Manx Marine Environmental Assessment

Ecology/Biodiversity

Subtidal Ecology

The seabed off the coast of Jurby, North West Isle of Man. Photo: C & P Roriston.

MMEA Chapter 3.3

October 2018 (2nd edition)

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Manx Marine Environmental Assessment

Second Edition: October 2018

This document was produced as part of the Manx Marine Environmental Assessment, a Government project with external stakeholder input, funded and facilitated by the Department of Infrastructure, Department for Enterprise and Department of Environment, Food and Agriculture.

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Suggested Citations

Chapter
Howe V.L. 2018. Subtidal Ecology. In: Manx Marine Environmental Assessment (2nd Ed). Isle of Man Government. pp 48.

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Subtidal Ecology

Summary

The Isle of Man has a long history of marine research on benthic habitats. Much of the research from the Port Erin Marine Laboratory focussed on the sea area around the south of the Island. The Calf of Man is recognised for its high biological diversity and presence of rare species in the diverse rocky reef habitats which surround the islet. In recent years, significant progress has been made in understanding of the marine habitats throughout the Manx territorial sea. Recent studies have also highlighted extensive areas of regionally important habitats, for example:

- There is an extensive horse mussel reef to the north east of the Point of Ayre, a small but diverse reef south of Douglas and another small area off the Jurby coast. A large horse mussel reef south of Langness is thought to have been largely lost but patches of reef habitat have recently been recorded in the area.
- Eelgrass beds are found in Langness Gully, Garwick Bay, Gansey and in the south of Ramsey Bay.
- Extensive maerl beds have been found in Ramsey Bay and at a number of other sites around the Isle of Man.
- *Sabellaria spinulosa* (Ross worm) have been found in the extreme southern area of the Manx Territorial Sea.

The Bangor University/Isle of Man Government Benthic Survey, which was carried out in 2008, is the most important development in the systematic mapping of the Manx marine environment. Additional information has been collected at a finer resolution by dive surveys, carried out by marine biologists and by recreational divers trained in Seasearch methods. More recently master's degree students from Bangor University have undertaken detailed habitat mapping using a towed video camera in *Baie ny Carrickey*, Niarbyl, Laxey, Port Erin and Douglas bays.

The Fisheries Directorate of the Department of Environment, Food and Agriculture now also has the capacity to collect high resolution benthic information from the fisheries protection vessel *Barrule*. In 2011 a detailed survey of Ramsey Bay was carried out from the vessel to produce a baseline for future monitoring of the effects of the Ramsey Marine Nature Reserve.

In terms of conservation of benthic habitats, a network of marine nature reserves (MNRs) (formerly fisheries closed/restricted areas and conservation zones) protects the seabed from scallop dredging in the bays of Ramsey, Laxey, *Baie ny Carrickey*, Port Erin, Niarbyl and Douglas, around the Calf of Man and significant areas out to the 3 nautical mile limit. These MNRs protect a total of 431km^2. The Island's first Marine Nature Reserve, in Ramsey Bay, remains the most spatially complex, with specific management zones to protect eelgrass meadows, horse mussel reefs, maerl beds and kelp forests, rocky shore and fishing interests. The highly protected zones of Ramsey Marine Nature Reserve cover an area of 47km^2 or 1.18% of the Manx Territorial Sea. The latest MNR areas came into force on 1st September 2018 and provide protection for over 50% of Manx 0-3 nm zone, and over 10% of the total territorial sea.

Whilst Manx waters have now been relatively well studied, gaps in knowledge do remain. New horse mussel reefs and eelgrass meadows continue to be discovered as more survey

work is carried out. This highlights the importance of targeted benthic survey work to support Environmental Impact Assessments in Manx waters.

Introduction

This chapter gives an overview of current knowledge of Manx subtidal habitats and ecology and references to more detailed sources of information. Good reviews of the state of knowledge on the Manx marine environment in 1990 are given by Geffen *et al*. (1990) and Hawkins *et al*. (1990). Gubbay (2000) reviewed potential sites for Marine Protected Areas in Manx waters. Bruce *et al*. (1963) (Marine Fauna of the Isle of Man) remains the main reference for marine species records, although many more marine records are now held on databases (e.g. the UK National Biodiversity Network) and by organisations in the Isle of Man and further afield.

The established Manx Biological Records Partnership (MBRP) brings together all biological records held by the Isle of Man Government, Manx National Heritage, the Manx Wildlife Trust, and other organisations. For more information about the development of the MBRP see the Manx Biodiversity website: http://www.manxbiodiversity.org/MBRP.html.

For further information about the availability of reports and data on the Manx marine environment, Tomlinson (2008) is also a useful resource.

Baseline

History of subtidal research in Manx waters

The Isle of Man's subtidal environment has been the subject of research for more than 150 years. In the 1840s, noted Manx oceanographer and marine biologist Professor Edward Forbes carried out extensive experimental dredging work in Manx waters. His diverse publications provide information on the presence and abundance of numerous marine species. For example, in his monograph on molluscs he identifies the Arctic clam (*Arctica islandica*, then known as *Cyprina islandica*) as "on the north and east coasts but rare". He described horse mussels (*Modiolus modiolus*, then known as *Mytilus modiolus*) as "common in deep water on all the coasts". Most interestingly, he repeatedly refers to the "scallop banks" to the north, which were made up mainly of *Pecten opercularis* (queenies) and also *Pecten maximus* (king scallops). Forbes also described extensive oyster banks of the native oyster, *Ostrea edulis*: "On the north and east coasts plentiful. The oysters on the north coast are extremely large and very coarse, but those on the east coast are esteemed and brought to market. The bank is situated off the village of Laxey." (Forbes 1838).

In his contribution to a visitor's guide to the Isle of Man in 1841 Forbes noted:

"Many scarce shellfish abound on the coast, and on the banks which surround the Island. On the rocks at low water live *Trochus umbilicatus, Littorina tenebrosa, Skenea depressa, Rissoa cinpilla* and *Keiia rubra;* also (though more rarely) the scarce *Velutina otis…* Oysters are found at Laxey and on the north coast, and large scallop beds on many parts of the coast… Besides the shellfish, the neighbouring sea furnishes also many rare animals of the genera *Asterias, Ophiura, Echinus, Comatula,* and *Actinia."* (Forbes 1841a).

Edward Forbes published a detailed study of Echinoderms (the sea urchin and starfish phylum), including extensive information on Manx waters (Forbes 1841b) and a comprehensive study of British Molluscs (Forbes and Hanley 1853). He first described many of the species commonly known from Manx waters, for example the heart urchin *Brissopsis lyrifera* and the brittlestar *Ophiura albida.*

Twentieth Century Research

Jones (1951) carried out a systematic survey of the marine fauna of the south of the Isle of Man (within a 15 mile radius of Port St Mary) and provides descriptions for the location of key areas of habitat such as horse mussel (*Modiolus modiolus*) reefs and *Glycymeris glycymeris* (another bivalve) beds:

"In an area of several square miles centred about 3 miles south-west of the Calf, the bottom is overlaid by a deposit of dead shells, chiefly those of *Glycymeris glycymeris*. *Modiolus modiolus* occurs in small numbers throughout the area of this community except on the very finest gravels and coarse sands, but it is found abundantly off the south-east coast. Here it forms in places a solid mass of shells on the bottom, the animals attached to one another by byssus threads. The bed of *Modiolus* commences as a narrow strip less than ¼ mile in width about 4 miles SSE of the Calf in 30fm., and runs in an arc to about the same distance offshore to the south of Langness about the 20fm. line. From here the bed broadens out considerably, becoming 3-4 miles in width, but with the *Modiolus* much less concentrate than in the western part, and finishes from 3-7 miles south of Douglas Head in 16-22 fm. The bed seems to be outside the course of the strongest tidal currents, which run close to the Calf and to Langness, but in an area where there is still considerable water movement." [The area of this horse mussel reefs is shown in Figure 13 in this chapter.]

Jones then goes on to describe the typical fauna of *Modiolus* beds, noting the unusual occurrence of *Balanus hameri* and *Capulus ungaricus* on the mussels and the occurrence of the pea crab *Pinnotheres pisum* inside the shells.

Researchers at Port Erin Marine Laboratory (Hill *et al*. 1999) used Jones' research from the 1950s to compare with data collected in the 1990s to look at changes to benthic habitats over the intervening 40 year period. They identified expected changes such as loss of fragile species from heavily dredged sites and also a loss of species from some of the more lightly dredged areas, including fragile tube-dwellers. One particularly interesting finding by Hill et al. (1999) was that some of the scavenger species that have become very common on dredged grounds, including the common starfish *Asterias rubens*, the common whelk *Buccinum undatum* and the edible crab *Cancer pagurus*, and the red whelk or buckie *Neptunea antiqua* were not present in the historical samples collected in the 1940s. Other species that appeared to have become more common included the brittlestars *Amphiura chiajei* and *Amphipholis squamata*, the bivalve *Nucula sulcata* and the worm, *Lumbrineris* sp. The study also identified a highly significant change in the polychaete to mollusc ratio, with the proportion of polychaetes found to be higher in the more recent samples.

A wide range of other studies were carried out on the impact of dredging on the Manx seabed and to assess the impact of the Port Erin Closed Area on benthic habitats by scientists at the Port Erin Marine Laboratory during the twentieth century and until the laboratory closed in 2006. Projects of note included the Dredge Disturbance project led by Dr Andy Brand (publications include Bradshaw *et al*. 2001, Bradshaw *et al*. 2002, Jenkins *et al*. 2001).

More recently, Lambert *et al*. (2012) used the 2008 Bangor University benthic survey of Manx waters and the vessel monitoring system fishing effort data to assess the impact of fishing on seabed habitats in Manx waters.

They found that high fishing effort corresponded to smaller emergent epifauna (animals that grow up off the surface of the seabed) and lower biomass of these species (including the bryozoa *Cellaria sinuosa*, hydroid *Hydrallmania falcata* and the soft coral *Alcyonium digitatum*). Emergent epifauna provide habitat for juvenile scallops and other species, therefore contributing an important ecosystem service. The study also attempted to estimate the loss of epifaunal biomass caused by fishing, coming up with a range of between 0 and 34% of epifaunal biomass being lost to fishing each year. The average estimated value was 8%.

The study also looked at how physical environmental variables influenced the size and biomass of emergent epifauna. They found that stronger currents were generally associated with higher biomass of emergent epifauna. Higher wave stress was associated with lower biomass and size of emergent epifauna. Other studies have found that wave induced mortality can impact on communities down to 50m on continental shelves.

The study showed that fishing intensity was correlated with lower biomass and small sizes of organisms and concluded that this decrease in complexity is likely to affect mobile epifauna and juvenile fish because of the reduction in food and shelter provided. They also concluded that the impact of fishing pressure on habitat is likely to have a direct impact on the recruitment of scallops if it limits settlement habitat such as the bryozoa *Cellaria*.

Island-Wide Sub-littoral Dive Surveys

Port Erin Marine Laboratory scientists (Veale *et al*. 1998) carried out an initial Phase 1 sublittoral survey of the Isle of Man between 1995 and 1997. In total, 162 surveys were carried out by 63 divers. The locations of the dives in 1995, 1996 and 1997 are shown in Figure 1. Species lists and descriptions of habitats are available for each of these sites.
Veale et al (1998) remains one of the best overviews of Manx coastal marine habitats, giving detailed descriptions of seven zones around the coast. Their overall description of the Manx seabed was as follows:

"Generally, bedrock and boulder slopes dominate the habitats close to the shore in the South of the Island, with sand and gravel sediments at greater depths. The sedimentary coastline of the north of the Island slopes down to seabeds of a similar composition. Sediment is generally finer on the west coast than the east coast, reflecting the deeper water closer to shore at the former."

During their surveys, Veale *et al*. (2008) identified features of conservation interest including extensive areas of maerl and a sublittoral blue mussel bed around the Point of Ayre, sea caves at the Sugarloaf and Ronaldsway and an eelgrass bed in Ramsey Bay. The survey also identified 20 locations for maerl. Maerl was found to be abundant between the Point of Ayre and Ramsey, off Douglas and Laxey on the east coast and off Kirk Michael on the west coast.

The sublittoral blue mussel bed found north of Ramsey was highlighted for conservation interest, particularly because of the shallow depth it was found at. The mussel bed found was 50cm high in 10-12m of water. Connor et al. (1997) found that subtidal *Mytilus edulis* beds usually occur beneath the limit of kelp growth.

