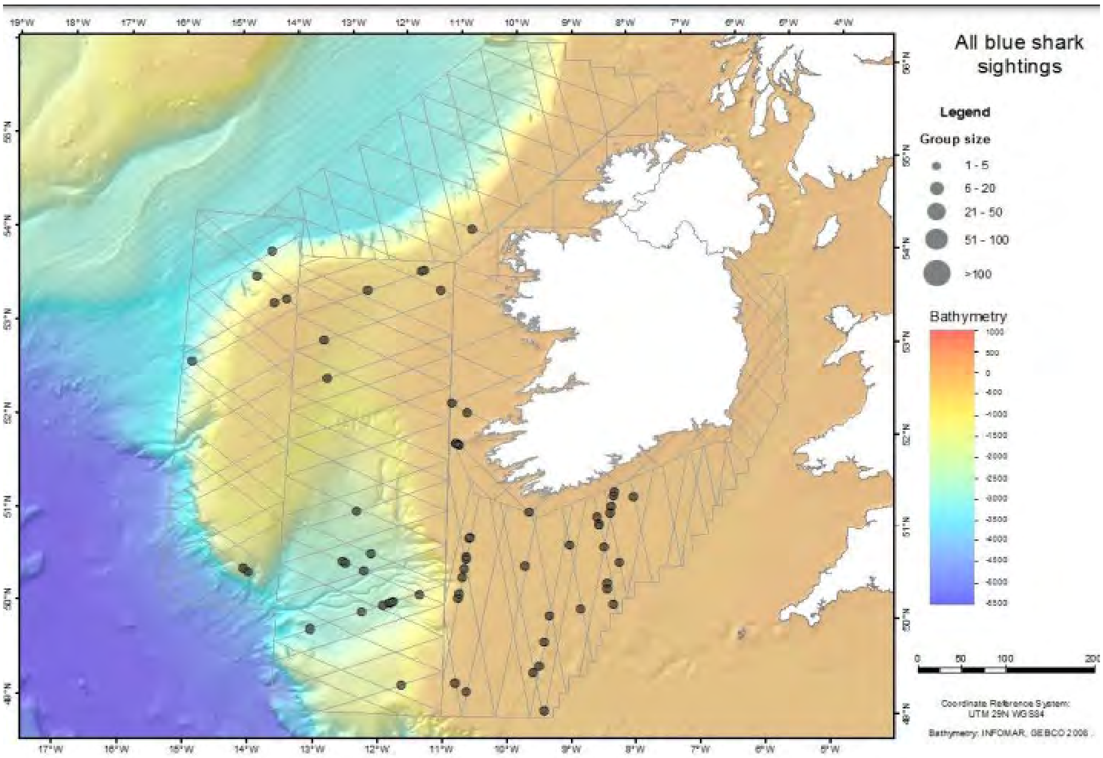
The blue shark (*Prionace glauca*) has also been observed in low numbers in the Irish Sea (ObSERVE, 2015). This species is on the IUCN Red List of Threatened Species as near threatened (IUCN, 2018). Sightings have been recorded off the west and south-west coast of Ireland indicating they may potentially be found within the IOSEA6 Study Areas Slyne-Erris and Porcupine Basin. (Figure C-12) Additionally, a study conducted by Nykänen et al. (2018) used tagging and aerial surveys to provide an unbiased large-scale abundance estimate for blue sharks. Modelling carried out in this study predicted 63% of time spent at the surface in shelf waters, reducing to 14% of time at surface in off-shelf waters (Nykänen et al., 2018). Distance to the continental shelf was a significant factor explaining the variance in the abundance of blue shark distributions with larger numbers predicted in areas around the shallow areas of Porcupine Bank and shelf margin.

Figure C-11 Basking shark sightings



Source: ObSERVE (Rogan et al. 2018).

Figure C-12 Blue shark sightings



Source: ObSERVE (Rogan et al. 2018).

C.2.4 Marine Mammals

Marine mammals present in Irish waters are cetaceans (whales, dolphins and porpoises), pinnipeds (seals) and European otters (*Lutra lutra*). All cetaceans and European otter are European Protected Species (EPS) protected under Annex IV of the EC Habitats Directive (Directive 92/43/EEC), which lists species of Community Interest in need of strict protection. It is an offence to deliberately capture, kill, injure or disturb animals classed as EPS. Harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncates*), grey seal (*Halichoerus grypus*) and common/harbour seal (*Phoca vitulina*) and European otter (*Lutra lutra*) are listed under Annex II of the Habitats Directive, which lists species whose conservation requires the designation of Special Areas of Conservation (SACs).

C.2.4.1 Cetaceans

Twenty-four species of cetacean have been recorded in Irish waters, with ten species known to be present all year round (O'Brien et al., 2009; Berrow et al., 2010).

Most cetaceans are wide-ranging, and individuals encountered within the Celtic Sea form part of much larger biological populations whose range extend into adjacent jurisdictions. As a result, management units (MUs) have been outlined for seven of the common regularly occurring species following advice from the Sea Mammals Research Unit (DECC 2016) and the ICES. These provide an indication of the spatial scales at which impacts of anthropogenic activities should be taken into consideration.

C.2.4.2 Cetacean distribution and abundance

A number of factors determine cetacean distribution and abundance. The availability and distribution of prey (Evans, 1990) is one. The distribution of prey is not uniform in space or time and dynamic physical and oceanographic features prevail to maintain this heterogeneous environment (Ó Cadhla et al, 2004). Water temperature is another factor affecting distribution. In waters over the Irish and UK continental shelf common dolphins and white beaked dolphins share similar diet and habitat preferences, yet the two species maintain niche partitioning based on water temperature (MacLeod et al., 2008; Wall et al., 2006). Some areas of upwelling and tidal races also tend to have higher concentrations of cetaceans (Pierpoint, 2008).

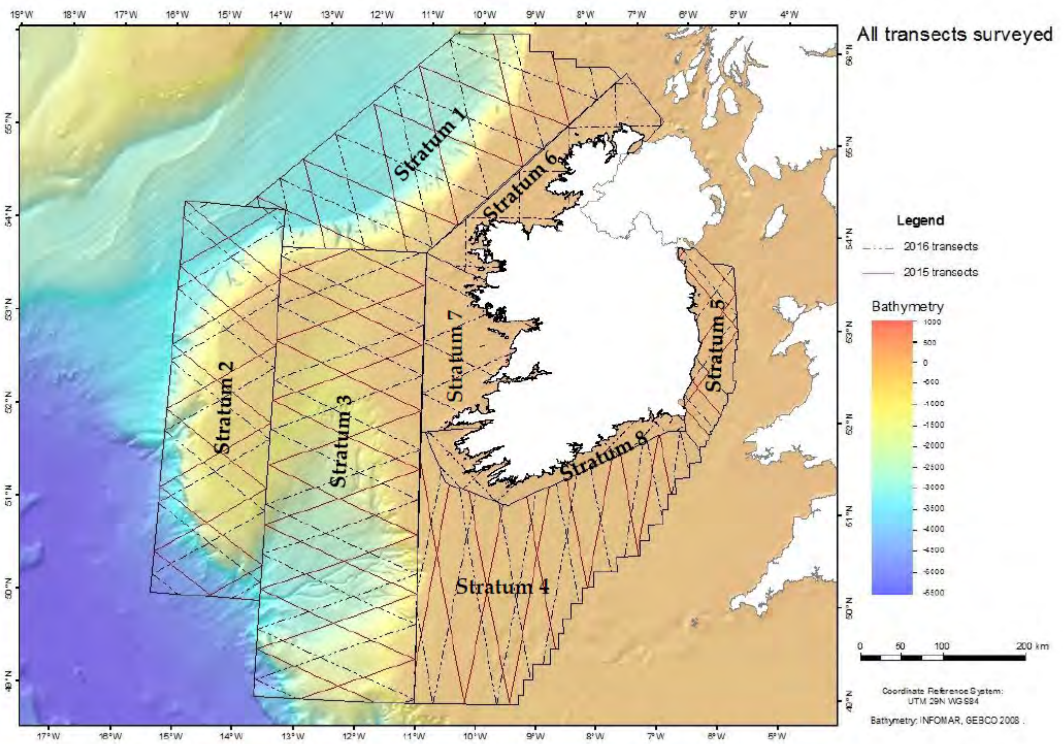
Aerial and acoustic surveys of cetaceans were conducted in the Irish Atlantic Margin between 2015-2016 (Rogan et al., 2018). This survey recorded cetacean occurrence, distribution, and abundance in Irish waters. Figure C-13 shows the aerial transects of the survey area which covers the IOSEA6 Study Areas.

The ObSERVE programme sighted at least 19 cetacean species, sightings were mostly recorded during the winter period and species richness was also higher in winter than in summer months.

Bottlenose dolphins, harbour porpoise and common/striped dolphins were the most frequency sighted odontocete (toothed whale/dolphin) species/species group that were observed during the ObSERVE Aerial survey. The ObSERVE programme predicted distributions of bottlenose dolphins in summer months which showed high concentrations off the south-west coast and south-west offshore waters. They were recorded and predicted with more frequency in all other areas of Irish waters during winter months (Rogan et al., 2018).

Winter months (November–March) in the Porcupine region experience a south-westerly migratory pattern for Humpback whales and an over-winter presence of other cetacean species, such as Fin and Blue whales. There were at least three different species of beaked whales, and sightings and density surface modelling have shown how crucial the Porcupine Basin and the continental shelf margin are to these species in both seasons.

Figure C-13 ObSERVE Aerial transect lines flown in summer and winter 2015 and 2016 in relation to bathymetry (Taken from Rogan et. al, 2018)



The Irish Sea and a region in the middle of the continental shelf, over the North Porcupine Basin, are Cetacean species distribution also varies with water depth and bottom topography (Berrow et al., 2010). Seasonal changes in species distribution are also evident for some species (Pollock et al., 1997). These changes may be related to prey availability, migratory movements or breeding requirements. At certain times of the year, some dolphins, e.g. common dolphin, are abundant along the shelf break at approximately 200 m (Selzer & Payne, 1988; Gowans & Whitehead, 1995). Large baleen whales such as fin and humpback whales migrate seasonally along the Irish shelf edge (Charif & Clark, 2009), with some evidence of feeding activity (Wall et al., 2009). However, these species also feed inshore along the south coast of Ireland and within the IOSEA6 Study Area between June and February each year (Whooley et al. 2011). Large baleen whales are generally scarce in the Irish Sea, with harbour porpoise being the most abundant species; however, minke whale are seasonally present in the Irish Sea (Berrow et al., 2010; Rogan et al., 2018).

Toothed whales, dolphins and porpoises

The diet of toothed cetaceans, which consists mainly of fish and squid, is an important factor in determining their distribution. Harbour porpoises feed on demersal fish, such as herring and have been found in areas associated with herring spawning. Many dolphins show seasonal movements into shallow coastal waters, which may coincide with calving or inshore feeding (Boelens et al, 1999). The distribution of toothed whales also varies with water depth and for some species there is also some seasonal variation in foraging habits (Wall et al., 2006). Harbour porpoise are predominantly found over the continental shelf and shallow offshore banks. Bottlenose dolphins are thought to have two ecotypes; an inshore ecotype spending most of the time in coastal waters and bays, and an offshore ecotype which may be found in offshore shelf waters and abyssal waters. Pilot whales and white-sided dolphins are usually observed in deeper shelf waters and in waters overlying the shelf slopes, where the water depth decreases rapidly. The deep waters and subsea canyon systems to the west of the continental shelf provides suitable habitats for deep-diving species, such as sperm and beaked whales (Berrow, 2002). The harbour porpoise is the smallest cetacean in Irish waters (Irish Whale and Dolphin Group, 2010b) and the most abundant and widespread cetacean species occurring over the continental shelf and all around the Irish coast.