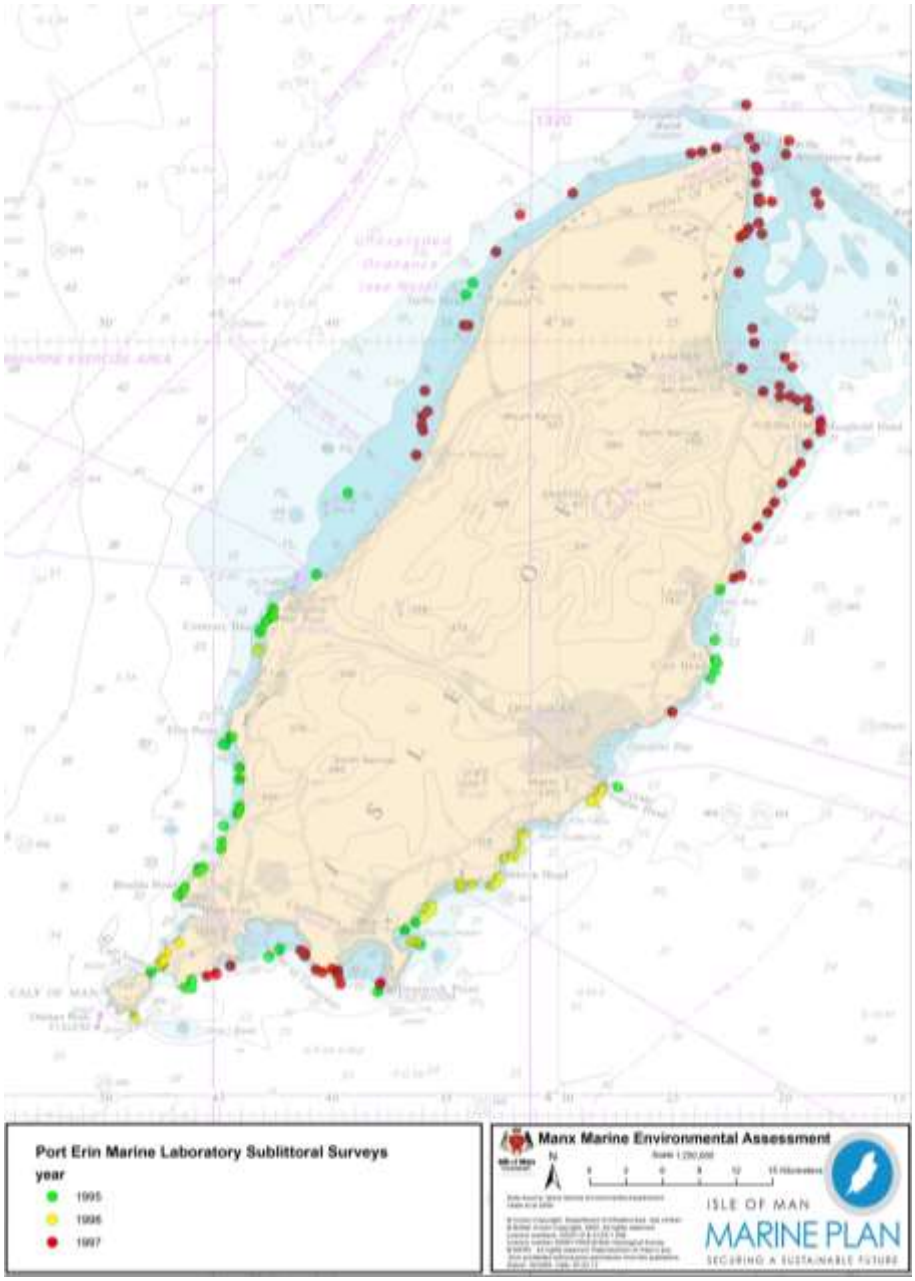


Figure 1. Location of Port Erin Marine Laboratory Sublittoral Surveys in 1995, 1996 and 1997. See Veale et al. (1998) for more details.

The main recommendations made by Veale *et al*. (1998) were:

- At the Calf of Man, resurvey the sites surveyed in 1991 and 1992 by Morrow *et al*. (1993).
- Survey off the North East of the Isle of Man, between the Dog Mills and the Point of Ayre, to determine the extent and diversity of maerl beds identified there.
- Survey the sublittoral blue mussel beds off the Point of Ayre.
- Carry out a series of dives around *Gob ny Rona* headland to locate the eelgrass bed.
- Survey dives of the sea caves at the Sugarloaf and the Anvil (on the Meayll Peninsula).

Phase 2 Sublittoral Survey

In 2000 Veale *et al*. (unpublished) led a second phase of the Isle of Man sublittoral survey to follow up on recommendations made in Veale et al. (1998). A total of 37 dives were carried out at 36 sites located between Ramsey and the Point of Ayre, in the grid shown in Figure 2. The main focus for this survey was to identify the distributions of maerl and edible mussels between the Dog Mills and Ramsey. They found live maerl at 20 of the 36 sites, comprising 1-50% of the total substrate. Dead maerl was found at an additional two sites. From this occurrence of maerl, Veale (unpublished) estimated that maerl was present over an area of 9.35km^2 and represented over 50% of the habitat in an area of 2.55km^2.

Horse mussels (*Modiolus modiolus*) were also identified from 17 out of the 36 sites, ranging from rare to abundant. There were five sites where horse mussels were categorised as abundant.

During the survey 209 different species of animals and plants were identified from the 36 sites.

The diversity of species in the sites with more than 10% maerl was compared with the diversity of species in sites with less than 10% maerl surveyed during this study. They found that while the Ramsey Bay high maerl sites were not more diverse than the Ramsey Bay low maerl sites, the Ramsey Bay high maerl sites were significantly more diverse than sites sampled inside the Port Erin Closed Area, which were protected from scallop dredging, but did not contain maerl.

Figure 2. Positions for Ramsey Bay dive surveys in 2000 from Veale et al. (unpublished).

Benthic habitat survey of Manx waters 2008-2011 and ongoing

In 2008, Bangor University in conjunction with the Isle of Man Government carried out the first systematic survey of benthic habitats in Manx waters, identifying substantial areas of habitats of high conservation importance. The RV. *Prince Madog* used drop-down video and stills cameras, grabs and other calibration tools to systematically survey the extent of Manx Territorial Waters. Still photographs of the seabed were analysed from more than 150 sites around the Isle of Man (see map Figure 3). After initial analysis of photographs from the majority of the 154 sites surveyed, Hinz *et al*. (2010) identified the main community types in Manx waters and the main areas of conservation interest. The study showed that the Isle of Man has a variety of distinct benthic habitats and associated communities.

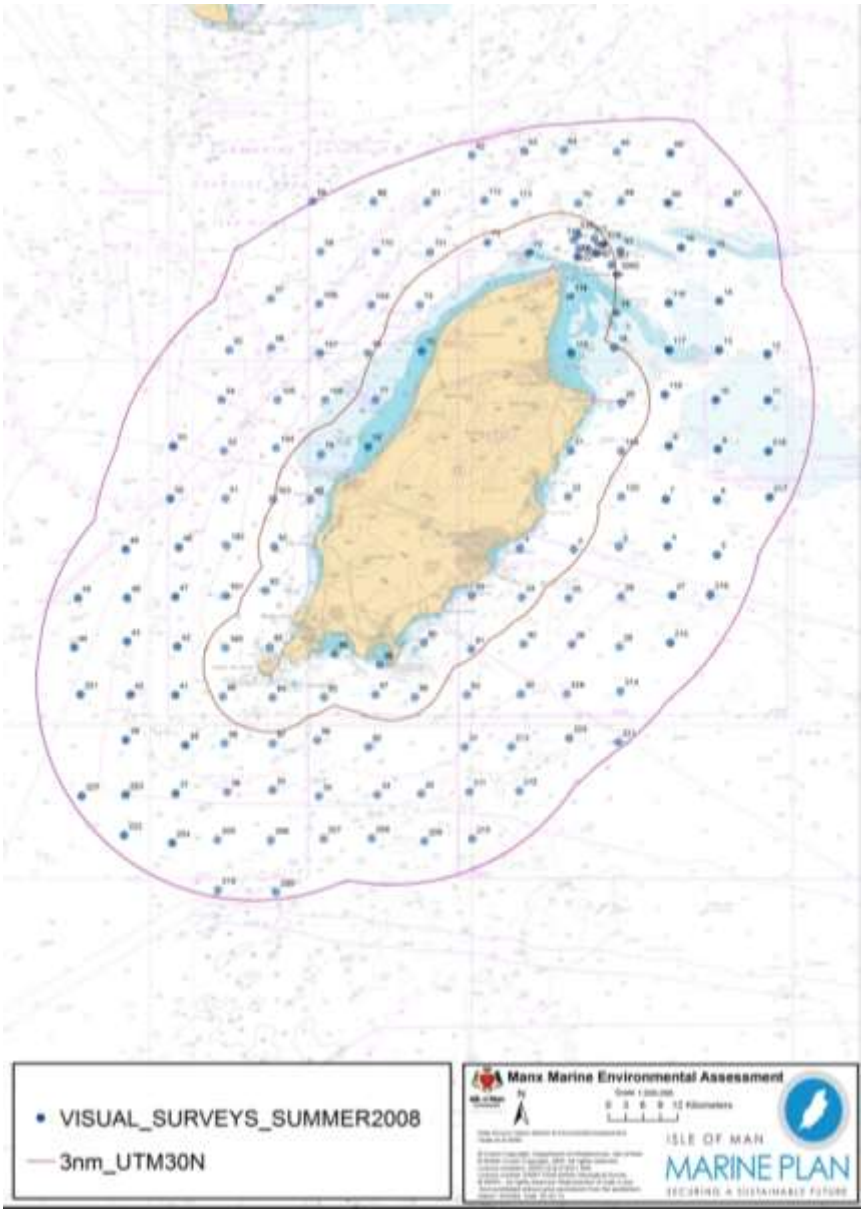


Figure 3. The stations surveyed by the RV. *Prince Madog* in 2008 and analysed by Hinz et al. (2010) and White (2011).

Preliminary cluster analysis of the seabed sediment and communities at each site revealed seven main communities (Hinz et al. 2010), shown in Figure 4:

a. High current areas dominated by the bryozoan *Alcyonidium diaphanum* and the common star fish *Asterias rubens.*

b. Deeper water muddy substrates dominated by the burrows of Norway lobster *Nephrops norvegicus*, polychaetes with emergent tubes, and *Sagartia* spp. anemones.

c. Brittle star *Ophiothrix fragilis* beds with hydroids, polychaete tubes, hermit crabs and queen scallops.

d. Coarse substrates dominated by top shells of the genus *Gibbula* with hydroids (e.g. *Nemertesia antennina),* dog cockles (*Glycymeris glycymeris)* and hermit crabs (second most common community identified in this survey).

e. Sand and gravel substrates dominated by the brittle star *Ophiura albida*, polychaete tubes, queen scallops, hydroids and hermit crabs (the most common community identified in this survey).

f. Algal and hydroid turfs.

g. Coastal areas dominated by *Laminaria* spp. and other algal cover with hydroid turf, emergent polychaete tubes and the anemone *Anthopleura ballii*.

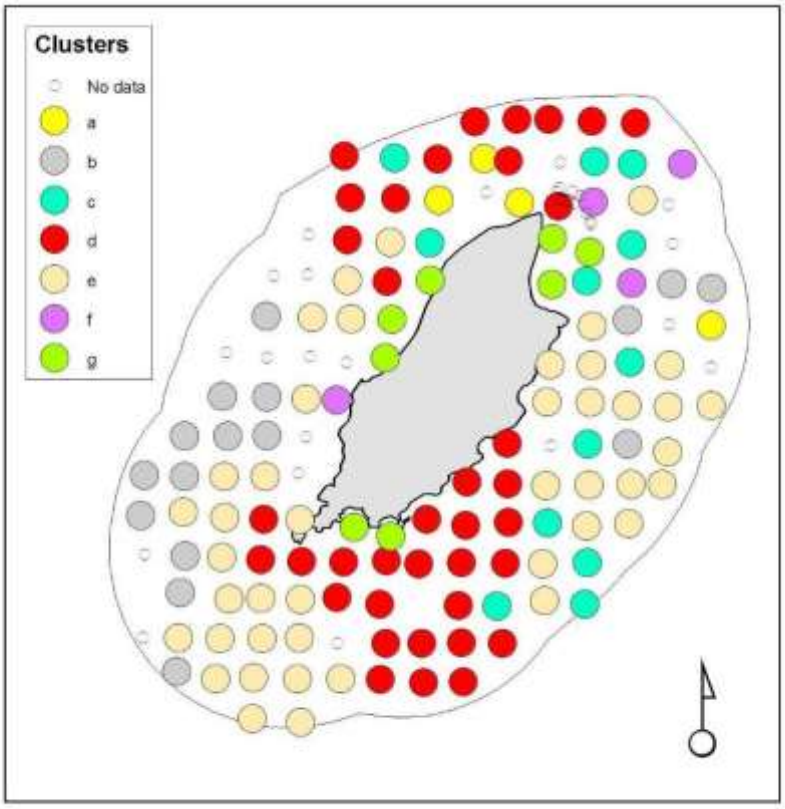


Figure 4 . The distribution of benthic communities identified by cluster analysis (from Hinz et al. 2010). See above for community descriptions corresponding with each letter. (Reproduced from Hinz et al. 2010 with permission).

Three main habitats of international conservation interest were identified during the survey: horse mussel reefs, maerl beds and Ross worm habitats (*Sabellaria spinulosa)*, which are all OSPAR priority habitats (OSPAR 2008-16). Individuals of the UK Biodiversity Action Plan (BAP) priority species, the sea anemone *Edwardsia timida,* were also recorded. The distribution of these priority habitats is shown in Figure 5.

Hinz et al. (2010) highlighted the importance of protecting the horse mussel, maerl and *Sabellaria spinulosa* habitats, recommending statutory protection for the areas identified and suggested that such protection could enhance the role of habitats such as maerl as a nursery area for queen scallops.

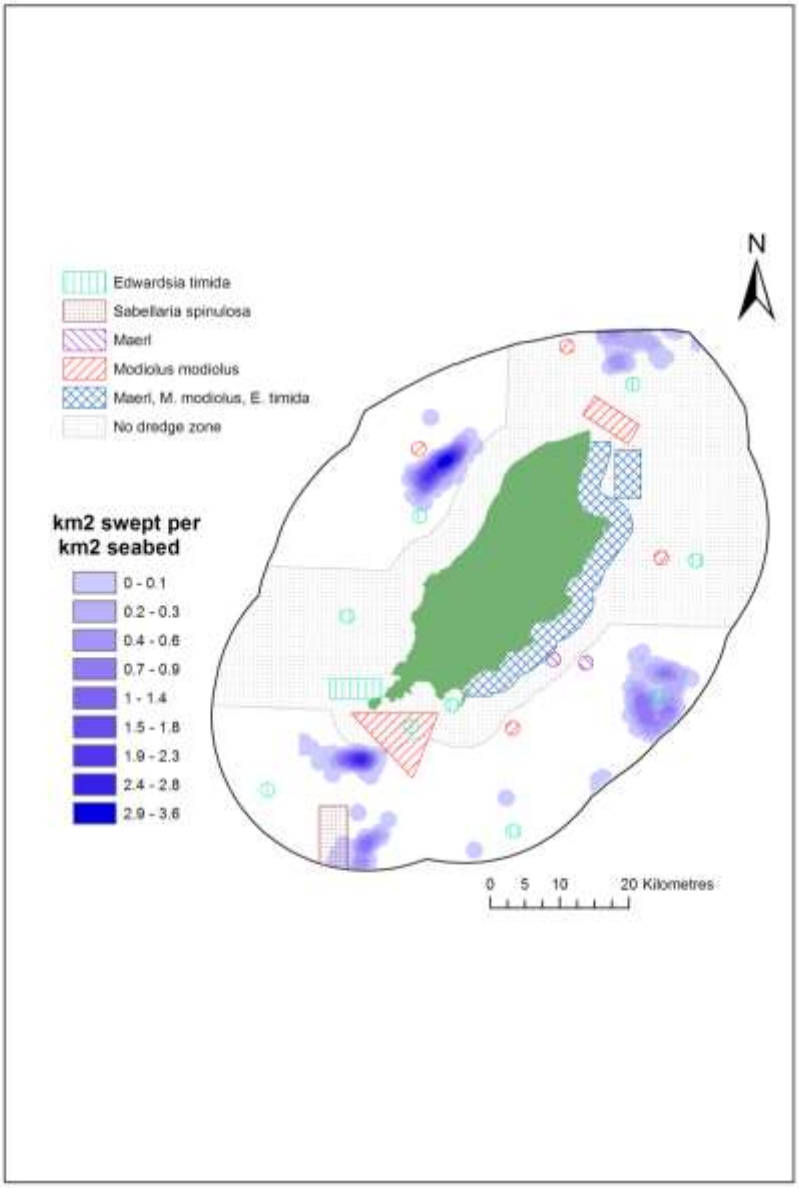


Figure 5. Areas containing species of conservation importance identified in Hinz et al. (2010) and estimated areas dredged for queen scallops between November 2007 and October 2008. Shaded area represents the no dredge Queenie Management Zone. (Reproduced with permission from Hinz et al. 2010).

Detailed Analysis of Bangor Benthic Survey

In a more detailed analysis of the 2008 benthic survey photographs, White (2011) brought together information from 7325 photographs from 150 survey sites (shown in Figure 6). Using cluster analysis and EUNIS categories, White (2011) produced a higher level of analysis and maps of benthic habitat categories.

The study used a variety of approaches to produce extrapolated habitat maps and identify biological groups. The 20 habitats shown in Figure 6 are summarised in Table 1.

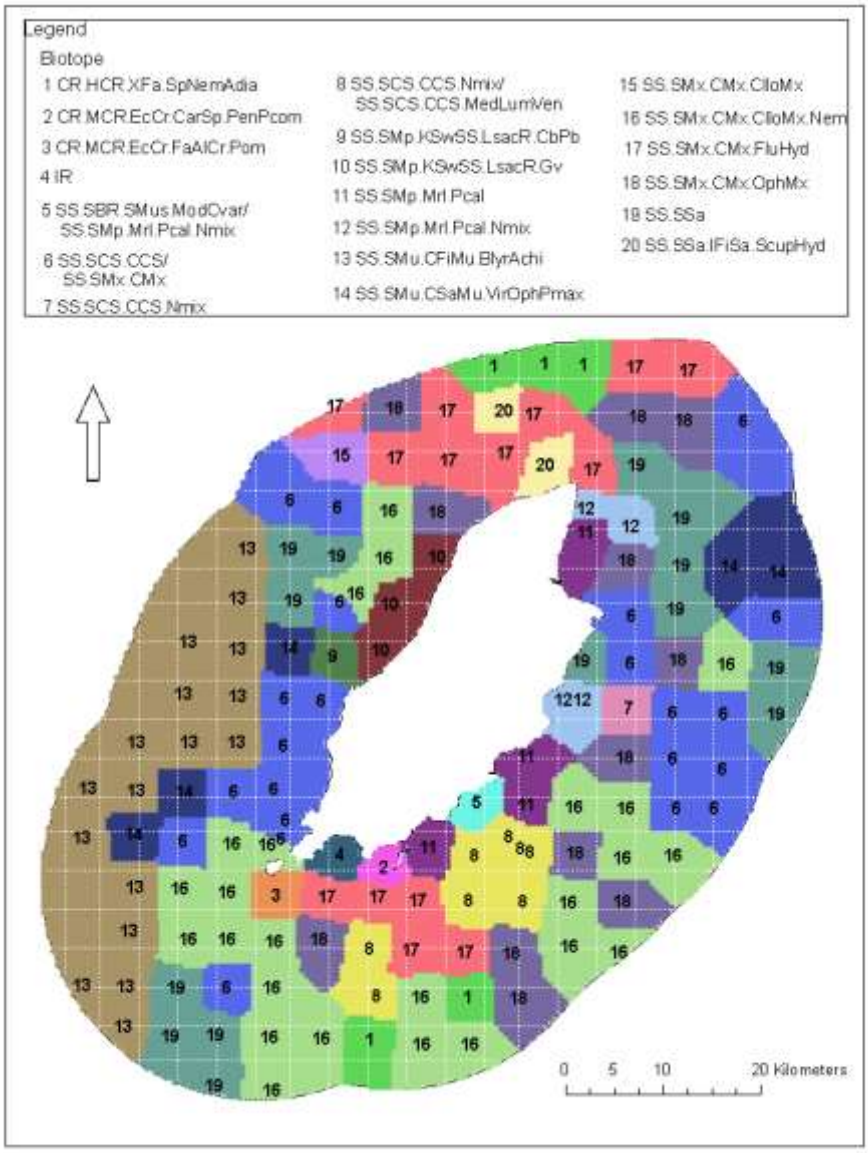


Figure 6. Distribution of biotopes at the lowest level of habitat classification based on significant community groupings. Classifications are based on the Marine Habitat Classification for Britain and Ireland Version 04.05 (Connor et al. 2004). (Reproduced from White 2011 with permission).

Table 1. The 20 habitats shown in Figure 6.

Biotope label	Biotope Code	Biotope Description
1	CR.HCR.XFa.SpNemAdia	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata
2	CR.MCR.EcCr.CarSp.PenPcom	*Caryophyllia smithii* and sponges with *Pentapora foliacea*, *Porella compressa* and crustose communities on wave-exposed circalittoral rock
3	CR.MCR.EcCr.FaAlCr.Pom	Faunal and algal crusts with *Pomatoceros triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock
4	IR	Infralittoral rock (and other hard substrata)
5	SS.SBR.SMus.ModCvar/ SS.SMp.Mrl.Pcal.Nmix	*Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata/*Phymatolithon calcareum* maerl beds with *Neopentadactyla mixta* and other echinoderms in deeper infralittoral clean gravel or coarse sand
6	SS.SCS.CCS/SS.SMx.CMx	Circalittoral coarse sediment/Circalittoral mixed sediment
7	SS.SCS.CCS.Nmix	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand
8	SS.SCS.CCS.Nmix/ SS.SCS.CCS.MedLumVen	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand/*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
9	SS.SMp.KSwSS.LsacR.CbPb	Red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles
10	SS.SMp.KSwSS.LsacR.Gv	*Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles
11	SS.SMp.Mrl.Pcal	*Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand
12	SS.SMp.Mrl.Pcal.Nmix	*Phymatolithon calcareum* maerl beds with *Neopentadactyla mixta* and other echinoderms in deeper infralittoral clean gravel or coarse sand
13	SS.SMu.CFiMu.BlyrAchi	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud
14	SS.SMu.CSaMu.VirOphPmax	*Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus* on circalittoral sandy or shelly mud
15	SS.SMx.CMx.ClloMx	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment
16	SS.SMx.CMx.ClloMx.Nem	*Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment
17	SS.SMx.CMx.FluHyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment
18	SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment
19	SS.SSa	Sublittoral sands and muddy sands
20	SS.SSa.IFiSa.ScupHyd	*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles.

Another output of White (2011) was a map of the broad substrate categories:

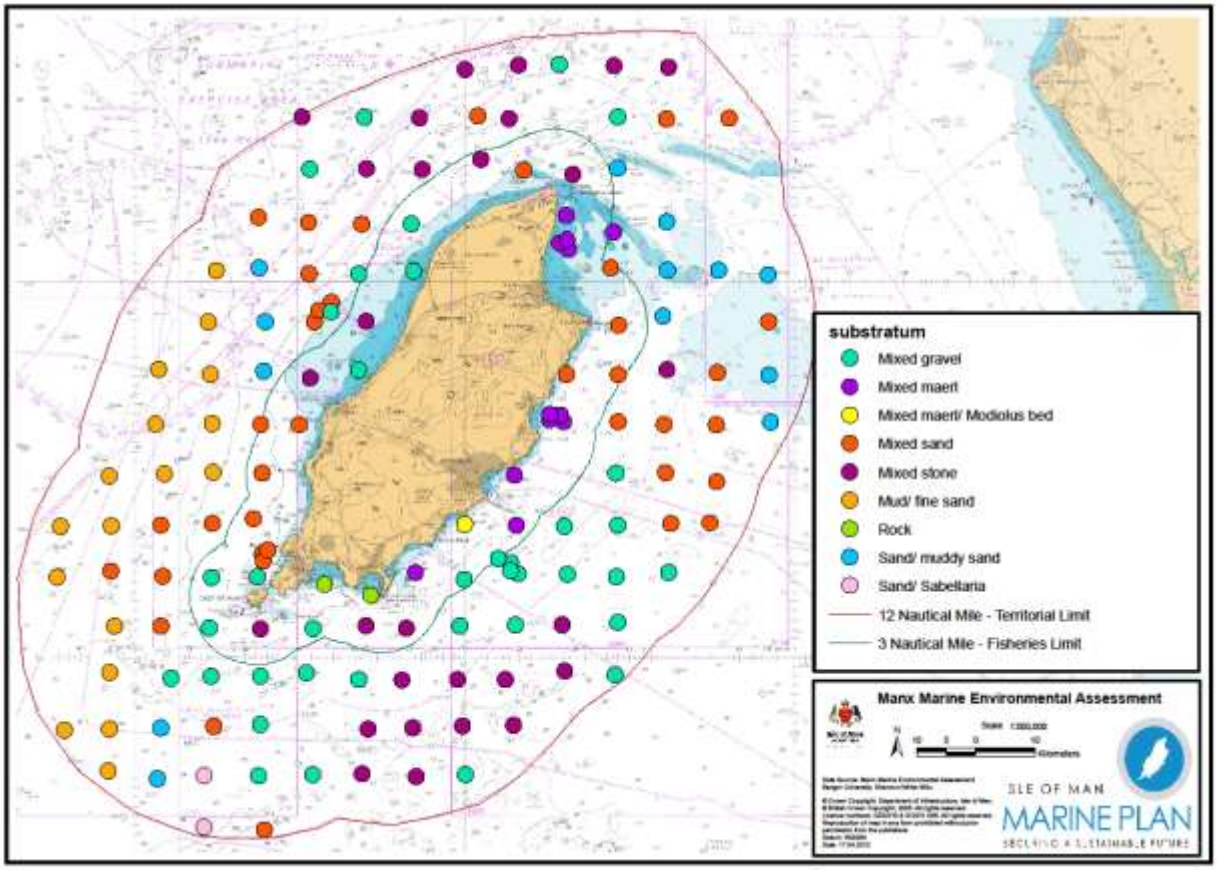


Figure 7. Distribution of different substrata categories in the Manx territorial sea as determined through image analysis and sediment particle size analysis. Derived from data collected during the Bangor University habitat survey in 2008, analysed by White (2011).

The outputs of the 2008 benthic habitat survey (Hinz et al. 2010 and White 2011) provide the first interpolated overview of habitats in Manx waters and also emphasise the importance of carrying out more detailed survey work on specific sites. Whilst the study picked up the newly discovered horse mussel reef habitat south of Douglas, the extensive horse mussel reefs off the Point of Ayre and the former important horse mussel area off Langness were not recorded as part of the systematic survey because of the wide spacing of the survey sites. At the Point of Ayre this was partly due to the difficult conditions encountered in the high currents of the Ballacash Channel. Similar problems elsewhere may mean that important habitats could be missed. This highlights the importance of new habitat surveys for Environmental Impact Assessments for marine developments.

Baie ny Carrickey habitat surveys for European lobster and brown crab

May (2015) conducted a baseline survey of the benthic habitats in *Baie ny Carrickey* Closed Area and to investigate habitat associations of commercially fished European lobster and brown crab. Seabed habitats were sampled using video techniques and benthic assemblages classified using the Marine Habitat Classification for Britain and Ireland. The results indicate that benthic assemblages are diverse across the area, with large extents characterised by rocky reefs (Figure 8).

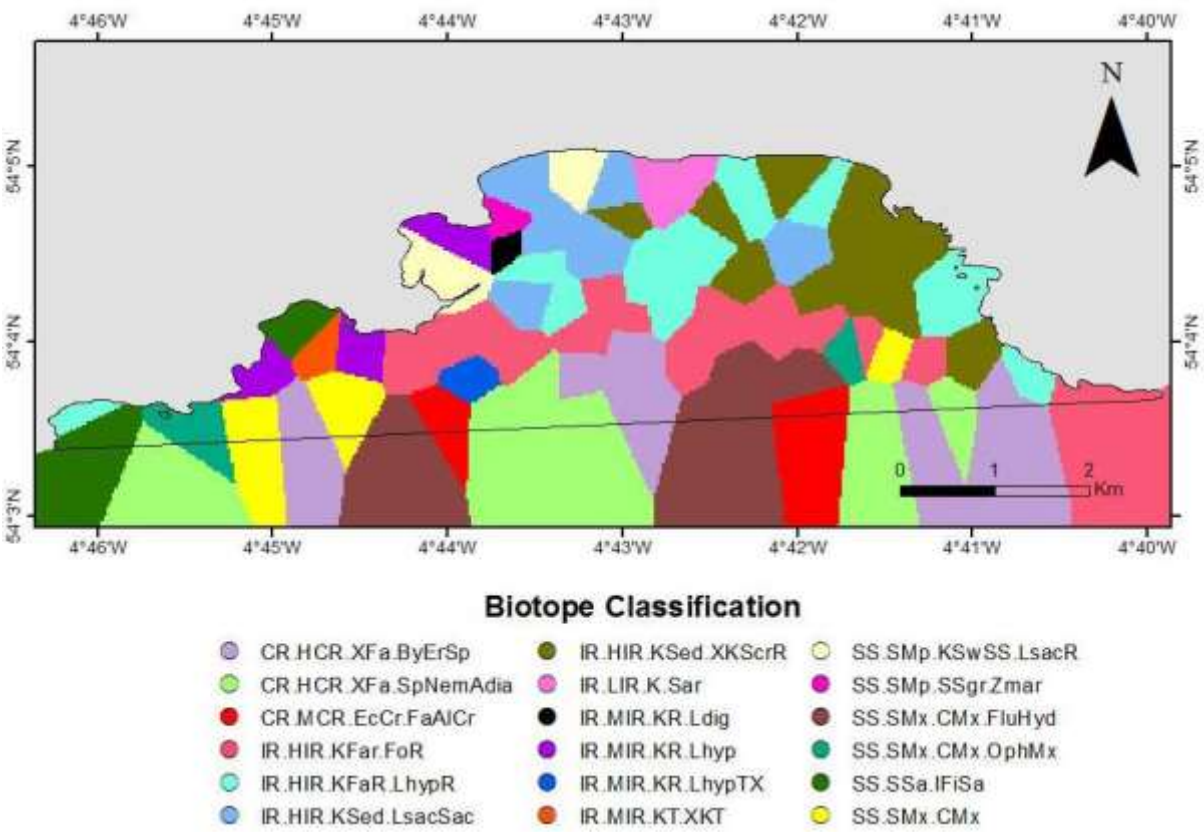


Figure 8. Distribution of biotopes in Baie ny Carrickey classified using the Marine Habitat Classification for Britain and Ireland (May 2015).