They have a varied diet of herring, mackerel, sprat, pollack, hake, sardines and sand eel; squid and octopus may also be eaten. As they feed predominantly on demersal fish they are rarely found over deep water, but have been recorded over offshore banks (Wall et al., 2006). The population estimate for the Irish Sea is 15,230 (SCANS II, 2008). The density of harbour porpoises in the Celtic Sea has doubled between SCANS I and SCANS II surveys, but this may reflect a change in the overall distribution of porpoises rather than an actual population increase (Aecom & Metoc, 2010). Sightings are common from June through the autumn/winter, but reduced encounter rates from well-watched sites such as Howth Head, Dublin and the Old Head of Kinsale, Cork suggest they move offshore in spring between March and June (IWDG, 2010b). Where they go is unknown, but the fact that encounter rates increase in June, when calves are first recorded suggests they move to offshore calving/breeding grounds.

The common dolphin is the second most frequently recorded cetacean species in Irish waters and within the IOSEA6 Study Area it is most abundant off the south-west coast and in the Celtic Sea (Reid et al., 2003). They are also observed over deeper waters (e.g. continental shelf edge). Abundance estimates in the Irish Sea from the SCANS II survey is 366. Between south-eastern Ireland and west Wales, abundance was estimated at 186 in 2004, 1,644 in 2005 and 2,166 in 2006 (Evans et al., 2007). There appears to be an eastward movement along the south coast during autumn and winter, with sightings peaking off Kerry towards late summer, between September and January off Co. Cork and November to February off Co. Waterford (Berrow et al., 2010). Records from IWDG ferry surveys show a noticeable increase in their numbers in the Irish Sea in the summer and autumn (Berrow et al., 2010).

The bottlenose dolphin in Irish waters appears to have both a coastal and an offshore distribution with highest densities recorded off the western seaboard and in the Celtic Sea (Reid et al., 2003). They are commonly sighted in the Irish Sea and there is a well-studied resident population in Cardigan Bay, Wales. Photo-identification studies suggest that there is a pan-coastal population of bottlenose dolphins which range long distances around all Irish coasts and to the UK (O'Brien et al., 2009). The SCANS II surveys estimated abundances of 235 in the Irish Sea and 5,370 in the Celtic Sea (SCANS II, 2008). There is a small "semi-resident" group at Roches Point, Cork Harbour (Ryan et al., 2010). This is the third most frequently recorded species in Irish waters (Berrow et al., 2010) and they have a year-round distribution with a peak between May and September (this may be due to an increase in observers during these months).

Risso's dolphins occur predominantly in shelf and coastal waters in Ireland. The two areas of highest abundance are for this species are off the south-west and south-east coasts. A breeding population appears to be present in the southern Irish Sea and the species is also regularly recorded around the Isle of Man (Berrow et al. 2010; Baines & Evans, 2009). They have been recorded throughout the year in Irish waters with a wide distribution (Aecom & Metoc, 2010) and there is some evidence of seasonal movements in the Irish Sea (Baines & Evans, 2009). Risso's dolphins feed mainly on squid, cuttlefish and octopus, and small quantities of fish and co-operative foraging has often been observed. The killer whale has been observed off all Irish coasts and in the Irish Sea. Sightings occur predominantly in inshore coastal waters (Berrow et al., 2010). There is some evidence of increased sightings during late summer and autumn, with occasional incidences of killer whales entering harbours and estuaries (e.g. Cork).

The long-finned pilot whale occurs predominantly in the deeper waters of the continental slopes and waters to the west of Ireland. The species breeds in Irish waters and groups have been infrequently recorded in shallower waters off the southern and south-western coasts of Ireland and as far east as the English Channel (Berrow et al., 2010). Sightings in the IOSEA6 Study Area come from February, April, September and October (IWDG, 2011b), reflecting a year-round presence in Irish waters. Dolman et al. (2010) reported on unusually high numbers of strandings of this species off the south-western Irish coastline in the first half of 2008.

Species rarely observed in the IOSEA6 Study Area include the northern bottlenose whale, striped dolphin, white beaked dolphin and white sided dolphin. Beaked whales and sperm whales are typically found in deeper water habitats to the west of the IOSEA6 Study Area but also in slope and canyon habitat bounding the IOSEA6 Study Area to the south. Pygmy sperm whale strandings have occurred of the south-western Irish coast (IWDG, 2011a), indicating a distribution for this species in deep water, slope and canyon habitat to the south-west of Ireland.

Baleen whales

The distribution of prey is an important factor in the distribution of baleen whales. They typically feed on krill and pelagic schooling fish species and their distribution is often related to oceanographic features such as fronts, upwellings and associated areas in which prey availability is high. Some species also eat squid depending on the season. In the summer months, minke whales for example feed mainly on fish in the inshore waters around the UK and Ireland (Pollock et al., 1997).

A number of baleen whales have been recorded from the IOSEA6 Study Areas, particularly off the southern Irish coast and over the Celtic Deep. The minke whale is the most widespread and frequently recorded baleen whale in Irish waters. They are present mainly from April to November and occur along all Irish coasts, most commonly off the south and south-west of Ireland (Reid et al., 2003; Berrow et al., 2010). Sighting concentrations occur in the Irish Sea from May to July (IWDG, 2011b).

Minke whales have the most varied diet of all baleen whales, feeding on various small fish, including capelin, sand eel, herring and cod; they may also feed on small squid (IWDG, 2011d). Minke whales have been stranded on every coastline in Ireland with the stranding incidence reflecting their distribution and temporal occurrence (IWDG, 2011a).

Fin whales are seasonally abundant in shelf edge waters to the west of Ireland and in shelf waters off the southern coast of Ireland. Sightings of migrating animals off the west coast peak in December and January (Charif & Clark, 2009) and feeding aggregations have been recorded along the shelf slopes (Wall et al., 2009). Fin whales forage from June to February off the south coast, generally moving eastwards with the passing months. The high level of site fidelity and inter-annual occurrence of individuals along the southern Irish coast indicate that these inshore waters are an important foraging habitat for fin whales (Whooley et al., 2011). The fin whale is the second-largest living animal on earth, second only to the blue whale and dwarfing the most abundant baleen whale in Irish waters, the minke. Fin whales have a varied diet, comprising fish species such as herring, mackerel, cod, sand lance, squid and capelin, but young whales may take small invertebrates like krill and copepods.

Humpback whales have been recorded in small numbers inshore off all coasts including the Irish Sea, with the majority of sightings occurring along the Cork coast (Berrow et al., 2002). It has also been recorded in St. George's Channel and the Irish Sea (IWDG, 2011c). Singing individuals have been recorded between October and March moving south-westerly, suggesting that the offshore waters off the west coast of Ireland are a migratory route (Charif et al., 2001; Charif & Clark, 2009). Repeat sightings of individuals show high site fidelity along the south coast (Whooley et al., 2005).

The blue whale and sei whale are typically found in deeper waters over the continental shelf on the west coast of Ireland. Acoustic data show a southward migration of blue whales occurs each winter, peaking in November/December (Charif & Clark, 2009). Blue whales have been sighted feeding on krill on the slopes of the Porcupine Bank and Seabight, to the west of Ireland (Wall et al., 2009). Sei whales are rarely encountered in Irish waters; however, this species is prone to episodic influxes (Schilling et al., 1992), and the last recorded influx in Irish waters appears to have occurred around 1999/2000 in the Porcupine Seabight (Ó Cadhla et al., 2004).

C.2.4.3 Pinnipeds

The grey seal and harbour seal (also known as the common seal) are the two seal species native to Irish waters. Both species have established themselves in terrestrial colonies (or haul-outs) along all coastlines of Ireland, which they leave when foraging or moving between areas and to which they return to rest ashore, rear young, engage in social activity, etc. The haul-out groups of harbour seals have tended historically to be found among inshore bays and islands, coves and estuaries (Lockley, 1966; Summers, 1980), particularly around the hours of lowest tide. The grey seal breeds on exposed rocky shores, on sand bars or in sea caves with ready access to deep water. Other haul-out areas for the grey seal are located on exposed rocky areas or steeply shelving sandbanks.

Grey seal typically breed on remote uninhabited islands or coasts and in small numbers in caves between September and December. Grey seal moulting occurs approximately 3-5 months after the end of the breeding season. Harbour seal often haul out onto tidally exposed sandbanks to rest, moult and suckle their young. Pupping tends to occur between June and July, followed by moulting which takes approximately 4-5 weeks.

The estimated at sea distribution of grey and harbour seal has been mapped in a study by Russel et al. (2017) and is shown in Figures C-14 and C-15 below. As the figures illustrate, there is an estimated mean at sea grey seal usage around the Irish coast between 1 and 50 individuals per 5km^2. The Saltee Islands in Co. Wexford hosts a grey seal breeding population, with the most recent estimate in 2005 indicating the site supports a population of 571-744 individuals (National Parks and Wildlife Service, 2013c). Additionally, higher densities on the east coast of Ireland may be linked to the Welsh populations of grey seal with interchange between populations across the Celtic and Irish Sea (Lidgard et al., 2000).

Figure C-14 Grey seal at-sea usage: mean (Russell et al. 2017)

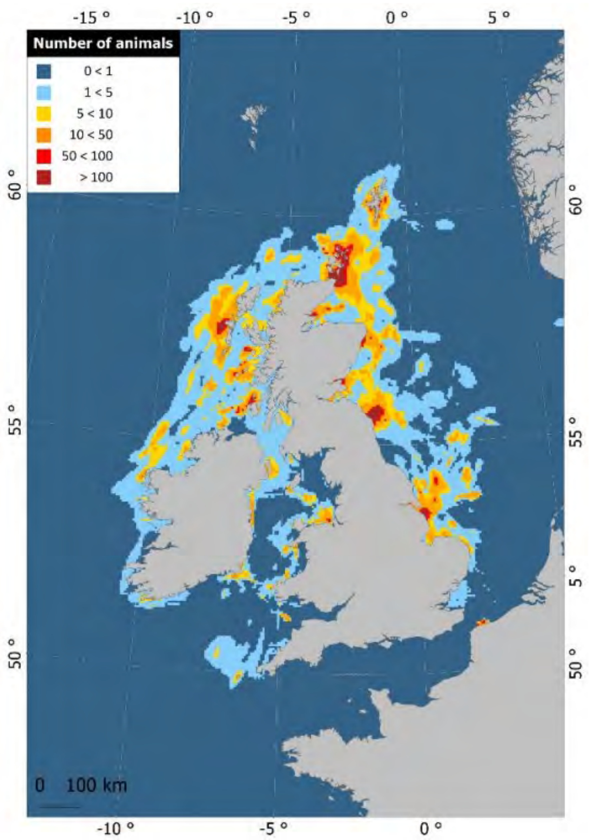
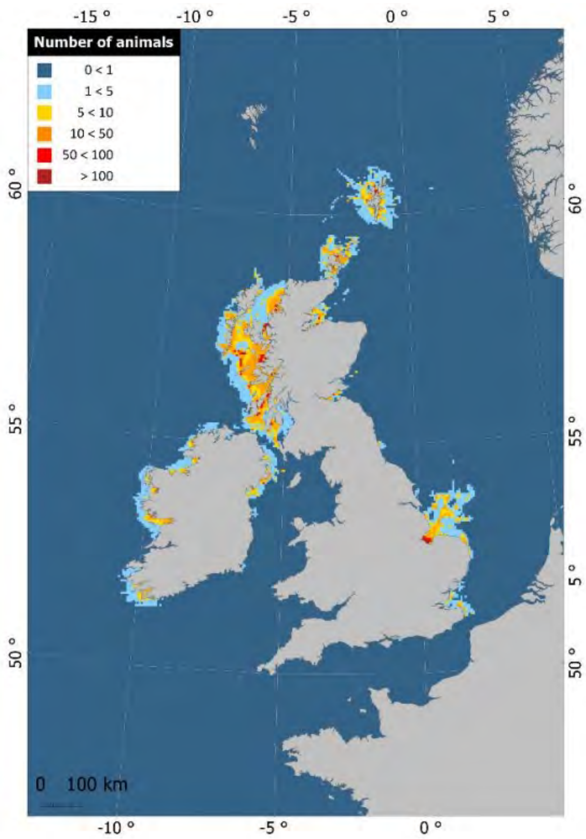


Figure C-15 Harbour seal at-sea usage: mean (Russell et al. 2017)



Walruses (*Odobenus rosmarus*) are also visitors to Atlantic waters with eight sightings recorded in the Republic and Northern Ireland since 1979 on the National Biodiversity Data Centre (NBDC). Most recently a walrus was sighted multiple times along the Irish coast in 2021 (IWDG, 2021). Due to the sporadic observations their presence within the IOSEA6 Study Areas cannot be ruled out (Ó Cadhla, pers comm; Cotton, 2007).