Scallop and benthic associations in Laxey and Niarbyl

Allison (2016) investigated king scallop (*Pecten maximus*) populations and their associated habitats within Niarbyl Bay and Laxey Bay. These sites were surveyed in June 2016 using a video camera mounted on a sledge. The data produced biotope maps and scallop densities (Figure 9). Laxey had limited habitats whilst Niarbyl reported a variety of habitats.

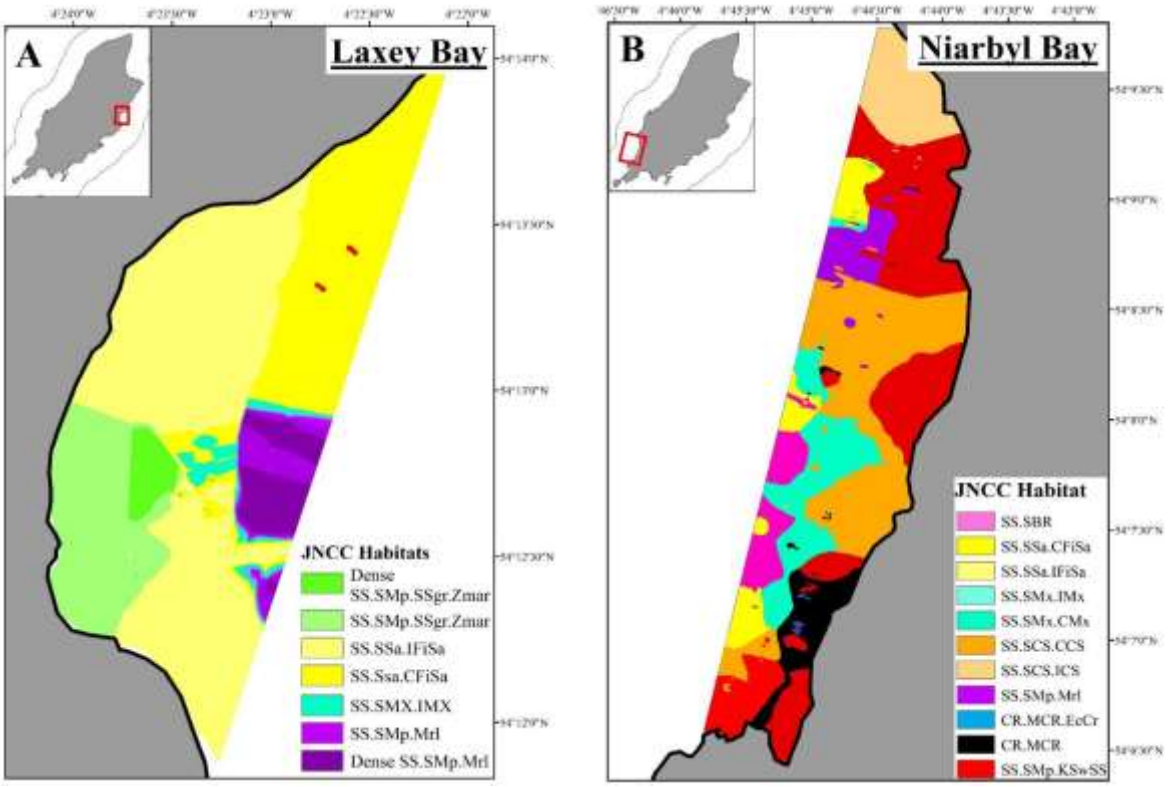


Figure 9. Biotope map of Laxey Bay and Niarbyl Bay, respectively. They were generated according to the JNCC habitat categories (Allison 2016)

Habitat mapping in Ramsey Marine Nature Reserve

Dempster (2016) undertook video tows within the marine nature reserve along with baited remote underwater videos to identify mobile species, such as fish and crustaceans, to create a biotope map (Figure 10).

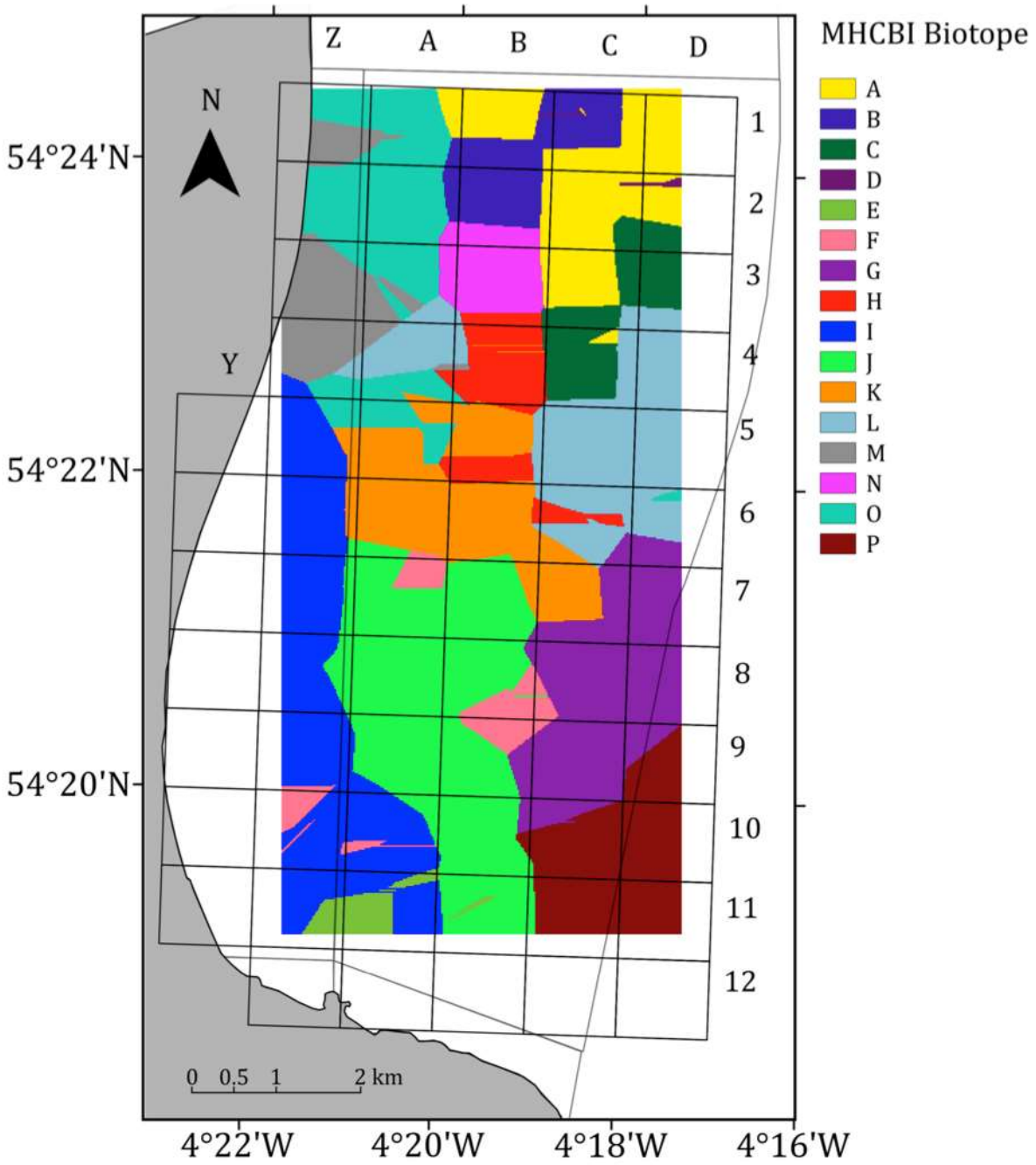


Figure 10. Biotope map showing the MHCBI (marine habitat classification for Britain and Ireland) classifications for Ramsey Bay (Dempster 2016)

There were additional habitat mapping projects for Port Erin Bay and Douglas Bay undertaken in 2016, as yet the data is unavailable.

Seasearch Dives Isle of Man 2005-2017

Seasearch is an initiative co-ordinated by the Marine Conservation Society in the UK to train recreational divers to collect survey data and record their results through a highly structured scheme. Seasearch divers have been active in the Isle of Man since the first Seasearch course took place in 2005.

Since 2008 there has been an active Seasearch Isle of Man Co-ordinator and the number of surveys has increased dramatically. Seasearch surveys have begun to make a significant contribution to knowledge of the Manx seabed. All Isle of Man Seasearch records are sent to UK Seasearch to add to their database, which feeds into the National Biodiversity Network (NBN) biological records database.

Since the initiative began several hundred dives have been completed all round the Island, with a variety of habitats being surveyed included eelgrass, maerl, mixed sediments and rocky reefs. In 2014 and 2015 the Porcupine Marine Natural History Society visited the Isle of Man undertaking dive surveys around the coast providing more in-depth surveys. In 2014 they identified a new species of starfish previously not identified on the Island, *Asterina phylactica,* along with four new nudibranch species. Seasearch divers also visited the Island in 2017 for a week of surveying.

In addition, Seasearch has undertaken non-native invasive species surveys of Douglas Harbour visitor pontoon, where the orange tipped sea-squirt (*Corella eumyota*) has been observed historically. The latest survey revealed it was no longer there. Probably having died off when the pontoon was lifted out for the winter.

Subtidal invasive non-native species

It is believed that there are 12 invasive non-native species present in both subtidal and intertidal habitats in Manx waters. At present there appears to be no significant impact associated with any of these species. However, monitoring these species is key and divers are being asked to report sightings of invasive species through the public sightings scheme that the Manx Wildlife Trust has set up. The scheme has produced an ID guide that divers can use to identify invasive species and then report any findings back to the Trust. An updated version of the ID will be launched in early 2018.

Distribution of Benthic Habitats of Conservation Interest in Manx Waters

This section identifies priority habitats, based on the OSPAR list of threatened and declining species and habitats and also UK Biodiversity Action Plan species and EU Habitats Directive habitats as a guide to national and international importance.

(a) Eelgrass (*Zostera marina*)

Eelgrass (*Zostera marina*) meadows are an important nursery area for many marine species (Davison and Hughes 1998) and play an important role as a marine carbon sink (Eelgrass is a protected species under Schedule 7 of the Wildlife Act 1990). In recent years, eelgrass has only been recorded in four sites in Manx waters and it is therefore important that these areas are protected from damaging activities. Since 2018 eelgrass areas have specific protected within the marine nature reserves and associated byelaws (Manx Marine Nature Reserves Byelaws 2018, SD2018/0186).

Historical records

Historically, eelgrass was probably more widespread in Manx waters. A 1919 map of Port Erin Bay shows eelgrass in Spaldrick Bay and inside the breakwater (Herdman 1919). Although there are anecdotal records of eelgrass in Port Erin from the 1970s (M. Bates pers. comm.), no more recent records of eelgrass are available from Port Erin Bay, despite the

area being a popular dive site and extremely well studied because of the proximity of the Port Erin Marine Laboratory.

It is likely that Manx eelgrass beds suffered losses due to the wasting disease which affected *Zostera* beds throughout the north Atlantic in the 1920s and 30s. Some additional eelgrass records can be found in the *Flora of the Isle of Man* (Allen 1984), including specimens thrown up by storms on Ballaugh shore, at Derbyhaven, Port St Mary (referenced to Knight and Parke 1931). Allen (1984) himself only recorded eelgrass material from Port Erin and describes eelgrass as "On sand below low-water mark. Rare?"

Eelgrass meadow (*Zostera marina*) at Langness, Isle of Man. Photo: F Gell.

The historical locations for eelgrass (*Zostera marina*) recorded in Allen (1984) with the known periods of fieldwork of recorders shown in brackets, are given below:

The Carrick, Ramsey Bay – Savage (1880s), Spanton (1880-86)
Ballaugh shore – thrown up by storms – Hoyle (1920s)
Douglas – Talbot (1858-7, 1880)
Peel – Clementson (1939-58)
Derbyhaven – Ralfe, LSG (1887-1936)
Port St Mary – Knight and Parke (1931, 69, 102)
Port Erin JRB (J. Bruce) LSG (Larch Garrad) & DJS (D J Slinn) – all since 1950
Sea shores – Backwell's (1855-57)

Allen also notes that *Zostera angustifolia* may also occur, but we are not aware of any records of this species.

Recent records
Current confirmed locations of eelgrass in Manx waters are shown in Figure 11.

The eelgrass site that has been subject to the most study is within Langness Gully, between the Langness Peninsula and Fort Island. The area of the eelgrass meadow is reported to have increased over the past 20 years. It originally covered an area of a few square metres

(Maura Mitchell pers. comm.) and has gradually spread to cover the whole of the inner gully area in depths of 5-8 metres. At least one undergraduate thesis from Port Erin Marine Laboratory has focussed on this eelgrass bed (Tmmink 1994).

The area is currently covered in dense eelgrass, interspersed with small patches of *Sargassum muticum* and there are also large oyster thieves, thought to be the invasive species *Colpomenia peregrina*. Other species associated with the eelgrass bed at Langness include the painted top shell, *Calliostoma ziziphinum*, the snakelocks anemone, *Anemonia viridis.* Fish species include pipefish and the 15-spine stickleback.

Another small eelgrass bed has been recorded at Garwick Bay, south of Laxey. This eelgrass bed covers tens of square metres and is patchier and sparser than the Langness site. It has been surveyed by Seasearch divers and it thought to be declining in area.