European otter

In Ireland, otter can be found in a range of aquatic habitats, including lakes, rivers, streams, estuaries, marshland, canals, and along the shore. Coastal otters require access to a freshwater supply because they must clean their fur of salt on a regular basis, which might affect its insulating characteristics. The Eurasian otter is in decline throughout its native range, however in Ireland populations are at their densest (Conserve Ireland, 2018). The majority of European otter populations are designated as fragile, declining, or extinct, making the Irish population all the more vital (Conserve Ireland, 2018).

The Eurasian otter has the widest distribution of all otter species, with its range covering parts of three continents: Europe, Asia and Africa (Bailey & Rochford, 2006). The extensive low rocky shores along parts of the southern coast of Ireland provide ideal habitats for otter populations, which often breed and rear their young within easy reach of the shore (Scollick, 1999). Otters are found on all coasts of Ireland and can exist at high densities in suitable coastal habitats and offshore islands (Yoxon, 2008).

European otter are protected within Ireland under the Wildlife Amendment Act (2000) where it is illegal to hunt, disturb, or intentionally kill otter. The otter is also listed on Annex II and Annex IV of the EU Habitats Directive (92/43/EEC).

C.2.5 Birds

Large numbers of seabirds occur in Irish waters year-round, with some species only present during the breeding season, over winter or during migration. The exposed and inaccessible coast of Ireland provides a perfect breeding habitat for many seabird species. In addition to this, coastal and offshore Irish waters provide local breeding and non-breeding seabirds, along with pelagic and passage migrants, with a rich source of nutrition, particularly near coastal upwelling and frontal systems such as along the Irish Shelf. The importance of these coastal areas for seabirds is reflected in the designation of some areas as Special Protection Areas (SPAs) or Ramsar sites (see Section C1.6).

The waters off western and southern Ireland are also internationally important fishing grounds and important nursery and spawning areas for fish and invertebrate species and as a result they are areas of concentration for foraging seabirds (Boelens et al., 1999).

Shearwaters (*Procellariidae*), gannets (*Procellariidae*), gulls and terns (*Laridae*) and auks (*Alcidae*) are common in the IOSEA6 Study Area. The majority of these birds breed in colonies located on the south-west, south and east coasts of Ireland while others overwinter in Irish waters. Other species such as some species of shearwater and skua are passage migrants that use the area as a migratory corridor.

At least 45 species of seabird (including divers and grebes) have been recorded during at-sea surveys in Irish waters, of which 23 species regularly breed around Ireland (Pollock et al 2008, Mackey et al 2004). In addition, a further 59 species of waterfowl and wader regularly occur at coastal sites such as estuaries around Ireland; including five grebe species, two heron species, 26 species of wildfowl and 26 wader species (Crowe 2005). Some of these species are migratory and are present only during migration periods in spring and autumn; others come to Ireland to breed or to spend the winter, while some are resident all year round.

C.2.5.1 Seabird Distribution

Physical factors including water depth, wind and weather, water movement, sea temperature and salinity also influence seabird distribution (O'Driscoll, 1998; Amorim et al., 2009).

The ObSERVE programme, a low-level aerial survey programme in the Irish Sea, determine winter, breeding and post-breeding density and abundance estimates for key seabird species, as well as the identification of important marine areas for seabird species, overall species richness and diversity.

Aerial surveys of Ireland's offshore and coastal waters were completed by Rogan et al. (2018) during the summer and winter period of 2015 and 2017 across the entire IOSEA6 Study Area. Over the survey period, a total of 24 seabird species or species groups were identified. Some seabird species were sighted infrequently, including great skua (*Stercorarius skua*), black guillemot (*Cepphus grille*) and scoter (*Melanitta* spp.), with other species observed during all seasons. Auk species (comprising razorbill, *Alca torda*, common guillemot, *Uria aalge*, guillemots, and Atlantic puffin, *Fratercula arctica*), northern fulmar (*Fulmarus glacialis*), northern gannet (*Morus bassanus*), and black-legged kittiwake (*Rissa tridactyla*) were the most frequently sighted and abundant species across all surveys. Shearwaters, terns and petrel species were mostly limited to summer surveys, while scoters, divers, and gull species were more common in winter surveys.

An additional ObSERVE study focused on the east coast in the Irish Sea identified 29 species of birds (Table C-11).

Table C-11 Seabird sightings summary for low level aerial surveys for seabirds in the Irish Sea in summer, autumn and winter 2016. Sight. indicates the number of sightings, Indivs. Indicates the total number of individuals counted. (Table taken from Jessop et al., 2018)

Species	Summer		Autumn		Winter	
	Sight	Indivs	Sight	Indivs	Sight	Indivs
Northern gannet	194	331	445	828	27	35
Cormorant/shag*	53	255	50	182	71	106
Northern fulmar	41	59	571	1337	75	137
Great skua			3	4	1	1
Herring/ common gull*	207	568	145	890	412	1268
Black-headed gull	9	17	12	67	49	214
Lesser black-backed gull			25	31	8	8
Greater black-backed gull			74	95	34	48
Black-backed gull spp	55	77	42	88	72	171
Little gull					37	80
Black-legged kittiwake	309	499	326	1355	310	567
Large gull spp	9	43	41	724	62	579
Small gull spp	38	63	31	763	97	144
Manx shearwater	790	3669	80	1062	2	5
Shearwater spp	3	7			2	4
Petrel spp	1	1	7	9		
Atlantic puffin	23	26	1	1		
Black guillemot	5	6	2	6		
Razorbill/guillemot*	1800	3849	3496	16444	2245	4470
Auk spp	20	135	2	31		
Arctic/Common tern*	299	498	144	737		
Roseate tern	66	131	13	34		
Sandwich tern	39	60	21	30		
Little tern	52	72	23	65		
Tern spp	7	8	1	4		
Common scoter			31	855	41	328
Velvet scoter			6	9	9	30
Scoter spp			6	45	4	11
Diver spp	4	4	115	879	170	252

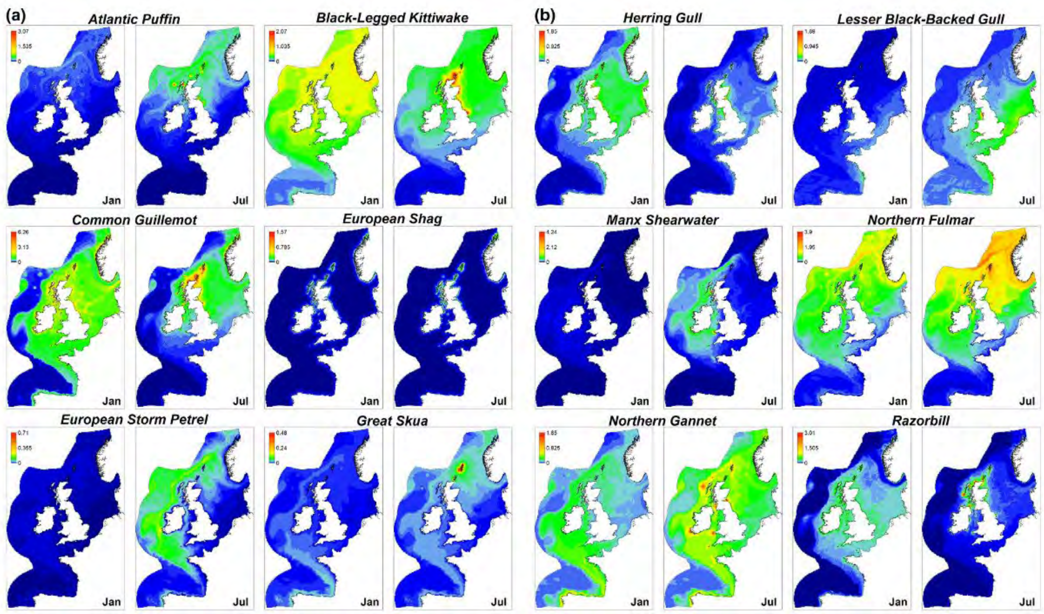
* The survey report indicates that when individuals could not be identified to species level, they were grouped into higher taxa categories, for example common/herring gull (*Larus* spp.), cormorant/shag, large gull species, tern species etc. Where

unidentified species are reported, numbers indicate only those individuals that could not be identified, and not all birds that would fall into the category (e.g. 'tern species' only includes those individuals that could not be identified to lower taxonomic level, and will not be included unless otherwise identified).

Species of high density include Northern fulmar along the south coast, and several unidentified gull species. Petrels were present in the highest densities within 300km of the coast during the summer breeding period, particularly in the Celtic Sea off the south coast of Ireland. Auk species were widely distributed in winter through the Celtic Sea, particularly to the south-east of Ireland. The continental shelf waters of the Celtic Sea are an area of high-seabird density and consistently have the highest summer densities and abundance compared to other areas off the coast of Ireland (Rogan et al., 2018).

A study conducted by Waggit et al. (2020) provides seabird distribution maps at basin and seasonal scales and provides a representation of the distribution patterns of seabirds within the IOSEA6 Study Area in January and July (Figure C-16). Black-legged kittiwake, herring gull, common guillemot, manx shearwater, northern fulmar, European storm petrel, northern gannet and razorbill, are the species predicted with highest densities.

Figure C-16 Spatial variation in predicted densities (animals per km2) of seabird species in January and July in the North-East Atlantic. Values are provided at 10 km resolution. A different colour gradient is used for each species (Taken from Waggitt et al., 2020)



The most important bird populations are protected with designated sites including SPAs, Ramsar sites and Natural Heritage Areas (NHA). The closest SPA to any of the IOSEA6 Study Areas is Lady Islands Lake SPA (IE0004009) located 20 km away from the IOSEA6 Celtic Sea Basin. The SPA is designated for the following special conservation interests (SCI) (NPWS, 2015):

- Gadwall Anas strepera
- Black-headed Gull Chroicocephalus ridibundus
- Sandwich Tern Sterna sandvicensis
- Roseate Tern Sterna dougallii
- Common Tern Sterna hirundo
- Arctic Tern Sterna paradisaea

C.2.6 Designated sites and species

A very wide range of species and habitats are afforded legal protection within the IOSEA6 Study Area, adjacent waters and coastal regions. The Habitats and Birds Directives (92/43/EEC and 79/406/EEC), the Convention on Wetlands 'Ramsar' 1975, the Bonn Convention 1997, the OSPAR Convention 1992 and the United Nations Convention on Biodiversity (the Rio Convention) 1992 provide the international framework for domestic policy on nature conservation. In Ireland, nature conservation is covered by the Wildlife Act and its subsequent Amendments (2000, 2005, 2010 and 2012), the European Community (Conservation of Wild Birds) Regulations.

There are a total of 913 protected areas in Ireland, 604 Natura 2000 sites - 165 Special Protection Areas (Birds Directive) and 439 Sites of Community Importance (Habitat Directive) - as well as 309 sites designated under national laws and 2.25% of these protected areas cover marine waters (Biodiversity Europe, 2022).

C.2.6.1 Special Areas of Conservation and Special Protected Areas

The European Union's Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna), in conjunction with the Birds Directive (Council Directive 79/409/EEC on the conservation of wild birds) is the main legal tool of the European Union for nature conservation. The stated aim of the Directive is to contribute to the maintenance of biodiversity within the European territory of the Member States through the conservation of natural habitats and of wild fauna and flora of Community interest.

The Habitat Directive seeks to establish a network of protected areas throughout the European Community. It is the responsibility of each Member State to designate Special Areas of Conservation (SACs) to protect habitats and species, which, together with the Special Protection Areas (SPAs) designated under the EU Birds Directive, form the Natura 2000 site network. Annex I of the Directive covers habitats, Annex II covers species, Annex IV the species in need of strict protection and Annex V the species whose taking from the wild can be restricted by European law. The Habitats Directive was transposed into national legislation by the European Communities (Natural Habitats) Regulations 1997 (SI 94 of 1997) which was since revoked and replaced by the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011).

The location of offshore SACs in relation to the IOSEA6 Study Area, including those in neighbouring States, is shown in Figure C-17 (Drawing Reference: P2510-PROT-004-A). Note that there are three habitats listed in Annex I of the Habitats Directive that might potentially occur in the offshore areas of the Irish and Celtic Seas:

- Sandbanks which are slightly covered by sea water all the time;
- Reefs; and,
- Submarine structures made by leaking gases.

Ireland currently has no offshore SACs or SPAs within the IOSEA6 Study Area. The closest of these, the Belgica Mound Province SAC (IE002327) located on the west of Ireland approximately 1 km east of the IOSEA6 Porcupine Basin located on the eastern edge of the Porcupine Seabight. The site is designated for the qualifying interest reefs (biogenic) of cold-water coral. In this area, *Madrepora oculata* and *Lophelia pertusa* are the main reef-forming coral species. A spectacular array of epibionts, including hydroid, bryozoan and glass sponge *Aphrocallistes* sp. species, are found attached to coral colonies. Gorgonian coral *Acanthogorgia* sp., *octocoral Anthotela* grandiflora, eunicid polychaetes, crustaceans *Bathynectes* sp. and *Pandalus* sp., *stylasterid* colonies *Pliobrothus* sp. sometimes with attached gastropods *Pedicularia* sp., unattached gastropods Clio sp. and Diacria sp., sea urchins Cidaris sp. and bivalves *Chlamys sulcata* and *Delectopecten vitreus* are also present.

The west coast of Ireland is a highly indented complex of headlands, embayments and estuaries with a diverse range of shore types and exposures to the Atlantic. This diverse coastline supports a rich variety of habitats and species. Much of the coast is designated as SACs for a range of marine features including seals, otters, reefs, large shallow inlets and bays, lagoons, marine caves, intertidal sand flats and salt marsh. Breeding sites for a number Annex I bird species including Arctic terns, storm petrels and barnacle geese have been designated as SPAs. The region is important for shorebirds and for breeding populations of the shag, puffin, Manx shearwater, razorbill and great black-backed gull

C.2.6.2 Transboundary protected areas

The UK currently has 116 SACs with marine components 25 of which are partly or wholly within UK offshore waters, and 125 SPAs with marine components. The UK SACs have the potential to be impacted by the plan as they are designated for mobile species. The closest of which is the West Wales Marine / Gorllewin Cymru Forol (UK0030397) is designated for harbour porpoise and located 19.8 km from the IOSEA6 Celtic Sea Basin. Impacts will mostly be due to activities occurring in the IOSEA6 Celtic Sea basin. The Cardigan Bay SAC (located 59.4 km east of IOSEA6) holds a resident population of bottlenose dolphins which can range long distances between the UK and Irish coasts (O'Brien et al., 2009). Pembrokeshire Marine SAC (located 20 km east of IOSEA6) holds a population of grey seals which are known to travel across the Irish Sea between the UK and Irish coasts (Hammond et al., 2005). These designations and interests highlight the sensitivity of the coastal area, which, despite its distance from the IOSEA6 Study Area, is regarded as vulnerable to events such as hydrocarbon spills.

The nearest UK SPA to the IOSEA6 site is the Skomer, Skokholm and the Seas off Pembrokeshire (UK9014051) approximately 31.6 km from the IOSEA6 Celtic Sea Basin.

These designations will be taken into account further through appropriate assessment following Habitats Regulations Assessment (HRA) screening. Interest features of SPAs include highly mobile and long range foraging species such as Manx Shearwater, which are recorded to have a range of 1346.8 km (Woodward et al. 2019). Aberadon Coast SPA located 45.5km east of the IOSEA6 Celtic Basin) designates Manx shearwater as a conversation interest which could be impacted by IOSEA6 activities. Spilled oil and chemicals at sea can have a number of environmental and economic impacts, the most conspicuous of which are on seabirds and marine mammals; however, any spill reaching shore would impact directly upon habitats. Sites such as Grassholm (36.1 km east) designated for northern gannet and Ramsey and St David's Peninsula Coast SPA (located 36.1 km east) are in close vicinity to the IOSEA6 Celtic Sea basin, which gives potential for the SPA site objectives to be impacted.

Other transboundary protected sites include Marine Conversation Zones (MCZs) (Figure C-17 (Drawing Reference: P2510-PROT-004-A)). Designated under the Marine Coastal Access Act 2009, these are areas aim to protect a range of UK important, rare or threatened habitats and species. There is only one MCZ located in Wales which is the Skomer MCZ located 48km south-east of the IOSEA6 Celtic Sea Basin. This site protects seabirds such as puffins, guillemots, razorbills and gannets, additionally the area is used as a haul out site during breeding season for grey seals (NRW, 2022). There are in total 91 MCZ in English waters and the nearest sites to the IOSEA6 the south-east of the IOSEA6 Celtic Sea Basin. The closest of these sites is the South of Celtic Sea Deep MCZ (40.7 km away), which is protected for the following benthic habitats moderate energy circalittoral rock, subtidal coarse sediment, subtidal mixed sediments and subtidal sand. The varied nature of the seabed within this site means it supports a wide range of animals, such as worms, bivalve molluscs (for example scallops and clams), starfish, anemones, and a variety of fish such as John Dory, haddock and angler fish (Defra, 2019). In Northern Ireland there are five inshore MCZs, the nearest site to the IOSEA6 Study Area is Carlingford Lough MCZ (located 211 km north of the IOSEA6 Celtic Sea Basin). The site is protected for benthic habitat of Subtidal (sublittoral) mud: sand slugs (*Philine aperta)* and slender sea pen (*Virgularia mirabilis)* in soft stable infralittoral mud.

C.2.6.3 OSPAR Marine Protected Areas

A key element of OSPAR Annex V 'On the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area' is the development of an ecologically coherent network of Marine Protected Areas (MPAs). OSPAR aimed to have this established by 2010.

The network is intended to make a significant contribution to the sustainable use, protection and conservation of marine biodiversity including in areas beyond national jurisdiction (OSPAR recommendation 2003/3). Habitats which have been specified as in decline and or threatened in OSPAR Region V (wider Atlantic) and may be of potential relevance to the west of Ireland are:

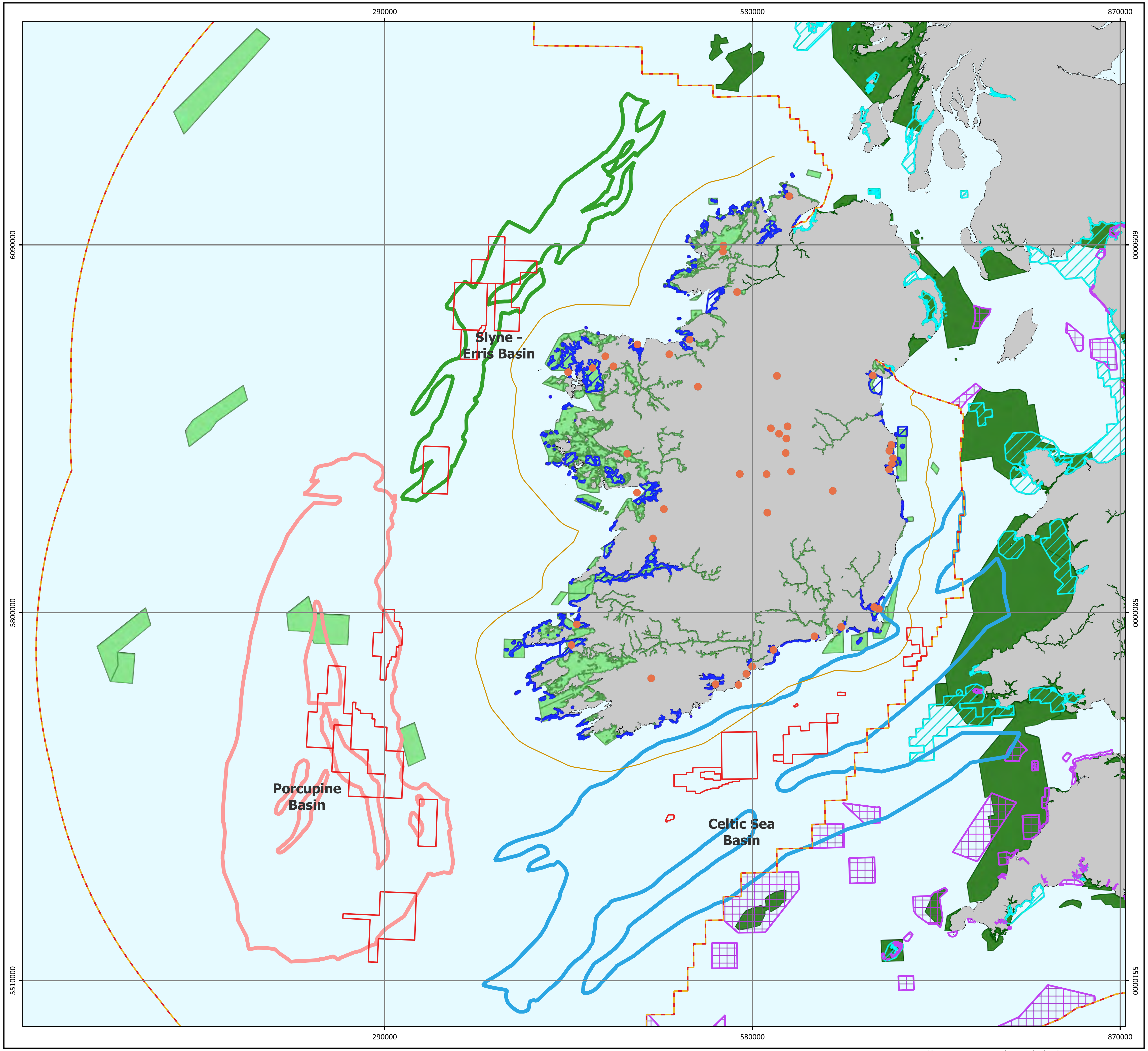
- carbonate mounds;
- deep sea sponge aggregations;
- Oceanic ridges with hydrothermal vents/fields;
- *Lophelia pertusa* reefs;
- *Modiolus modiolus* beds; and,
- Seamounts.

Those habitats which have been specified as in decline and or threatened in OSPAR Region III (Celtic Seas) and may be of potential relevance to the west of Ireland are:

- deep sea sponge aggregations;
- *Lophelia pertusa* reefs;
- Maerl beds;
- seapen and burrowing megafauna communities;
- intertidal mudflats;
- intertidal *Mytilus edulis* beds on mixed and sandy sediments;
- *Ostrea edulis* beds;
- Zostera beds;
- Maerl beds;
- *Sabellaria spinulosa* reefs; and,
- *Modiolus modiolus* beds.

C.2.6.4 RAMSAR Marine Protected Areas

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Convention's mission is the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world (Ramsar, 2002). One of the criteria for international importance is that the site regularly (i.e. over a period of five years) holds 1% of the biogeographic population of a species or 20,000 individuals. A total of 45 sites have been identified as Ramsar sites in Ireland as wetlands that are of significant value for nature (RAMSAR, 2022). The closest of these to any IOSEA6 Study Area is the Raven (3IE010) in Co. Wexford located approximately 43 km north-east of the IOSEA6 Celtic Sea Basin (northern edge).