The largest recorded area of eelgrass in Manx waters is in the south of Ramsey Bay. There have been anecdotal reports of eelgrass in the south of Ramsey Bay as far back as the 1950s. In 2010 Seasearch divers carrying out surveys for razorshells found eelgrass around the Carrick, in the south of Ramsey Bay. Further surveys carried out in 2011 to provide a baseline for the Ramsey Marine Nature Reserve identified extensive, dense eelgrass beds occupying a narrow band along the coast off Maughold Broughs. Again, the eelgrass was found at around 5-8m in depth. Further Seasearch surveys in 2012 revealed more extensive areas of eelgrass in deeper waters (10-12m) in the south of Ramsey Bay.

The eelgrass beds of Ramsey Bay are now protected with Ramsey Bay Marine Nature Reserve. The Eelgrass Zone is highly protected from all impacts, whilst the meadows within the Fisheries Management Zone (off the Maughold Brooghs) is protected from dredging and trawling under a voluntary agreement with the Manx Fish Producers' Organisation. Local divers suggest that since the implementation of the marine nature reserve the area of eelgrass has extended outside its defined zone.

Recently, a small area of eelgrass has been found at Gansey by Haywood and Hextall (2014). The area is estimated to be 1,443m^2 in size, with dense swards in some areas. Little is known about this site, although it is now incorporated within the *Baie ny Carrickey* MNR.

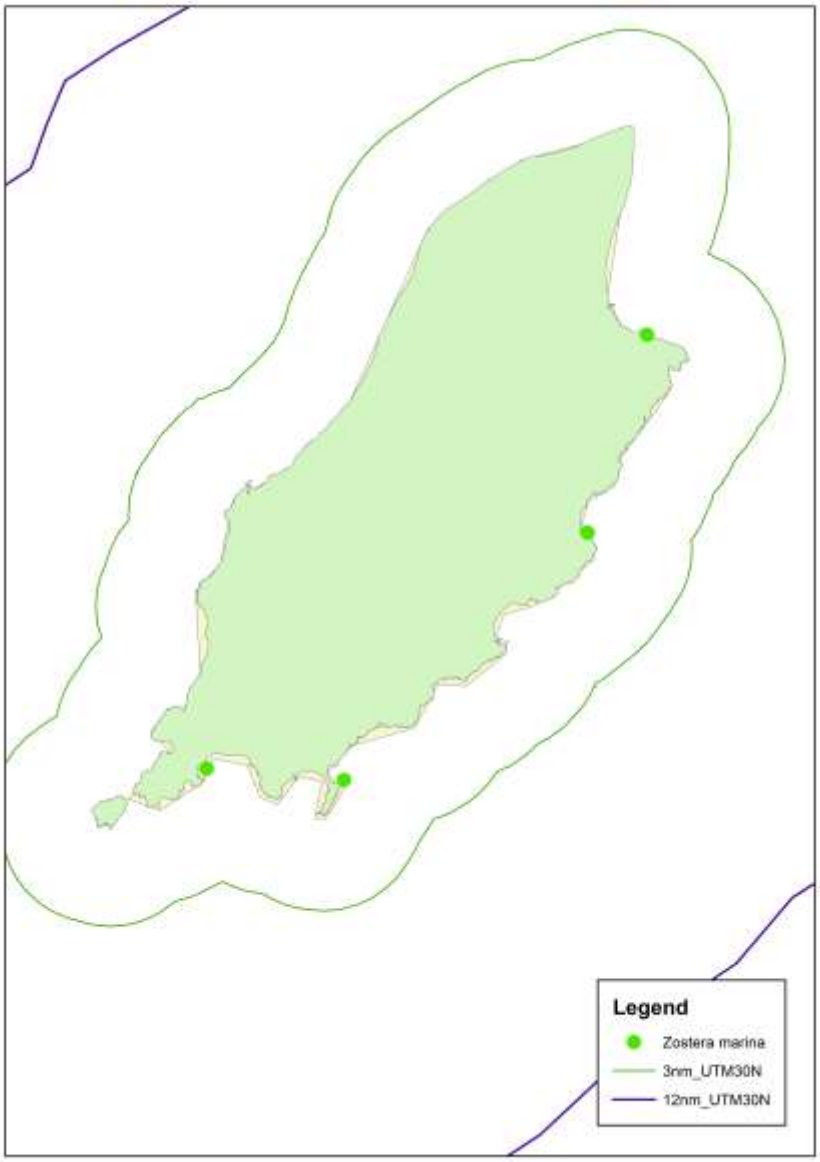
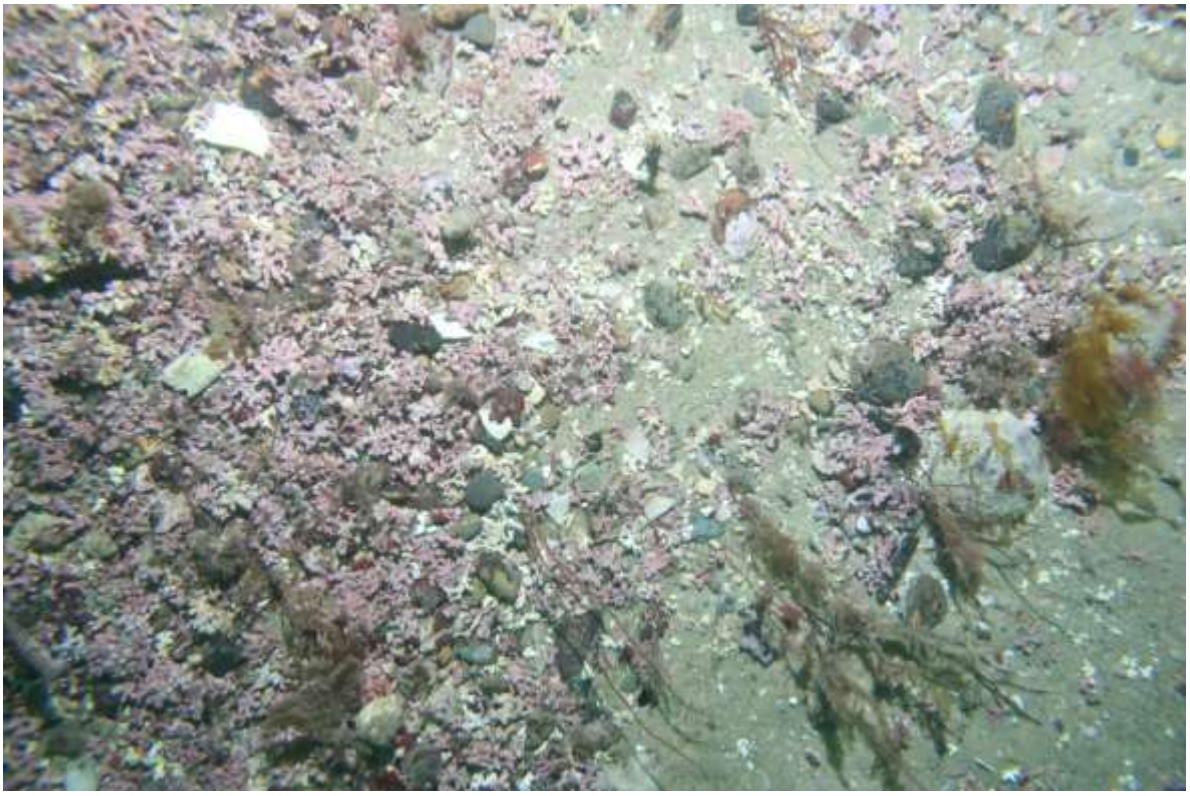


Figure 11. Current known locations of eelgrass (*Zostera marina*), a protected species under the Wildlife Act 1990.

(b) Maerl

Maerl is a type of calcified seaweed that forms reef-like structures on the seabed. Maerl is on the OSPAR list of threatened and declining species. Maerl beds are extremely diverse. In studies in the Clyde more than 600 species were found associated with maerl beds (Barbera et al. 2003). Maerl is also known to be an important nursery ground for scallops, cod and other species (Kamenos et al. 2004a).

The maerl in Manx waters is most likely to be *Phymatolithon calcareum* (Veale et al. 2008), which is listed on the EU Habitats Directive Annex V, Biodiversity lists for England, Wales and Northern Ireland and a UK Biodiversity Action Plan priority species. Maerl has been recorded at numerous locations in Manx waters in the surveys described above. The most extensive known bed of maerl is in Ramsey Bay (image below), but more extensive areas may be present in less well-studied areas. Figure 12 shows recorded locations of maerl.



Maerl (pink structures) habitat in Ramsey Bay. Photo: Bangor University Benthic Survey 2008.

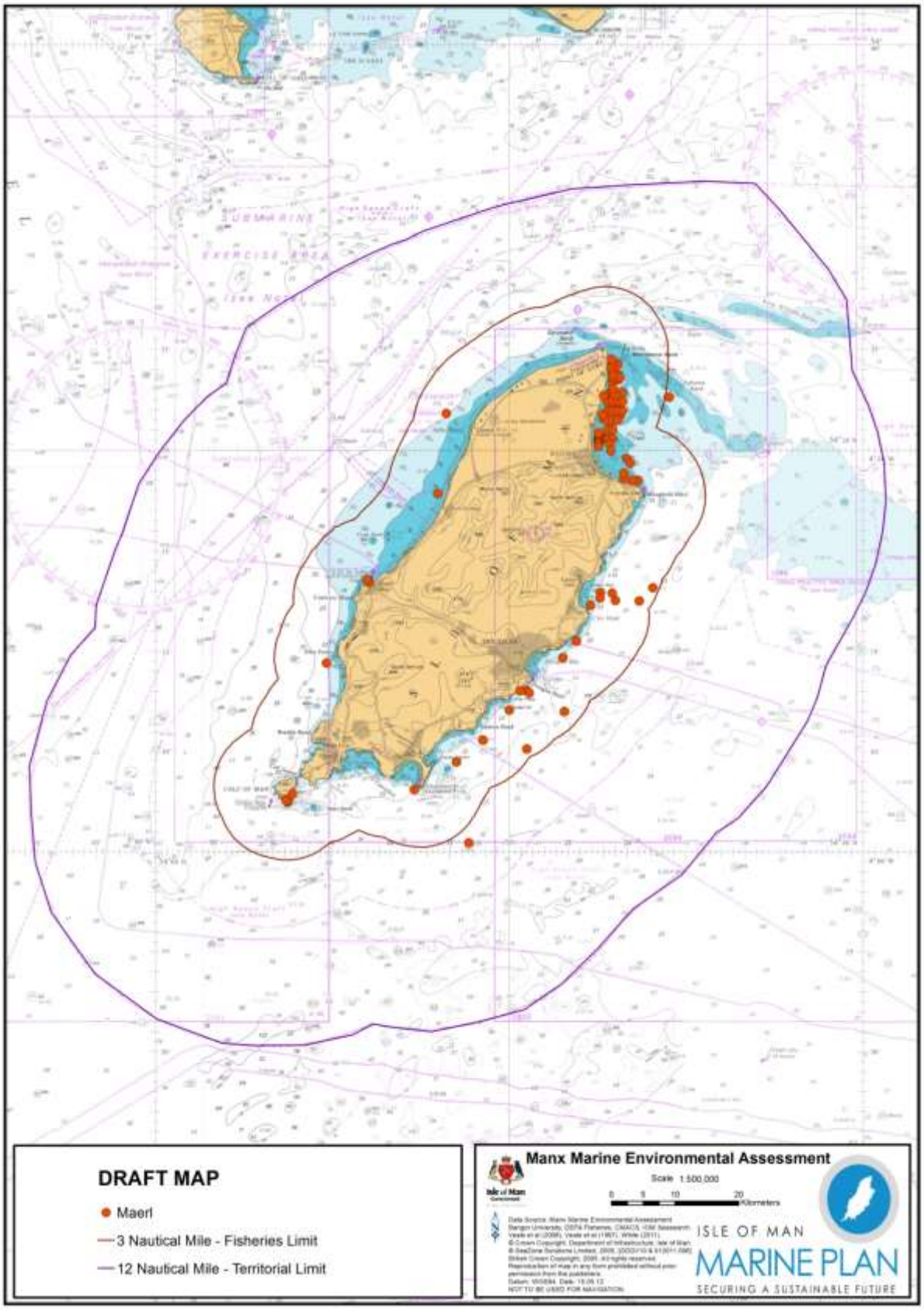


Figure 12. Current location of maerl beds, recorded from the 2008 Bangor University benthic survey, Veale et al. 1998 and unpublished and Seasearch surveys.

(c) Horse mussel reefs (*Modiolus modiolus*)

Horse mussel reefs are on the OSPAR list of threatened and declining species. They are a priority conservation habitat and are particularly important to conserve because they may takes decades, or longer, to establish as a habitat. Horse mussel reefs play an important role in shaping the seabed, and as a large area of filter feeding molluscs, also make an important contribution to water quality.

The locations of recent records of horse mussel habitat are shown in Figure 13. In his work in the 1940 and 1950s, Jones (1951) identified a large area of horse mussels off the south west of the Isle of Man. This area is also shown in Figure 11. More recent surveys have identified the extensive horse mussel reef in the Ballacash Channel, off the Point of Ayre, a highly diverse horse mussel reef off Little Ness, south of Douglas and a horse mussel reef off the north-west coast of the Isle of Man, in the area of unexploded ordinance off Jurby.

Terry Holt discovered a previously unreported horse mussel reef in the Ballacash Channel in 1996 whilst carrying out surveys as part of the Environmental Impact Assess for hydrocarbon exploration (Holt and Shalla unpublished 1996 and 1997). Surveys to identify herring spawning areas revealed the extent of the horse mussel reef and also the extensive areas of brittlestars and other habitats in the vicinity.

The horse mussel reef in the Ballacash Channel, off the Point of Ayre. Photo – Rohan Holt, Countryside Council for Wales.