IOSEA6 - ENVIRONMENTAL REPORT

PROTECTED SITES

Study Area and Protected Sites

Drawing No: P2510-PROT-007	B

Legend

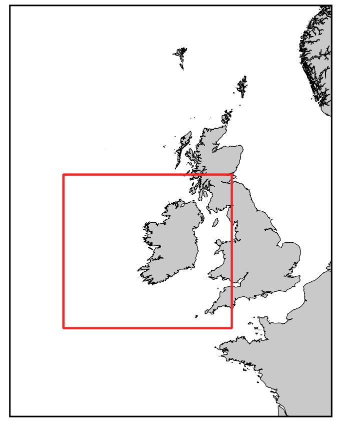
- IOSEA6 Area
- 12 NM Limit
- EEZ Boundary

Protected Sites

- RAMSAR Sites
- NPWS SAC
- NPWS SPA
- JNCC SAC
- JNCC SPA
- UK MCZ

Offshore Geological Basins copy

- Celtic Sea Basin
- Porcupine Basin
- Slyne - Erris Basin



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Coordinate System	ED50 / UTM zone 29N
WKID	EPSG:23029
Scale @A3	1:3,000,000
Data Sources	NPWS, DECC, JNCC, NIEA, GEBCO, NE, NRW
File Reference	J:\P2510\Mxd\02_PROT \P2510-PROT-004.qgz
Created By	Emma Kilbane
Reviewed By	Emma Langley
Approved By	Emma Langley

An Roinn Comhshaoil, Aeráide agus Cumarsáide
Department of the Environment, Climate and Communications

intertek

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C.2.7 Marine Reptiles

C.2.7.1 Turtles

There are few recordings of sea turtle species in Ireland. Of the seven sea turtle species, leatherbacks (*Dermochelys coriacea*) are recorded annually as they forage widely in temperate waters, visiting Irelands coast in summer and autumn. A study of leatherback relationships with jellyfish aggregations in Irish and Welsh waters was conducted in 2006. They reported from a historical dataset, the TURTLE Database; 1950-2005, that there were 143 individuals observed between Irish and Welsh waters (Houghton et al., 2006; CSIP, 2021. 125 individuals sighted between the months of July and September, indicating a high degree of seasonality Biodiversity Ireland highlights the distribution of leatherback records around the coast of Ireland but with low numbers. The coast of Ireland has one record per 10 km with only one hotspot off the coast of Co. Cork which indicates higher records (70-111 individuals sighted). It is likely that the Ireland observations are underrepresented on the TURTLE database (Pierpoint, 2000). A review of turtle occurrences by Botterell et al (2020) reports less than 120 sightings, strandings and captures of leatherback turtles along the west coast of Ireland between 1910 and 2018.

The Cetacean Strandings Investigation Programme (CSIP) and the Turtle Implementation Group (TIG) produce a report on the annual strandings and sightings of Marine Turtles (Penrose, Westfield and March, 2022). The latest report is for 2021 and reports on all species of marine turtle. The report gives the number of observations over an 11 year period which is from 2011-2021. In the Ireland leatherback was the most commonly observed species (98 sighting) across the 11 year period . In comparison with the previous observation period (2001 – 2011) the more recent figures have decreased in the past eleven years (Penrose, Westfield and March, 2022). The report states that the decline in observation of leatherback turtles is most likely due to reduced effort in recording (Table C-12).

Table C-12 Eleven-year comparison of turtle observations in the UK and Republic of Ireland. 1. Indicates the first eleven year period from 2001-2011 and 2 indicates the second period from 2011-2021 (Adapted taken form Penrose, Westfield and March, 2022)

Country	GT		HB		KR		LBT		LOG		OR		UNI	
1. 2001-2011 **2. 2011-2021**	1	**2**	1	**2**	1	**2**	1	**2**	1	**2**	1	**2**	1	**2**
England	1	**0**	0	**0**	3	**14**	155	**98**	30	**20**	0	0	58	26
Scotland	2	**2**	0	**0**	4	**6**	84	**42**	32	**5**	0	0	11	3
Rep. of Ireland	1	**0**	0	**0**	1	**4**	164	**72**	30	**17**	0	0	16	3
Wales	0	**4**	0	**0**	3	**12**	75	**54**	15	**7**	0	1	11	1
Channel Islands	1	**0**	0	**0**	0	**1**	0	**2**	1	**2**	0	0	2	0
N. Ireland	0	**0**	0	**0**	0	**0**	8	**1**	0	**0**	0	0	2	1
Isle of Man	0	**0**	0	**0**	0	**0**	16	**3**	0	**3**	0	0	4	0
Offshore	0	**0**	0	**0**	0	**0**	5	**4**	0	**1**	0	0	1	1
Total	5	**6**	0	**0**	11	**37**	507	**276**	108	**55**	0	**1**	105	**35**

GT = Green turtle, HB = Hawksbill turtle, KR = Kemp's ridley turtle, LBT = Leatherback turtle, LOG = Loggerhead turtle, OR = Olive ridley turtle, UNI = Unidentified turtle.

*The offshore values account for observations which cannot be allocated to a specific country

C.2.8 Invasive Non-Native Species

Invasive Non-Native Species (INNS) can potentially threaten biodiversity and ecosystem functions. A report conducted by NBDC assessed the risk of 377 recorded INNS in Ireland (O'Flynn, Kelly and Lysaght, 2014). Of the 377 species 66% of the species were at risk of low impact, 21% ranked with a risk of medium impact and 13% ranked as having a risk of high impact. Twelve percent of all high and medium impact species occur in the terrestrial environment (O'Flynn, Kelly and Lysaght, 2014). It should be noted that report advised on limitations of assessing marine INNS as there was a lack of marine data.

The Invasive Species Northern Ireland website (ISNI, 2022) lists the below invasive species as established in Irish waters:

- Wire weed (*Sargassum muticum*)
- Wakame (*Undaria pinnatifida*)
- Smooth cordgrass (*Spartina anglica*)
- Slipper limpet (*Crepidula fornicate*)
- Pacific oyster (*Magallana gigas*)
- Leathery sea squirt (*Styela clava*)
- Japanese skeleton shrimp (*Caprella mutica*)
- Devil's tongue weed (*Grateloupia turuturu*)
- Carpet sea squirt (*Didemnum vexillum*)

In addition, the DAERA Marine Map Viewer highlights records of INNS species around the coast of Northern Ireland (if a common name is not listed, brief description added for reference):

- Red Algae (*Antithamnionella spirographidis*)
- Red Algae (*Antithamnionella ternifolia*)
- Honeycomb Aplidium (*Aplidium glabrum*)
- Red harpoon weed (*Asparagopsis armata*)
- Modest barnacle (*Austrominius modestus*)
- Hook weed (*Bonnemaisonia hamifera*)
- Colonial ascidian (*Botrylloides diegensis*)
- Bryozoan (*Bugula fulva*)
- Brown bryozoan or common bugula (*Bugula neritina*)
- Bryozoan species (*Bugula simplex*)
- Chinese hat snail or Chinese hat shell (*Calyptraea chinensis*)
- Pom-Pom Weed (*Caulacanthus ustulatus*)
- Creephorn (*Chondracanthus acicularis*)
- Bamboo worm (*Clymenella torquate*)
- Dead Man's Fingers (*Codium fragile fragile*)
- Oyster Thief (*Colpomenia peregrina*)
- Ponto-Caspian freshwater hydroid (*Cordylophora caspia*)
- Orange-tipped sea squirt (*Corella eumyota*)
- Pacific Oyster (*Crassostrea gigas*)
- Orange-striped green sea anemone (*Diadumene lineata*)
- A free-living benthic ostracod (*Eusarsiella zostericola*)
- Gammarid amphipod (*Gammarus tigrinus*)
- Polychaete species (*Goniadella gracilis*)
- Red algae (*Gracilaria vermiculophylla*)
- Griffiths coral weed (*Griffithsia corallinoides*)
- Medusa worm (*Loimia medusa*)
- Sea grapes (*Molgula manhattensis*)
- Gammarid amphipod (*Monocorophium acherusicum*)
- Amphipod (*Monocorophium insidiosum*)
- Amphipod (*Monocorophium sextonae*)
- Soft-shell clam (*Mya arenaria*)
- Mussel red worm (*Mytilicola intestinalis*)
- Algae (*Neosiphonia harveyi*)
- Rainbow trout (*Oncorhynchus mykiss*)

- False angelwing (*Petricola pholadiformis*)
- Tubeworm species (*Pileolaria berkeleyana*)
- New Zealand mud snail (*Potamopyrgus antipodarum*)
- Polychaete species (*Proceraea cornuta*)
- Polychaete species (*Pseudopolydora paucibranchiata*)
- Manila clam (*Ruditapes philippinarum*)
- Common roach (*Rutilus rutilus*)
- Polychaete species (*Sternaspis scutate*)
- Bryozoan species (*Tricellaria inopinata*)
- Copepods species (*Triconia minuta*)
- Dark Sea Lettuce (*Ulvaria obscura*)
- Red-rust bryozoan (*Watersipora subtorquata*)

Invasive Species Ireland and NBDC Ireland (NBDC, 2021; ISNI, 2022) have complied a catalogue of non-native species in Ireland which includes additional species such as the Chinese mitten crab (*Eriocheir sinensis*). Invasive Species Northern Ireland lists three species which are of concern in Irish waters which are the carpet seaquirt (*Didemnum vexillum*), slipper limpet (*Crepidula fornicata*) and Asian rapa whelk (*Rapana venosa*). The Asian Rapa whelk is not established and is listed as a potential invasive species which could be introduced to Irish Waters by ballast water, aquaculture and hull fouling.

C.2.9 Existing Environmental Problems

Under the Strategic Environmental Assessment (SEA) Regulations (European Directive 2001/42/EC) existing environmental problems relevant to the Plan must be considered, specifically those which have particular environmental importance such as protected sites under the Habitats Regulations. The following sections details existing problems which relate to the SEA topic 'Biodiversity, Flora and Fauna'.

C.2.9.1 Impact of climate change

Long-term changes in temperatures and weather conditions are the result of climate change. Climate change can occur naturally but anthropogenic pressures such as burning of fossil fuels has been the main driver of the change. Climate change can be observed using three indicators, temperature, precipitation and sea level rise. Currently, Irelands temperature is changing in line with global trends with a temperature increase of 0.8°C since 1900 with an expected increase of 1-1.2 or 1.3-1.6°C depending on emissions by the middle of the century (2041-2060). Sea surface temperature (SST) in Irish waters have increased by approximately 0.6c per decade since 1994 (EPA, 2022). Over a ten year period (2009-2018), records of SST at Malin Head, Co. Donegal is observed to have risen by 0.47°C above the 1981-2010 mean (Camaro Garcia and Dwyer, 2021). Precipitation between the period 1989 to 2018 was 6% higher than compared to the previous 20-year period with the decade of 2006-2015 being the wettest on record (Camaro Garcia and Dwyer, 2021). Sea level around Ireland has risen by approximately 2-3mm/year since the early 1990s and analysis of sea level data from Dublin Bay suggests a rise of approximately 1.7mm/year since 1938 (Camaro Garcia and Dwyer, 2021). Additionally, measurements of Irish waters on the west of Ireland between 1991 and 2013 have indicated that it is becoming more acidic in the last 10 years with an decrease of 0.5 in Ph level (in line with global averages) (Camaro Garcia and Dwyer, 2021). The impacts of climate change can affect biodiversity flora and fauna both directly and indirectly.

Phytoplankton are sensitive to changes in temperature and acidity levels. Increases in temperature can cause changes to the phytoplankton production by altering the intensity of the blooms indirectly affecting marine organisms by reducing light transmission within the water column. There has been a decline in overall copepod abundance since 1958 in the Celtic Sea. The cold-water species *Calanus finmarchicus* and *Pseudocalanus spp*. have decreased in abundance; however, the warm-water copepod *C. helgolandicus* has increased in abundance and has spread northwards, presumably in response to ocean warming (ICES, 2018).

Additionally, increased plankton biodiversity has been correlated to a decrease in the size of fish populations and this in-turn has a negative impact on the wider marine ecosystem. Modelling of phytoplankton changes predict that in tropic waters diversity of phytoplankton will decline while in northern waters it will increase, this will alter the marine ecosystem globally as well as in Irish waters (Henson et al., 2021). Additionally, ocean acidification can impact fish and shellfish species indirectly from food web effects due to calcifying planktonic organisms (Heath et al., 2012).

As well as phytoplankton community and distribution shifts climate impacts extend to larger species shifts in the marine environment. Biological responses in fish have been recorded due to external pressures (Brophy et al., 2020). A study conducted by Brophy et al (2020) on fish populations in the Celtic Sea highlighted the long-term changes in the ecosystem. The results of the study identified that changes in fish growth and abundance were a result of climatic fluctuations (Brophy et al., 2020). Distributions of herring during a warm period from the 1930's-1960's in the English Channel decreased and the distribution contracted while the Norwegian spring-spawning herring population increased (Toresen and Østvedt, 2000). This further identifies that warming of the climate can impact the species distribution found in the IOSEA6 area as southern species become more prominent while northern species become less abundant (Heath et al., 2012). While more mobile species can adapt to potential unfavourable conditions, more sessile or site specific species can also be at risk for instances sandeels are mainly found on coarse sandy sediments and have less ability to adapt their distribution in response to warming sea temperatures (Heath et al., 2012).

C.2.9.2 Anthropogenic disturbance

Offshore activities have been increasing around the coasts of Ireland, in particular there has been an increase in survey activity in relation to offshore wind development (Connolly, 2018). Vessel noise and noise generated from equipment used during all stages of development have been shown to have ramifications for acoustically sensitive marine organisms and the functioning of marine ecosystems (Merchant et al., 2016; Erbe et al., 2019). Sources of underwater noise are categorised into impulsive or continuous noise. Impulsive noise can occur from acoustic pulses such as explosions, pile driving or seismic airguns (Merchant et al., 2016; Daly and White, 2021). The effect of these pressures on marine life has been observed to cause physiological stress and displacement (Merchant et al., 2016). Shipping traffic is a source of continuous noise in the marine environment and has been associated with masking, which reduced the range and clarity of communication between marine mammals (de Vere, Lilley and Frick, 2018). The effects of acoustic masking can lead to decreased foraging efficiency or increased exertion in communication. It was found that killer whales increased the level of their call sound in response to background noise from vessel traffic (Holt et al., 2009).

A study conducted offshore on the south-west Ireland (within the Porcupine Basin) found a significant effect of seismic activity across multiple species and habitats (Kavanagh et al., 2019). Fewer sightings of toothed whales were observed with an 88% (82–92%) decrease in sightings of baleen whales, and a 53% (41–63%) decrease during active seismic surveys when compared to control surveys (Kavanagh et al., 2019). Merchant et al. (2016) conducted a study in the Celtic Sea measuring the level of anthropogenic noise and found that compared to other study sites off the north of Scotland the Celtic Sea was generally undisturbed by anthropogenic noise despite being 15 km east of a convergency of shipping lanes. This baseline may have changed since the 2016 study as an increase in offshore activity in the south-east of Ireland has occurred in the last number of years.

There has been limited knowledge on the effect of noise and vibration on the acoustic environment in deeper areas, however a study was conducting along the Celtic Sea margin (along the shelf of the Porcupine Basin) on the impact of bottom trawling on marine noise. This study identified that noise during the trawling activity was at a considerably higher level than ambient noise and a nearby underway research vessel (Daly and White, 2021). Overall, active bottom trawling along the basin margin can contribute to a higher noise level than activities such as point source drilling (Daly and White, 2021).

Drilling and pile driving are two anthropogenic activities that directly impact the seabed and cause significant vibrations that could affect benthic invertebrates (Roberts and Elliott, 2017). Similar to terrestrial organisms, marine species may use vibration to detect biotic and abiotic cues, but the significance of this and the sensitivities to vibration for many marine species have not yet been well-documented (Roberts and Elliott, 2017). Although this has not been well researched in underwater noise research, additional vibration exposure may cause behavioural or physiological changes, or even physical damage at high amplitudes or specific frequencies (Roberts and Elliott, 2017).

Displacement, disturbance, and avoidance can be an impact from anthropogenic activity which can affect mammals and seabirds. Seabirds are particularly sensitive to visual disturbance, and it can be detrimental to breeding success. Displacement occurs when a reduced number of birds are found within or adjacent to the area where there is anthropogenic activity (MMO, 2018). The sensitivities of birds to activities varies depending on species. Tern are reported to have lower sensitivity to short-term direct disturbance impacts, such as visual impact but are sensitive to indirect longer term impacts like changes to their targeted fish and benthic communities, whereas cormorants have low sensitivity to longer term impacts but higher sensitivity to short term direct impacts like displacement (MMO, 2018).

Pressures on fish stocks are a continued source of anthropogenic disturbance. Commercially exploited fish and shellfish are monitored with the regulations under the Common Fisheries Policy. The most recent MSFD assessment identified that the populations of all commercially exploited fish and shellfish are within safe biological limits. While this is the case pressures on stocks can cause wider ecosystem pressures or instances to feeding birds and cetaceans.

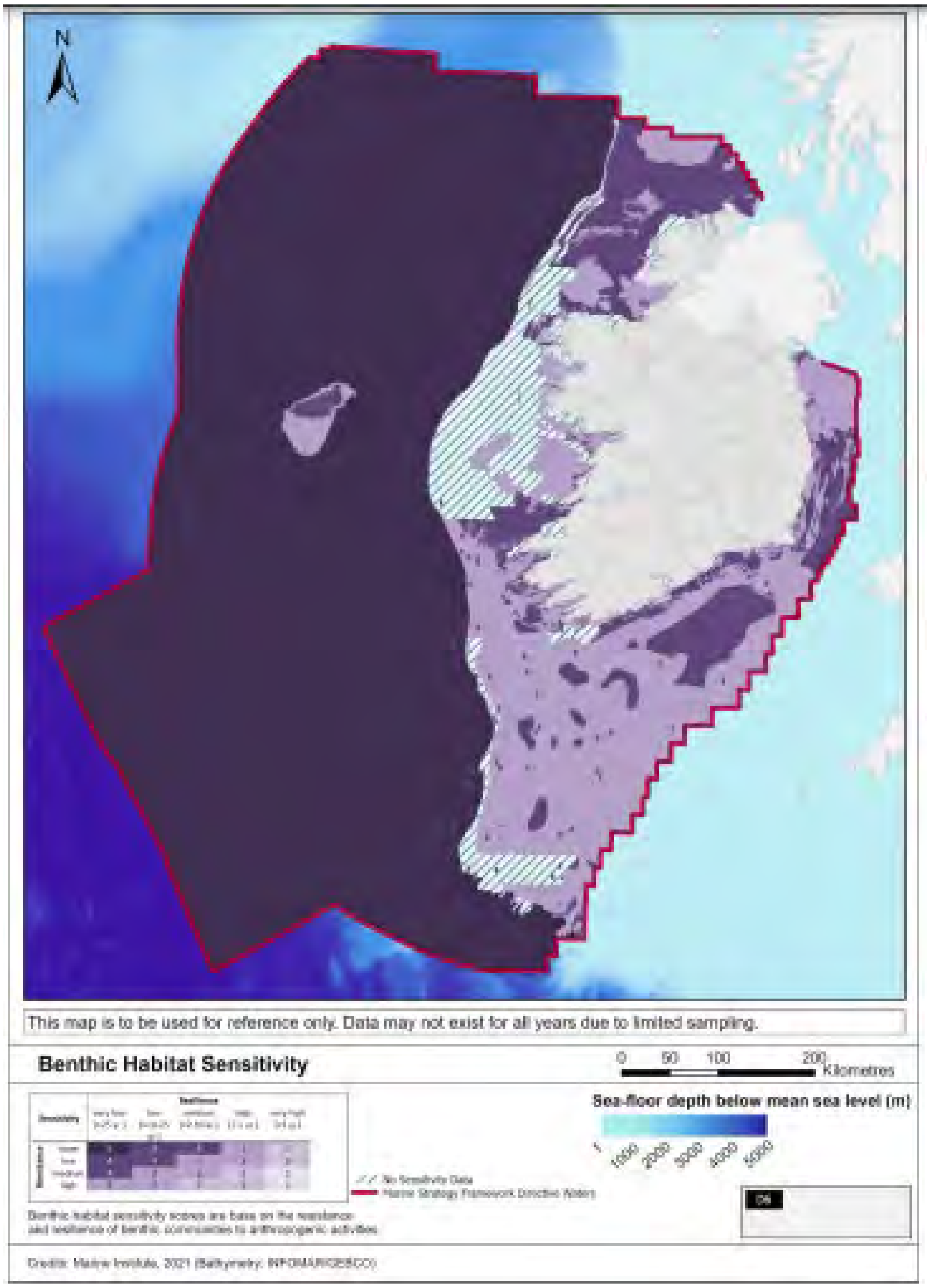
C.2.9.3 Loss and damage to habitats

Physical habitat loss is a major stressor on the marine ecology. If the substrate, morphology, or topography of a habitat is permanently altered, it is lost. Offshore installations, port anchorage, dredging and dumping, wind farms, sand or gravel extractions, and other types of constructions in or over the seabed are the main causes of such damage (WISE Marine, 2022).

Significant damage has occurred to shallow sediment habitats and reefs as a result of bottom fishing practices especially beam trawling (OSPAR, 2010). The predominant fishing activities associated with abrasion on the seafloor are demersal trawling and bottom dredging.

In relation to 'Sea-floor integrity', the Marine Strategy Framework Directive considers that 'good environmental status' is achieved when ‘Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected (EC, 2008, 2017). The MSFD framework uses 'Sea-Floor integrity' as a descriptor to assess overall environmental status. The framework was set to achieve GES by 2020, however in both strategy 1 and 2 of the monitoring of the MSFD GES has not been achieved for seafloor integrity. Figure C-18 displays the benthic habitat sensitivity

Figure C-18 Benthic Habitat Sensitivity, based on the combined assessments of habitat resistance and resilience (Source DHLGH, 2021b)

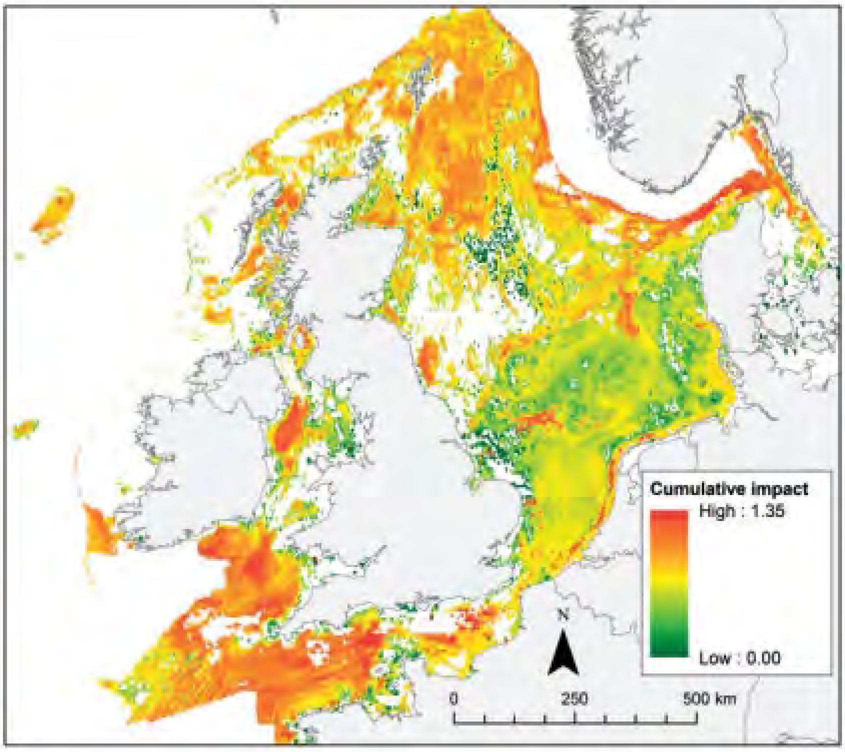


Impact to the seafloor can occur from fisheries practices such as trawling. Bottom trawling is widespread globally and impacts seabed habitats both direct and indirectly (Pitcher et al., 2022). In Ireland direct impacts include removal of species such as removal of cold water coral species. Cold water corals grow at a rate of 1mm per year which makes them more sensitive to damage as their recoverability rate is lower.

Although the harm produced by such operations in shallow coastal waters has been widely established, the impacts of deeper trawls are less well understood. This is a cause for concern, as deep-bottom trawling has become more common in recent decades, and deep-sea ecosystems are known to be particularly vulnerable to such disturbances (SFEP, 2013).

Cumulative impacts also cause impacts to the seafloor, activities such as sediment removal for aggregate extraction, installation of hard structures for cable or infrastructure protection, abrasion and removal from fishing or dredging (Kenny et al., 2018). Figure C-19 displaces the cumulative impact for sediment abrasion combines four pressures to highlight potential abrasion displaying high impact areas in the Celtic Sea (Kenny et al., 2018).