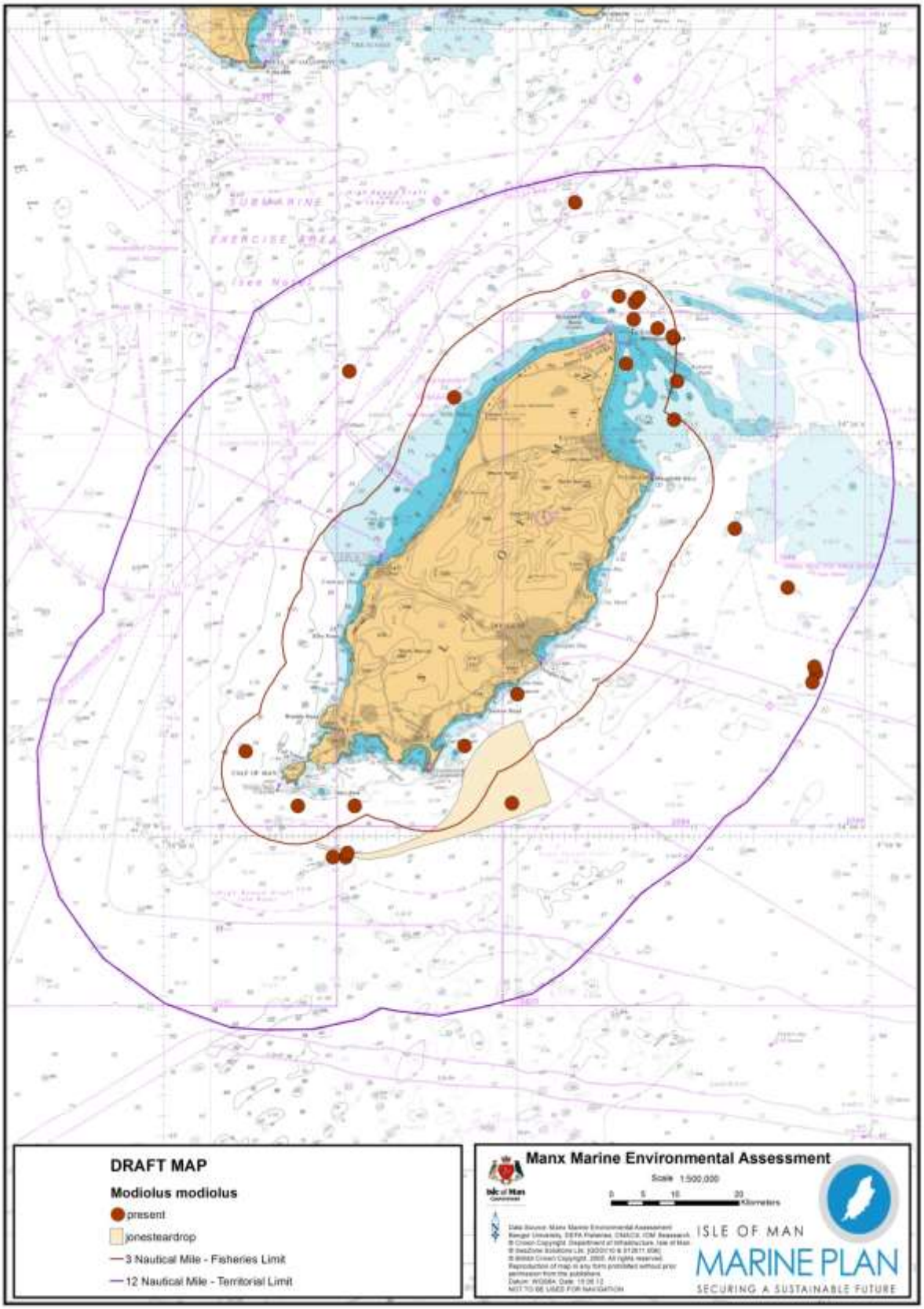


Figure 13. The distribution of horse mussel (*Modiolus modiolus)* in Manx waters. The figure uses data from the Bangor benthic habitat survey, Seasearch dives and Jones 1951 for the yellow shaded area which shows the location of the horse mussel reef detected in that survey.

Countryside Council for Wales Horse Mussel Reef Surveys, 2007-2009

In 2007, the Marine Monitoring Team of the Countryside Council for Wales collaborated with the Wildlife and Conservation Division of the Isle of Man Government Department of Agriculture, Fisheries and Forestry to establish a monitoring site on the horse mussel reef in the Ballacash Channel, off the Point of Ayre. The survey team used the information gathered by Dr Terry Holt and his team in the late 1990s as part of an Environmental Impact Assessment of the area. They established a permanent monitoring site at what was thought to be a good example of the horse mussel reef habitat. The location of the monitoring site was centred on 54°26'.196N 004°18'.177W. Twelve permanent monitoring quadrats were installed and each year the quadrats were photographed and videoed to allow detailed analysis of the habitat. Between 2007 and 2008 damage occurred to the permanent monitoring quadrats, thought to be as a result of towed fishing gear. This damage allowed an assessment of the impact of damage on the habitat. Cooke (2009) quantified changes in the quadrats following damage and found that structural complexity of the habitat was reduced and that abundance of most species (except scavenging hermit crabs) and diversity of species decreased. Cooke (2009) found that bivalves were most affected by the fishing damage, with a 75% decline in abundance.

Bangor University survey of the horse mussel reefs off the Point of Ayre 2008

Bangor University also carried out a side scan sonar survey of the Ballacash Channel horse mussel reef in 2008 with additional seabed photographs and surveys (Hinz *et al*. 2008). The Ballacash Channel is a difficult place to carry out surveys and because of the strong tidal currents, it was only possible to deploy the camera two hours either side of slack water.

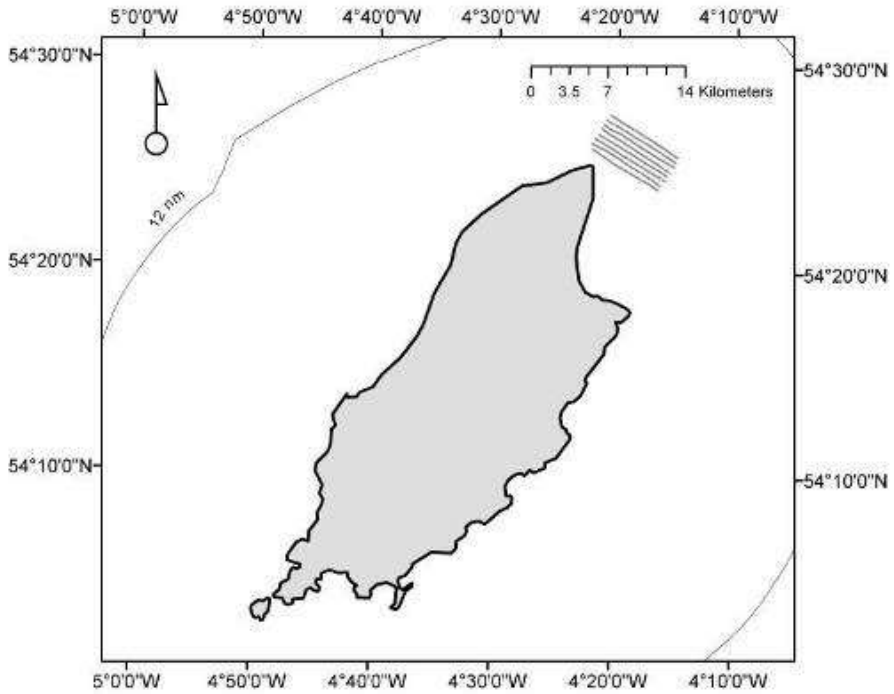


Figure 14. Location of Bangor University side scan sonar surveys to identify boundary of Ballacash Channel Horse Mussel Reef (Hinz et al. 2008).

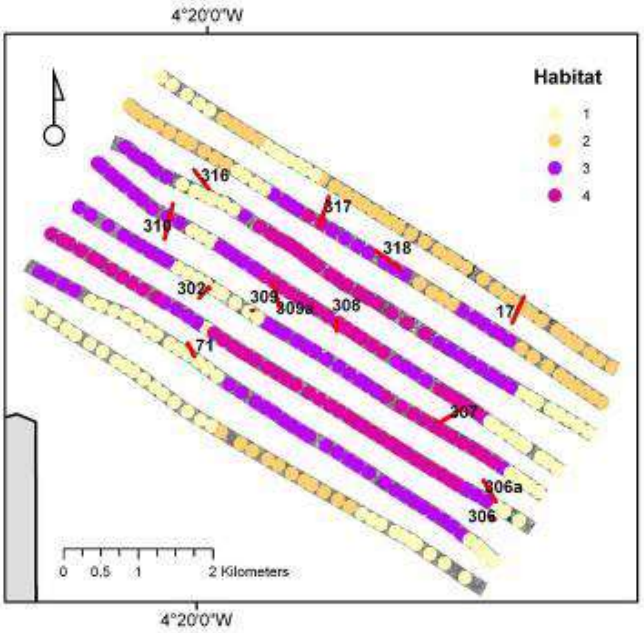


Figure 15. Broad habitat categories identified using side scan and drop-down camera (Hinz et al. 2008).

The location of the side scan sonar surveys are shown in Figure 14 and the habitat categories identified are shown in Figure 15.

The habitat categories shown are:
1) Smooth surface indicating a level substratum of similar type.
2) Clear wave structures indicating sand waves.
3) Some structured substratum present most likely *Modiolus* beds.
4) Extensive structural substratum present most likely *Modiolus* beds.

The study identified potential horse mussel reefs areas (the pink areas – habitat numbers 3 and 4). This concurs with previous habitat maps produced by Terry Holt at the Centre for Marine and Coastal Studies (CMACS) (Holt and Shalla unpublished 1996, 1997). The horse mussel reef habitat (categories 3 and 4) covered an area of 16 km^2 (53% of the area surveyed). The study identified the northern, southern and south eastern edges of the horse mussel reef, but it was not possible to identify the northern and western extent and the report concluded that it was possible that the reef would extend to the northwest as well.

Horse mussel reefs surveyed in ground discrimination survey by Department of Environment, Food and Agriculture, 2011

Further information about the boundaries of the Point of Ayre horse mussel reefs was collected, as part of a detailed benthic habitat survey of the Ramsey Bay and Ballacash Channel area, by DEFA (Isle of Man Government), as part of the survey and monitoring for Ramsey Marine Nature Reserve (Kennington 2011). The survey used Hy-Pack ground discrimination system to map seafloor characteristics and they were visually confirmed using sledge-mounted video surveys and grab sampling. Figure 16 shows the possible boundaries of the horse mussel reef areas based on the initial interpretation of the data collected on this survey. Higher resolution information was collected by a team of volunteer divers. For more information about this survey see the Marine and Coastal Conservation chapter (3.7) of this report.

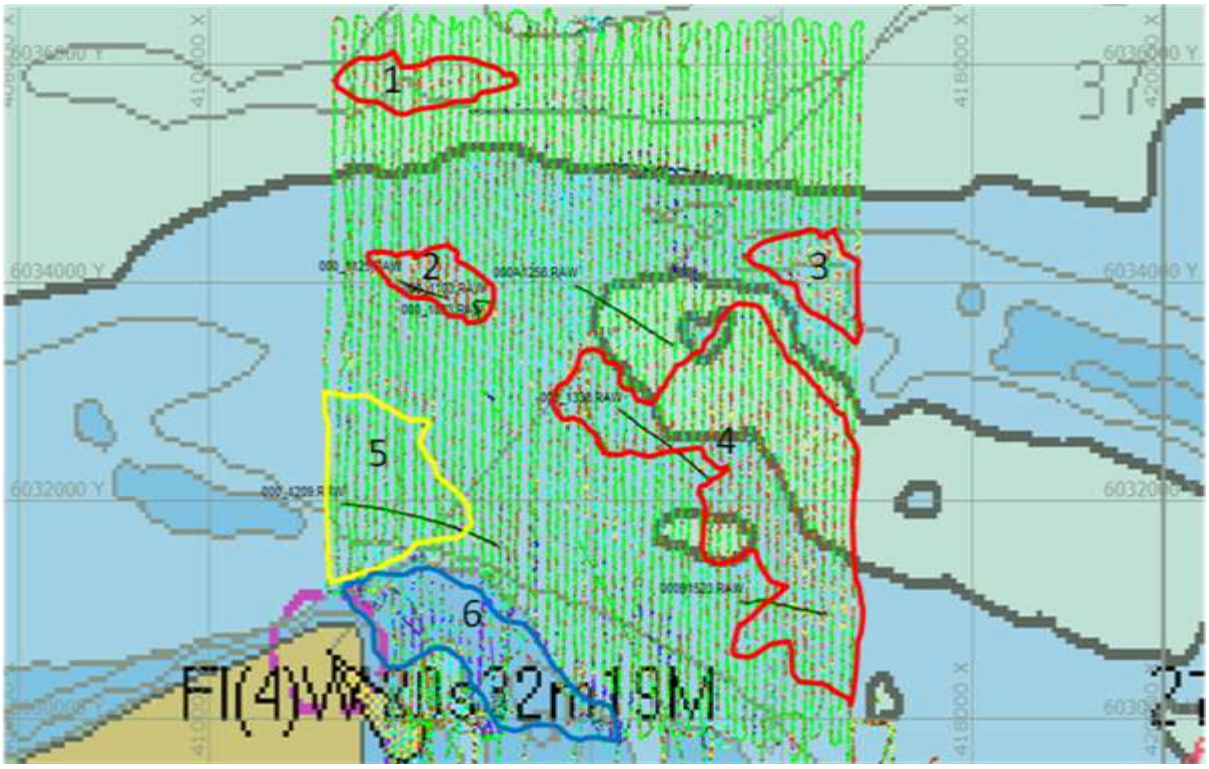


Figure 16. Detailed survey of the horse mussel reefs off the Point of Ayre carried out by DEFA in 2011. Red areas represent confirmed and potential horse mussel reefs identified by video survey and Hy-Pack. The blue zone is a scoured zone and the yellow zone is an area of cobbles. The green lines denote paths of video tows. Reproduced with permission from Kennington 2011.

Newly recorded horse mussel reef south of Douglas

In 2008, Seasearch divers discovered a highly diverse horse mussel reef site to the south of Douglas. The following summer a detailed survey of the site was carried out (Perry and Roriston 2009). Soon after its initial discovery by divers, this site was also picked up during the Prince Madog surveys (Hinz *et al*. 2010, White 2011).

White (2011) highlighted the diversity of the horse mussel reef off Little Ness, south of Douglas and also the density of horse mussels found at the site. White (2011) also highlighted the vulnerability of this area of horse mussel reef to damage by fishing activity. In her analysis of the spatial distribution of habitats and fishing activities, as medium fishing effort was recorded adjacent to the site. White (2011) recommended that the extent of the horse mussel reef habitat should be investigated further in this area and measures taken to protect the area.

In a more detailed study of the horse mussel reef, Perry and Roriston (2009) estimated the area of the main part of the reef to be approximately 0.22km^2, running parallel to the coast for around 780m, about 800m from the coast. The density of live horse mussels at this site was exceptionally high with estimates of 200 live horse mussel per m^2 from visual counts and over 240 per m^2 from sampling.

Horse mussel reef located south of Douglas (survey station 23) from the Bangor University/DEFA benthic survey. Image was captured during a visual habitat survey conducted within the 12 nautical mile territorial limit of the Isle of Man in 2008.

(d) *Sabellaria spinulosa* (Ross worm)

Sabellaria spinulosa are on the OSPAR list of threatened and declining species, Annex 1 of the Habitats Directive and they are also a UK BAP species. The 2008 Bangor University benthic habitat survey identified *Sabellaria spinulosa* to the south of Manx waters (see Figure 17 and image below). The habitat had not previously been formally recorded.

***Sabellaria spinulosa* tubes located at survey station 205 on the Bangor University visual habitat survey in 2008 (Photo: Bangor University)**

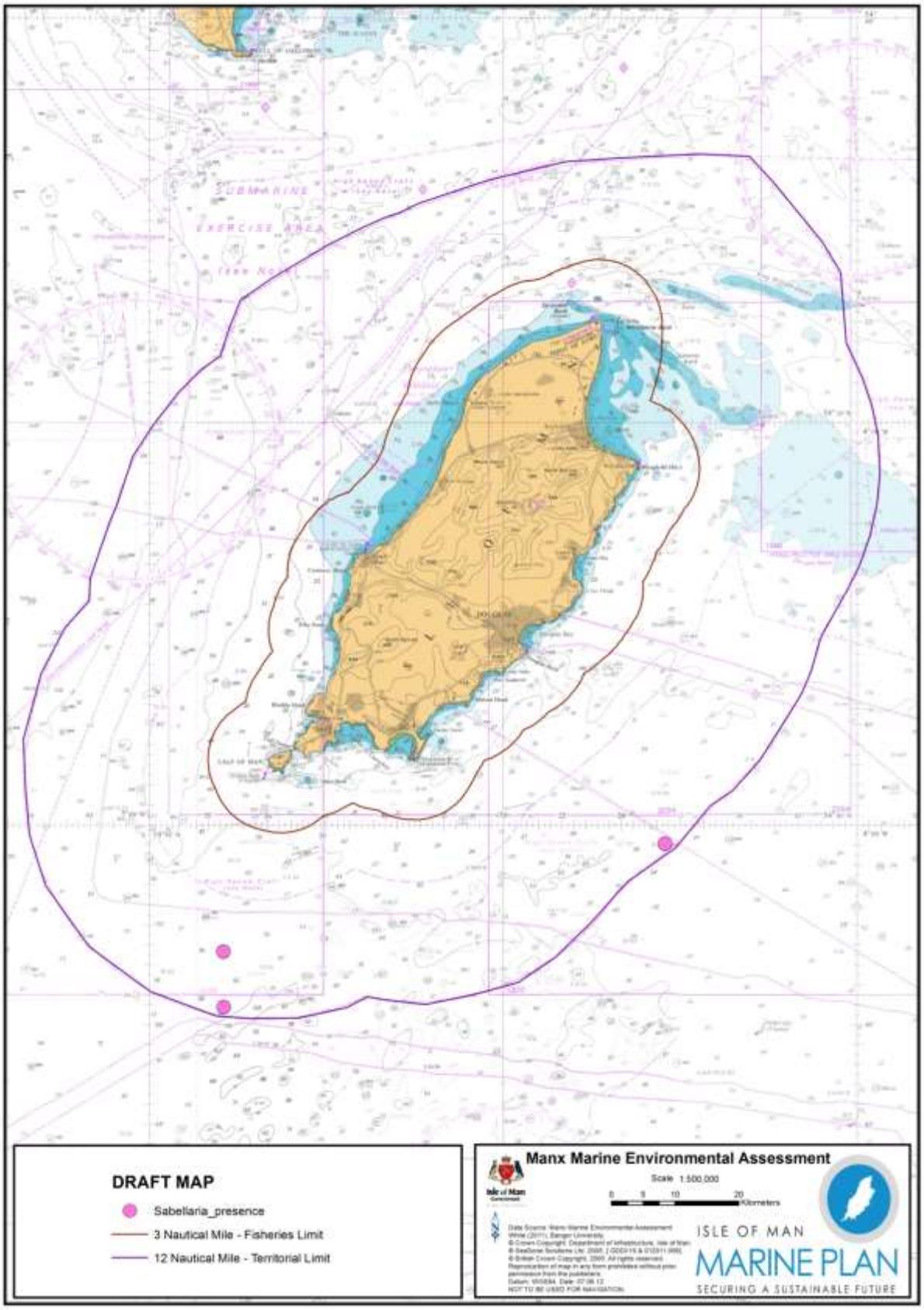


Figure 17: Location of *Sabellaria spinulosa* (Ross worm) identified through Bangor University benthic surveys 2008 (from White 2011).

(e) Rocky reef habitats

Rocky reefs are listed on Annex 1 of the EU Habitats Directive. The coast of the Isle of Man from Peel round to Maughold Head is primarily rocky, creating rocky reef habitat subtidally. The southern coast of the Isle of Man has been particularly well studied by divers and the rocky reef habitats of the Isle of Man are thought to be of high diversity. For descriptions of the rocky reef habitats common around Manx waters see the section on the Calf of Man and the survey reports from the Calf of Man (Morrow *et al*. 1991, Veale *et al*. 1998). Other sources of information on the rocky reef habitats of the Isle of Man can be found in the two dive guides available for Manx coasts (Sanderson *et al*. 1994 and Mitchell & Hextall 1994).

Rocky reef habitat off the Calf of Man, Isle of Man. Photo Chris Wood, Seasearch.

The Calf of Man

The Calf of Man has long been recognised for its rocky reef habitat and high biological diversity. In the 1980s and 1990s the Calf of Man was extensively studied by divers associated with the Port Erin Marine Laboratory and a number of detailed reports, theses and species list were completed for sites around the Calf.

In a comprehensive survey of 34 sites around the Calf of Man in 1991, Morrow *et al*. (1993) found that the "clear water and strong tidal streams around the Calf support bottom-dwelling communities, dominated below the kelp zone by filter-feeding invertebrates, which are unusually rich for the Irish Sea".

Morrow *et al*. (1993) provide a full description of the habitats and communities present around the Calf of Man. The subtidal habitats are based on bedrock and boulders and are

dominated by kelp and other algal beds and extensive animal turfs, particularly on vertical surfaces. Morrow *et al*. (1993) identified 95 species of conservation importance in total and also identified sites as particularly important for biodiversity. They also describe the diversity of the Calf compared to other sites:

"The Calf has an exceptionally high faunal diversity, clearly greater than that of three large localities, in adjacent areas of the British Isles, which have been the subject of comparable studies."

During the surveys scientists found 30 species of marine animal that had never been found in Manx waters before, 12 species that had never been found in the Irish Sea before and 1 species of sponge that had never been found in the British Isles before. They also identified two species of nudibranch (seaslugs) new to science (*Doto sarsiae* and *Doto hydrallmaniae*). Both these species have since been recorded in Northern Irish waters but one of them has only been seen at one other site so appears to be uncommon (B. Picton pers. comm.). For many of the other species listed this was the first time they had been recorded in the Irish Sea. In 1993 a total of 449 species of marine animals and plants had been recorded around the Calf of Man. It is likely that subsequent research and survey work in the intervening 16 years has identified additional species, but that information has not been collated.

The Chicken Rock, to the south west of the Calf of Man, is known for its big shoals of Pollack (*callig* in Manx Gaelic) (Sanderson *et al*. 1994. C. Perry pers. comm.). It is also becoming increasingly known for regular sightings of Risso's dolphins (*Grampus griseus*) (Manx Whale and Dolphin Watch (MWDW) 2007 and 2008 reports).

In a more recent dive survey of important marine sites around the Manx coast, Veale et al (1998) recommended that populations of Ross coral (the bryozoan *Pentapora foliacea*) should be monitored around the Calf because they are "considered vulnerable to fishing activities (Bunker and Mercer 1988, Edwards 1993, Eno *et al*. 1996) and may be declining around the Calf (M. Bates pers. obs.)". The current status of Ross coral around the Isle of Man is not known.

In her 2000 "Review of Marine Nature Reserve Sites around the Isle of Man", Gubbay identified the Calf as one of 13 important Manx marine sites on the basis of "rich and varied sublittoral fauna with most listings of Manx fauna found around the Calf. Internationally and nationally rare species".

Gubbay also identified, "Rare bryozoan species including *Alcyonidium mammilatum*, *Tubulipora lobifera* and *T. penicillata*." and the presence of Ross Coral, *Pentapora foliaceae*, (now known as the Potato Crisp Bryozoan).

In their dive guide to the Calf of Man, Sanderson *et al*. (1994) described the diversity at the Burroo:

"Any description short of a laborious catalogue of species cannot do justice to the diversity of marine life at the Burroo. In fact, in the areas exposed to fast flow, it is sometimes a challenge to find a single square centimetre of bare bedrock, so abundant is the life there!"

In a review of the Status of Marine Nature in the Isle of Man, Hawkins *et al*. 1990 state that the extension of the terrestrial protection of the Calf of Man to the marine environment was discussed in 1987. Hawkins *et al*. (1990) also identified marine sites around the Calf of Man of particular ecological significance:

(a) Gibdale – notable for high diversity and *Echinus* (listed as "near threatened" on the IUCN Red List of Threatened Species).
(b) The Stack – notable for *Flustra foliacea* horn wrack.
(c) Culberry – notable for *Flustra foliacea* and jewel anemones (*Corynactis viridis*).
(d) Burroo – notable for its diversity of habitats and communities.

Seasearch dives around the Calf of Man, including a systematic survey in 2011, have confirmed the continued importance of the site in terms of biodiversity. Diverse animal turfs and high structural complexity continue to characterise the habitats and numerous species of British Isles' interest can still be found around the Island.

(f) Sand banks

There are extensive sandbanks off the north of the Isle of Man: the Ballacash Bank, the King William Bank and the Bahama Bank. The extensive Irish Sea Sandy Mound extends from the east of the Isle of Man into UK waters. A survey of the UK part of the Irish Sea Sandy Mound (between the Isle of Man and the UK) was carried out by JNCC and AFBI in 2008 (Mitchell *et al*. 2008). They described the eastern side of the Sandy Mound as an area of bi- and poly-modal sands. They found areas of fine sand and silt/clay throughout the site and shell-debris was common, but patchy. Shell debris included large numbers of razorshells (*Ensis* spp.). The north-east side of the site was found to contain gravel. The southern area of the site contained the finest sands and mud. Mitchell *et al*. (2008) concluded that the area of sandbank they surveyed was part of a large sandbank extending into Manx waters. Mitchell *et al*. (2008) also highlighted the importance of surveying the whole site as one entity and also looking at the whole site, and the surrounding seabed, to assess the sensitivity and conservation value of the area.

Under the EU Habitats Directive, subtidal mobile sandbanks are included under "Sandbanks which are slightly covered by seawater at all times".

To the south of the Isle of Man, the Wart Bank is a well-know and previously well-studied site. Gubbay (2000) highlighted Wart Bank as a possible site for a Marine Protected Area in Manx waters for its importance as a feeding area for fish and seabirds.

Jones *et al*. (1965) surveyed Wart Bank between 1961 and 1965 using SCUBA diving and echo sounder from vessels. The bank is about 3.3 km across and 1.4 km from north to south at the widest point and lies in 8-30m depth of water. Their surveys showed that the sand waves were very mobile, travelling on average 5-10cm/day. One sand waves crest moved 74cm during a single flood tide. The marine life observed during the dives included shoals of sandeels, (*Ammodytes lanceolatus* and *Gymnammodytes semisquamatus*). Plaice (*Pleuronectes platessa*) and hermit crabs (*Pagurus bernhardus*) were also observed on the surface of the sand waves. They described the bank as a well-known feeding ground for cod and pollack, but they did not directly observe large numbers of these species during dives. Jones et al. (1965) noted that other larger infauna were not numerous, probably because of the unstable nature of the sediments. They did not study the microfauna.

Wart Bank was included with the Calf of Man within a new marine nature reserve in 2018.

(g) Brittlestar beds

Brittlestar (Ophiuroidea) beds were identified as important biogenic habitats in the UK Marine SAC review in the 1990s (Hughes 1998). Hughes (1998) highlighted the importance of the Isle of Man for its extensive brittlestar beds and cited a study in the 1960s (Brun 1969), which featured a brittlestar bed between depths of approximately 27-36m in Manx waters with densities of brittlestars of up to 2000 individuals per m^2. Hughes (1998) also cites historic records of brittlestar beds in Manx waters in Garner (1878) and Chadwick (1886). Jones (1951) also identified extensive brittlestar beds in Manx waters:

"The two ophiuroids *Ophiotrix fragilis* and *Ophiocomina nigra* occur in some places in enormous numbers, and as far as can be judged by dredge hauls must sometimes completely cover the bottom. *Ophiotrix* is usually the commoner, and sometimes occurs alone, but *Ophiocomina* is usually present in smaller numbers. On the other hand *Ophiocomina* is occasionally present to the exclusion of *Ophiothrix*. The conditions that favour the presence of one of the other species have not been determined, but the *Ophiothrix* seems to prefer rather deeper water and cleaner ground, while *Ophiocomina* is more abundant close to the coast or where there is less water movement."

The Bangor University benthic survey in 2008 indicated that seabed dominated by brittlestar beds is widespread in Manx waters. In Hinz *et al*. (2010) nearly half of the sites assessed in Manx waters fell into one of two brittlestar-dominated biotope categories.

White (2011) found that high abundance of the brittlestar *Ophiura albida* was associated with higher fishing pressure, which agreed with the findings of Kaiser *et al*. (2000), which looked at benthic communities associated with different levels of fishing pressure in Manx waters.