Figure C-19 Cumulative impact map for sediment abrasion (bottom fishing activities), sediment removal (aggregate extraction), smothering (sediment disposal activities) and hard structure deposits (oil and gas, wind-farms, tidal, and wave generation) (Taken from Kenny et al., 2018).



C.2.9.4 Marine Litter

Marine litter consists of discarded domestic and industrial waste which has made its way into the environment and discarded or lost fishing gear. Plastics make up 70% of marine litter which is a concern for marine life due to their persistence in the environment. This causes issues such as entanglement which can cause injury or death to marine life. Additionally, as plastics erode micro-plastics are created which creates a chain issue if ingested.

The study conducted by SeaRover during mapping of Vunerable Marine Ecosystem's, recorded the presence and category of marine litter (Picton et al., 2021). Nylon gill nets and long lines were the most commonly recorded gear, but trawl nets were also observed. The majority of non-fishing gear and fishing gear were found in the north-west of the continental slope. On the continental slope adjacent to Ireland the SeaRover survey covered approximately 0.76 km^2 of seabed and observed discarded fishing gear on 42 dives within this area. From these results it is predicted that if the entire continental slope was surveyed, there would be more than 4 million encounters with lost fishing gear (Picton et al., 2021).

C.2.10 Potential Sensitivities to the Plan

The potential sensitive aspects to biodiversity, flora and fauna have been identified from the baseline descriptions of each sub-topic. Potential pressures arising from activities associated with the implementation of the Plan include seismic surveys and drilling activities:

- **Seismic survey**: Offshore seismic surveys are conducted by a vessel towing acoustic sound sources (air guns) 5 to 10 m below the sea surface along pre-determined survey lines. The air guns generate seismic energy by the release of bubbles of compressed air, which produce a primary energy pulse and an oscillating bubble.
- **Drilling**: The location of exploration wells will be guided by the results of the analysis of the seismic surveys, and the design, depth and dimension of the exploration well will be determined by the environmental characteristics of the locations and the location of the target geological horizon(s). This will also determine the type of drilling rig used (e.g. jackup, semi-submersible, drillship).

A summary of the potential pressures and sensitive aspects of the topic are displayed in Table C-13.

Table C-13 Summary of potential pressures of the Plan on Biodiversity, Flora and Fauna

Plan activity	Aspect	Pressure	Sub-Topic	Key sensitivities
Seismic survey and drilling	Generation of underwater noise during seismic survey(s)	Underwater noise changes	Marine Mammals Fish and Shellfish Benthos	An animal's ability to detect sounds produced by anthropogenic activities depends on its hearing sensitivity and the magnitude of the noise compared to the amount of natural ambient and background anthropogenic sound. In marine mammals, this may mask communicative or hunting vocalisations, inhibiting social interactions and effective hunting. In fish, this will affect high sensitivity hearing species because they have a specialisation of the auditory apparatus where the swim bladder and inner ear are intimately connected, underwater noise can cause injury or death to these species. High intensity or prolonged noise can cause temporary or permanent changes to animals' hearing. Where the threshold of hearing is temporarily altered, it is considered a temporary threshold shift (TTS), and the animal is expected to recover. If there is permanent aural damage (permanent threshold shift (PTS) where the animal does not recover, social isolation and a restricted ability to locate food may occur (Southall et al., 2019). Behavioural disturbance is more difficult to assess than injury and is dependent upon many factors related to the circumstances of the exposure (Southall et al. 2007, NMFS 2018). Disturbance may result in individuals moving away from the zone of disturbance and remaining at a distance until the activities have passed. There may also be changes in foraging, migratory or breeding behaviours; all factors that can affect the local distribution or abundance of a species. Introduced sound may also cause masking or disruption of the animal's own signals, whether used for communication, foraging or other purposes. There is also the potential for multiple project activities to occur at the same time resulting in in-combination effects. Drilling and pile driving are two anthropogenic activities that directly impact the seabed and cause significant vibrations that could affect benthic invertebrates. Vibration exposure may cause behavioural or physiological changes, or even physical damage, at high amplitudes or specific frequencies. However, this is not well studied in underwater noise research (Roberts and Elliott, 2017).
	Presence of vessel(s) and equipment	Visual and above water noise disturbance	Marine Mammals Fish and shellfish Birds	Visual and above water noise disturbance can occur from the physical presence of survey vessels, towed equipment and helicopters. Disturbance can lead to a number of physiological and behavioural responses which can affect different species. Seals hauled out on land could react to the presence of vessels. In general, ships more than 1,500m away from hauled out grey or common seals are unlikely to evoke any reactions, between 900m and 1,500m seals could be expected to detect the presence of vessels and at closer than 900m a displacement response could be expected (Brasseur & Reijnders,1994). This pressure would be most significant for breeding and moulting seals, hauled out on the coast and on intertidal banks. Chronic flushing as a result of vessel disturbance

				reduces nursing time, increases energy use and disrupts energy balance, which can compromise growth and survival (Jansen et al.,2010; Harding et al., 2005). Repeated or prolonged disturbance can also influence the distribution of seals, where they may be more likely to utilise undisturbed areas even if they are less favourable for habitat suitability or prey availability (Jansen et al., 2015). Therefore, prolonged or repeated visual and above water noise disturbance within 900 m of hauled out seals could result in reduced growth and survival of seals, particularly young pups, which could affect the demographic characteristics of the population. Basking shark typically aggregate in groups during mating and display courtship behaviour in surface waters. There is limited knowledge on exactly where basking shark are found in Ireland and what behaviours take place. However, observations of basking shark displaying courtship behaviour off the west coast of Ireland have been reported. Visual and above water noise disturbance has the potential to effect basking shark during their mating period reducing success rate of reproduction. Visual disturbance can lead to a number of physiological and behavioural responses which can affect bird species. Responses to disturbance can result in loss of energy; impaired breeding; unrest through increased vigilance; and disruption to incubation leading to increased nest failures due to predation and nest abandonment (Valente et al. 2011).
		Collision above and below water with static or moving objects not naturally found in the marine environment	Marine and other mammals	There is the risk that animals could collide with survey vessels. Shipping collision is a recognised cause of marine mammal mortality worldwide, the key factors influencing the injury or mortality caused by collisions is the ship size and its travelling speed. Ships travelling at 14 knots or faster are most likely to cause lethal or serious injuries (Laist et al., 2001).
			Fish and shellfish	Reference to collision for fish is specifically relating to basking shark, which are known to spend significant time at the surface and are more vulnerable to collision. Survey vessels and exploration vessels can be a source impact for basking shark transiting through the area.
			Birds	In places with high seabird density, light-induced bird strikes on vessels can occur which may result in bird mortality. This collision can occur if vessels are operating at night with light (Coleman et al., 2022). Many seabirds including most of the *Procellariiformes* (shearwaters and petrels) are active at night to avoid predation, this increases risk of collision above water if vessels are in operation at night (Birdlife International, 2012; Montevecchi, 2006).
Seismic	Seabed disturbance from placement of equipment on seabed (e.g. sea nodes or sea	Temporary habitat disturbance including penetration and abrasion	Benthos	There is the potential for localised areas of seabed and associated benthos to be disturbed by the placement of equipment on the seabed. Potential effects on the benthos include localised direct disturbance. Any immobile eggs, juveniles and shellfish present on the seabed around the operation area will be subject to direct seabed disturbance.
			Fish and Shellfish	
			Designated habitats	

	bottom cable surveys)			
Drilling	Seabed disturbance from placement of equipment on seabed (e.g. wellhead, anchors, concrete mattresses) or release of mud, cement and cuttings from tophole well section	Smothering and siltation rate changes	Benthos	Smothering and siltation rate changes could occur due to the placement of equipment on the seabed. The re-deposition of any suspended sediments can lead to smothering of sessile and low mobility species, such as filter feeders found in reef habitats, if deposition thicknesses are significant. However, any disturbance from placement of equipment will be in the immediate vicinity of the equipment. A study on subsea trenching operations, which would result in much greater disturbance to the seabed, found that coarse sediments are likely to settle back in the very near field (100 m) with finer particles deposited further afield (1-2 km). Fine material will be rapidly diluted and dispersed in the water and far-field deposition is predicted to be less than 1mm for trenching operations (Gooding et al., 2012).
			Fish and Shellfish	
			Designated habitats	
Drilling		Physical change (to another sediment type)	Benthos	Physical change can occur from drilling and installation of any equipment which can result in the localised permanent habitat loss in the direct footprint of the activity. The presence of potential rock protection could also represent a change in habitat type.
			Fish and Shellfish	
			Designated habitats	
Drilling	WBM & WBM contaminated cuttings discharge from surface, including payzone cuttings	Deterioration of water quality / effects on species	Plankton	Marine water column organisms are at a low risk of harm from chemical discharges because of rapid dilution and dispersal of chemicals. Impacts of chemicals are a result of a combination of persistence, bioaccumulation and toxicity (PBT). Discharge of contaminates cuttings may impact water quality and have the potential for interaction with marine life.
			Benthos	
			Fish and Shellfish	
			Marine and other mammals	
			Birds	
			Designated habitats	
			Marine reptiles	
Seismic survey and drilling	Marine discharges (normal operations / drill rigs)	Sediment contamination / potential for	Plankton	Impacts of chemicals are a result of a combination of persistence, bioaccumulation and toxicity (PBT). While the majority of chemicals used during offshore oil and gas operations are relatively benign, there is the potential for localised contamination of sediments through chemical discharges.
			Benthos	
			Fish and Shellfish	

		bioaccumulation in food chain	Marine and other mammals	
			Birds	
			Designated habitats	
			Marine reptiles	
		Deterioration of water quality / effects on species	Plankton	Marine water column organisms are at a low risk of harm from chemical discharges because of rapid dilution and dispersal of chemicals. Impacts of chemicals are a result of a combination of persistence, bioaccumulation and toxicity (PBT). While the majority of chemicals used during offshore oil and gas operations are relatively benign, there is the potential for localised contamination of sediments through chemical discharges.
			Benthos	
			Fish and Shellfish	
			Marine and other mammals	
			Birds	
			Designated habitats	
			Marine reptiles	
Drilling	Well testing (flaring)	Disturbance	Birds	Flaring could result in disturbance to birds, potentially attracting them to structures at night and putting them at risk of harm.
			Designated habitats and species	
Drilling	Drilling activity	Disturbance / Underwater noise changes	Benthos	Fish and shellfish could be displaced due to noise from drilling activities. This could also lead to impacts on marine mammals and other designated species.
			Fish and Shellfish	
			Marine and other mammals	
			Designated habitats and species	

Seismic survey and drilling	Accidental events (e.g. loss of diesel, chemicals, base oil; worst case scenario - blowout)	Hydrocarbon & PAH contamination	Plankton	Oil may enter the marine environment during seismic and/or drilling operations as a result of accidental event. Such an event would have the potential to directly impact surrounding species and habitats in both Irish waters and transboundary waters.
			Benthos	
			Fish and Shellfish	
			Marine and other mammals	
			Birds	
			Designated habitats	
			Marine reptiles	
Seismic survey and drilling	In-combination effect		Plankton	While the Plan has individual pressures which may or may not cause a significant effect, it is important to consider each pressure where a cumulative effect could occur in conjunction with another domestic or transboundary plans, projects and activities.
			Benthos	
			Fish and Shellfish	
			Marine and other mammals	
			Birds	
			Designated habitats	
			Marine reptiles	

C.2.11 Data Gaps

In terms of general biodiversity, flora and fauna, owing to COVID 19, surveying and sampling will have been disrupted from 2020 to 2021. As a result of the reduced activity in the offshore area, there is a data gap between these years, and the baseline may have changed.

Table C-14 Data gaps Identified for Biodiversity, Flora and Fauna

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
Plankton	IOSEA5 Area has not been comprehensively covered by previous surveys. In addition, there is no available data for the residence time in the water column of deposited aggregated phyto-detritus. Systematic collection of zooplankton is not carried out in Irish waters. Ireland relies on sporadic zooplankton research conducted in academic institutions and data gathered by the continuous plankton recorder, which does not cover a significant portion of Irish waters.	Marine Institute HABS Alert system indicates annual trends of plankton blooms. The CPR Data is continuously collected and will further inform baselines in areas where data is taken.	Not all areas of the IOSEA6 Study Area have been sampled to date; however, the surveys to date in the region do give a very good indication as to the plankton in the wider area.	The Marine Institute has developed a harmful agal bloom alert system to prevent toxin related aquaculture farm closures (Copernicus Marine Service, 2022). This system allows for weekly bulletins to be provided monitoring harmful blooms. These bulletins allow for weekly updates providing information on inshore transportation of blooms. The Marine Institute is conducting a Climate Change and zooplankton project which as part of its outputs aims to carry out a literature review (report) of all known zooplankton data collection in Irish waters and produce maps detailing locations and timing of key zooplankton sampling efforts in Irish waters. Currently the status of this project is ongoing.
Benthic	Large tracts of the IOSEA5 Area, particularly on the	While there is updated information with modelled data	Offshore mud sediments have little	EMODNet Phase 4 delivered for 2023. The creation of two

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
	flanks, have never been sampled. In addition, previous IOSEAs have noted that relatively few of the deepsea studies have been taxonomically orientated.	available, the gaps identified in IOSEA5 relating to deepsea survey limitations have not been addressed	data available on their sensitivities	new composite data products for Europe: coastal wetland habitats and essential fish habitats, and the upcycling of habitat maps classified in the previous version of EUNIS (2007-2011), into the new 2019 version.
			A large proportion of the area in the Clare Basin does not have classified EUNIS habitats. The Slyne-Erris and Mayo basins have a small proportion of seabed which has not been EUNIS classified.	The geographical survey of Ireland provide high level categorisations and will continue to update their data until 2026 EUSeaMap is updated every 2-3 years In addition, a number of wind farm developments have been proposed for the around the Irish coast and the EIA process for each of these has to include a benthic assessment

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
Fish and Shellfish	Relatively little synthesised information on the species present within the IOSEA5 Area, their distribution and key habits. This applies in particular to deep water fish species. In addition, there is limited information on spawning or nursery grounds for cephalopods, and information on basking shark distribution is limited to opportunistic sightings.	While there is updated information available, the gaps identified in IOSEA5 relating to a coordinated international approach for species and seasonal limitations on observations have not been addressed	41% of non-commercial fish species assessed in the MSFD, the environmental status is currently unknown.	The Marine Institute continues to release the Annual Stock Book. IBTS continues to gather information which will further inform baselines ObSERVE II has been undertaken and while results are not available yet any future SEAs should have access to these reports to update the baseline.
Marine and other mammals	Marine mammals, and cetaceans in particular, are highly mobile and many animals found in Irish waters are part of much larger global bio-geographical populations, which will be subject to effects outside of the IOSEA5 Area. Therefore, a long term, co-ordinated international approach is required to fully understand species ecology. In addition, due to their surfacing behaviour many species can be difficult to	While there is updated information available on sightings and observations of cetaceans in Irish water, the gaps identified in IOSEA5 relating to a coordinated international approach for species and seasonal limitations on observations have not been addressed.	Impacts of anthropogenic noise are not fully understood due to a lack of baseline data. In the Celtic sea and Irish Sea there has been an increase in number of site survey activities for offshore wind farms and the cumulative effect on marine mammals is currently unknown. Additionally, there is not a lot of information available on the potential effects of ship noise on pelagic and deep-diving marine mammals While there are observations of biological responses to noise the	Ongoing research is being carried to describe the baseline of marine mammals in Irelands. IWDG continues to carry out research into cetaceans and potential impacts In addition, a number of wind farm developments have been proposed around the Irish coast and the EIA process, underwater noise assessments are sometimes carried out as part of the application. ObSERVE II has been undertaken and while results are not

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
	observe especially during poor conditions; therefore observational effort has typically been focused during the more clement summer months. This has resulted in a deficiency of data during other times of year and may result in an underestimate of animal occurrence and abundance.		significance of this response is not as widely known. Offshore breeding habitats for certain species are unknown but are unlikely to occur in the IOSEA6 Study Area.	available, yet any future SEAs should have access to these reports to update the baseline. Seal Rescue Ireland keeps records of seal observations and provides research on seal populations in Ireland.
Seabirds	Previous IOSEA's have identified a deficiency in the overall understanding of seabird abundance and seasonal distribution in the offshore environment. Survey effort during autumn and winter months is limited to the continental shelf and rarely extends into deeper parts of the region. The extent of the impact of non-indigenous mammalian predators on island seabird colonies requires further investigation. Data is required on the impacts of fishing gear type on seabird mortality, due to entanglement, ingestion etc. A large amount of the existing data and research used to inform seabird ecology is dated (>20 years) and only covers parts of the IOSEA5 region.	ObSERVE studies conducted in 2018 have given information to address this gap. Highlighting bird distributions offshore and at coastal habitats. However, more studies to contribute to this knowledge base should be included in any future IOSEAs.	For some species in Ireland, there is a lack of long-term monitoring data sets. Comprehensive data is lacking on important offshore areas fir seabirds in breeding season and during migration. In most areas, little is known about how wintering waterbirds like seaducks use the waters around Irelands coastal estuaries and bays.	ObSERVE II has been undertaken and while results are not available yet any future SEAs should have access to these reports to update the baseline. In addition, a number of wind farm developments have been proposed for the around the Irish coast and the EIA process, seabird surveys are carried out to inform the process and will further inform the baseline for any future SEAs.

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
Marine reptiles	Most of the information on the distribution of marine turtles in Irish and UK waters has been gained from stranding data, providing little indication of their distribution at sea. There is also limited information on the extent of their range within the north Atlantic and their general movements outside the nesting period and no indication of their small-scale movements around Ireland and the UK.	The Annual marine turtle sightings and strandings report produced allows for information to be collected on species occurrence and temporal trends of species presence	Clearly targeted and collaborative international research is required on (a) the population ecology of Leatherback turtles in the North Atlantic and (b) the extent, severity and risk of impact from human activities on populations of this species. In the meantime, the overall environmental status of this species in Irish waters was assessed as currently unknown.	The NBDC continues to gather observations and stranding records of sea turtles. This can be used for future baselines to understand marine reptile occurrences in Irish Waters. Annual report on UK and Irish Marine Turtle Strandings and Sightings
INNS	Not included in IOSEA5	This section is a new addition to IOSEA6.	In Ireland, there are significant gaps in our understanding of marine invasive species.	The catalogue of INNS developed in 2018 will continue to be updated. A survey began in 2020 to map Irelands Invasive Marine Species which is still being carried out. Outputs of this survey are expected to be a database of INNS, and maps of incidence, distribution and potential spread.
Designated sites	Coral carbonate mounds are a key feature of the benthic environment and their importance is reflected in a number of offshore SAC designations. When they were first reported, the mounds were subject to intensive mapping by the hydrocarbon industry which greatly	GSI have surveys reefs on the west coast of Ireland further informing the baseline of the reefs in the area. Studies of the carbonate mounds are continue to be carried out (Lim, Wheeler and Arnaubec, 2017; Lim et al., 2018) have	-	NPWS monitor protected sites around Ireland and continue to update their conservation status. Additionally, in 2019 DHLGH began the process to expand the MPA network from 2.13% to 10% of the maritime area by 2030 (DHLGH, 2021a). The final report of the

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
	improved knowledge of their distribution. However, it is less clear what the condition is of associated habitats that occur on mounds since only direct visual inspection or sampling can inform whether deep sea fishing gear has caused damage. Understanding the condition of these features prior to the proposed activities taking place is important and would likely need to be informed by targeted surveys for specific developments	found the condition of the reef however it is still important to have targeted surveys before activities are carried to inform the conditions of the areas.		MPA Advisory Group was published and consultation was closed in July 2021. The Department is now in the process of developing stand-alone legislation to enable the identification, designation, and management of MPAs in accordance with Ireland's national and international commitments. NPWS is currently reviewing mapping of proposed sites and this work is expected to be carried out throughout 2022 (DHLGH, 2021a).

C.2.12 Predicted future baseline for the topic

Plankton: Aside from being a key component in the marine ecosystem, plankton are also important in climate and studies have found that plankton distribution is being altered by

Benthos: Studies on cold water coral changes in the Belgica mound have shown that the fraction of living coral facies has changed slightly, while the proportion of coral rubble facies has changed the greatest. This reveals a discrepancy between temporally separated data sets, implying that the mound surface may almost fully alter in 20 years (Lim, Wheeler and Arnaubec, 2017; Lim et al., 2018).

Climate change: One of the most influencing factors of a future baseline for biodiversity, flora, and fauna is climate change. The effect of climate change on marine mammals is still not fully understood and it is difficult to relate large scale environmental changes to smaller regional areas. With regards to IOSEA6, the species most likely to be impacted by climate change are those for which this region represents the edge of their range, for example white-beaked dolphin. However indirect effect of prey availability may also impact on animals. There are many species of marine mammals with differing preferred diets and therefore fluctuations in certain prey availability due to climate change driven causes may impact on some species and not on others depending on which, and how, any prey resource is impacted.

Climate-driven changes in the food chain may have negative impacts on seabirds most significantly through indirect impacts on prey resource, for example, changes in plankton communities caused by rising sea temperatures has led to large reductions in abundance of the zooplankton on which larval fish feed and poor sandeel productivity is associated with warmer sea-surface temperatures (Defra, Charting Progress 2010). Rising sea levels may also negatively impact on breeding seabirds due to the potential for loss of suitable coastal nesting sites.

Protected sites: The Irish Government plans to dedicate 30% of the maritime area to Marine Protected Areas by 2030 (DHLGH, 2020). The current area of protected waters totals 2.13% (DHLGH, 2021a). Additionally, The distribution of infrastructure and anthropogenic pressures will influence where new protected sites will be placed. It is expected that as focus is set to meet the 2030 deadline more research will be placed on the development of the MPAs. With new information becoming available there is the possibility that designated sites will occur in the IOSEA6 Study Area.

Marine Mammals: highly mobile species is problematic. Animals can be subjected to both natural changes and anthropogenic influences on a variety of global and regional scales and it is difficult to differentiate between whether any observed changes in populations are due to short term regional changes or long term environmental shifts. Animals will utilise a variety of habitats during different stages of their life cycle, therefore, changes, whether natural or anthropogenic, occurring at regional levels in other global locations, may result in observed changes to animal distribution and abundance at locations far from the pressure source. Additionally, different individuals and species of marine mammals react differently to a variety of pressures; hence, changes in the regional or global environment may impact on some species more than others.

By-catch in fishing gear represents a significant threat to marine mammals, predominantly affecting the smaller cetacean species such as harbour porpoise. Therefore, changes to the scale of fishing operations and fishing practices may impact on these species. Although a significant amount of research has been done on the effect of anthropogenic noise on marine mammals the impacts are still not fully understood, especially considering the variety of species for which consideration needs to be given. Underwater noise can cause death, injury and disturbance to marine mammals. Animals most susceptible to negative impacts of underwater noise may be those that are breeding in the region or feed in localised areas, such as beaked whales. Marine pollutants can significantly impact on marine mammals, effecting growth and reproduction.

Designated Sites: From an ecological perspective a combination of natural factors and anthropogenic pressures referred to in preceding sections will influence the distribution of protected species and condition of designated habitats in future. However, from a conservation perspective it is probable that as knowledge of the marine environment, especially offshore areas, grows further sites within the IOSEA6 Study Area will be designated as SACs and/or MPAs It is worth noting that where species or habitats listed in EU and national legislation occur outside designated sites there is a presumption of protection. This is of relevance to future offshore surveys, for example to inform impact assessment for drilling activity, which may encounter examples. Additionally, in 2019 DHLGH began the process to expand the MPA network from 2.13% to 10% of the maritime area by 2030 (DHLGH, 2021a). The final report of the MPA Advisory Group was published and consultation was closed in July 2021. The Department is now in the process of developing stand-alone legislation to enable the identification, designation, and management of MPAs in accordance with Ireland's national and international commitments. NPWS is currently reviewing mapping of proposed sites and this work is expected to be carried out throughout 2022 (DHLGH, 2021a).

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