Dense brittlestar bed in Manx waters (from site 69 of the Bangor benthic survey). Photo Bangor University.

(h) *Arctica islandica* (Arctic or Iceland Clam) habitat

Arctica islandica has been recognised as a threatened or declining species in the North Sea region by the OSPAR Convention. It was also identified as an important species for the UK Marine Conservation Zones project. Laxey Bay has long been known for its populations of *Arctica islandica*, although the species also occurs in Niarbyl Bay and Port Erin Bay. Ingham (1988) studied heavy metals in the Laxey Bay *A. islandica* populations and also aged a small sample, estimating the age range of the Laxey population to be between 65 and more than 120 years old. Figure 18 shows the known locations of *A. islandica* in Manx waters.

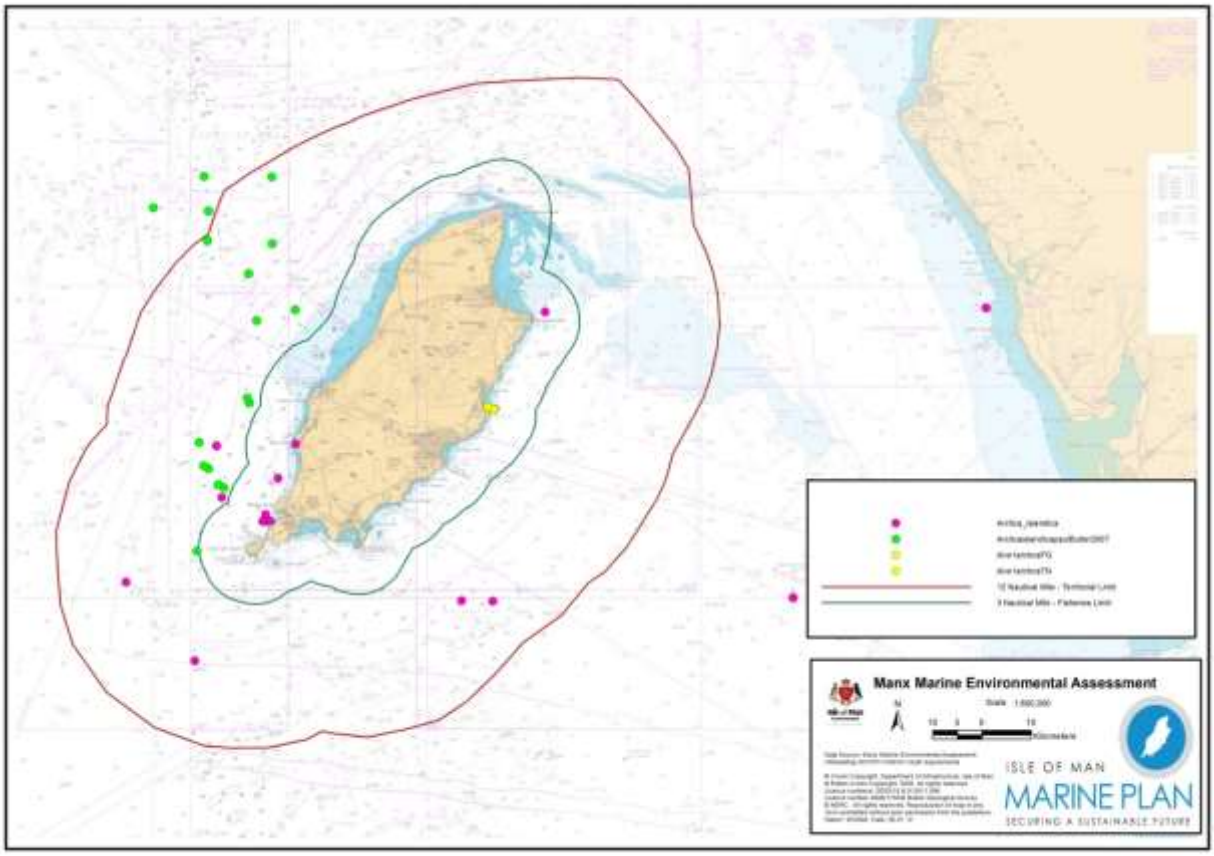


Figure 18. Sites where *Arctica islandica* has been recorded. All the green points were recorded by Butler (2009). Additional points have been recorded from dive surveys and other sources.

Fish Spawning Grounds

Ellis *et al*.. (2012) gave an updated overview of key fish spawning and nursery areas in the Irish Sea based on Cefas survey work and other sources of information. In addition to the importance of Manx waters for herring spawning, the report indicates the importance of Manx waters for many other species of fish as spawning or nursery areas. A few examples from Ellis *et al*. (2012) of fish using Manx waters or the wider Irish Sea include:

Spurdog – the Northern Irish Sea is important for juvenile spurdog.

Tope – little is known about the reproductive biology of tope, but juvenile tope have been caught in groundfish surveys, allowing some preliminary nursery grounds to be identified, including the Irish Sea around the Isle of Man.

Hake – ichthyoplankton surveys indicate the importance of Manx waters for hake spawning.

A particularly important feature of the Manx seabed is the extensive herring spawning ground off the east of the Isle of Man. This area is thought to be the most important herring spawning area in the Irish Sea. The main herring spawning ground is to the east and south east of the Island but herring spawning has also been recorded to the north and north east, including off the Point of Ayre (Dickey-Collas *et al*. 2001). Proactive management of the herring fishery has a long history in the Isle of Man and there was an annual closure of the fishery from 1st January to 5th July 1610 until 1823 (Smith 1923).

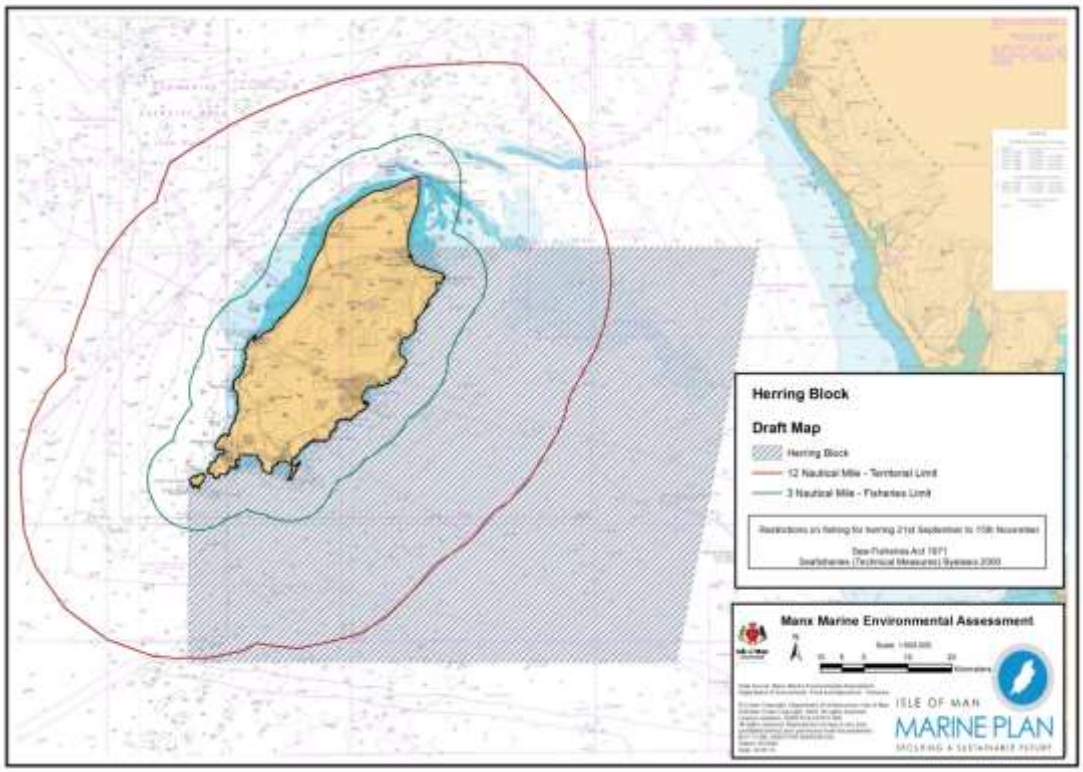


Figure 19. The location of the herring box, closed seasonally (from 21 September to 15 November) from capture of herring to protect spawning herring.

The herring box is protected under the Sea-Fisheries (Technical Measures) Bye-laws 2000, Part III Special Provisions Relating to Fishing for Certain Sea-Fish and is closed to herring fishing from 21 September to 15 November every year in a substantial area of the Manx Territorial Sea (see Figure 19).

For further information about fish species in Manx waters please see MMEA Chapter 4.1 (Commercial Fisheries and Sea Angling).

Other Priority Species

Edwardsia timida, the timid burrowing anemone, is a UK Biodiversity Action Plan priority species. During the Bangor University benthic survey, the species was recorded at a number of locations in Manx waters (Figure 20).

The occurrence of ross coral (*Pentapora foliacea*) (now also known as the potato crisp bryozoans) around the Calf of Man has been reported from a number of sources, including Morrow et al. (1993) and more recent Seasearch dives. *Pentapora folicacea* was identified in 2010 as a priority species on the Northern Ireland priority species list.

Seaweeds

Recent information about distributions of subtidal seaweed species in the Isle of Man can be found in Hardy and Guiry (2003) and more detailed historic information about seaweed distributions in Knight and Parke (1931).

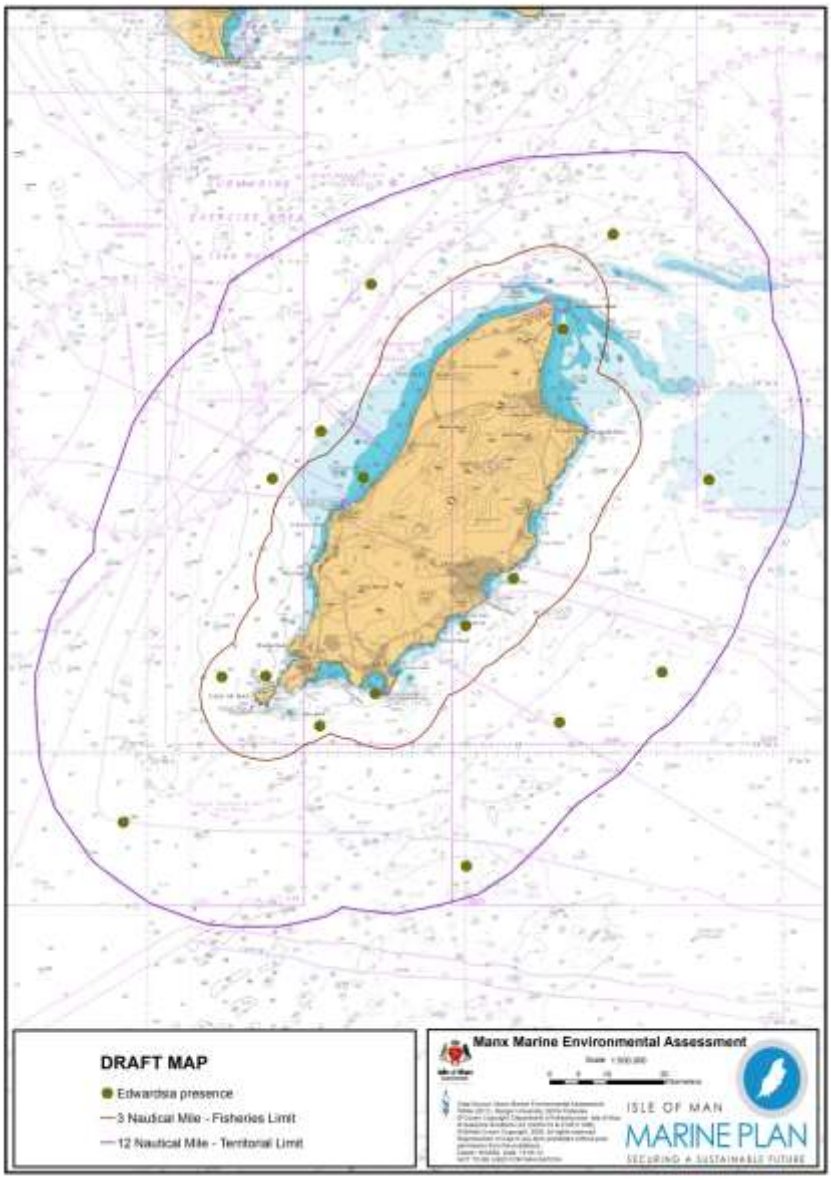


Figure 20. The locations where the sea anemone *Edwardsia timida* was recorded during the Bangor benthic survey 2008 (from Hinz et al. 2010 and White 2011).

Sensitivity of Benthic Habitats

Please note this section provides only a very brief overview of some of the main issues and sources of information. For more detailed information on impacts and mitigation please refer to the references and sources of information given. For specific advice on mitigation measures please contact the Department of Environment, Food and Agriculture and refer to UK and EU best practice.

Marine habitats are sensitive to a wide range of impacts related to marine developments. Key habitats such as maerl beds, eelgrass meadows and horse mussel reefs are all vulnerable to mechanical destruction or smothering as a result of marine developments. A good source of background information on the sensitivity of marine habitats to human impacts is the UK Marine Protected Area Centre: http://www.ukmpas.org/ (formally UK Marine SACs project website: http://www.ukmarinesac.org.uk/).

A more recent resource is the OSPAR Quality Status Report and associated background documents: http://qsr2010.ospar.org/en/qsr_assessments.html.

OSPAR reports are available on the impact of a wide range of marine developments on marine habitats and also on each of the OSPAR species and habitats.

As an example, horse mussel reefs are probably one of the most diverse and vulnerable habitats in Manx waters. In the OSPAR Commission background report on *Modiolus modiolus*, Rees (2009) recognised horse mussel reef habitats as "highly intolerant to substratum loss, abrasion and physical damage". Rees also highlighted the vulnerability of horse mussel reefs to towed fishing gear and other physical damage to the seabed and identified this as a key threat to the habitat. The CCW monitoring work carried out on the Point of Ayre horse mussel reefs showed what was thought to be fishing related damage between 2007 and 2008 reduced biodiversity and structural complexity of the horse mussel reef habitat. This site is now protected from mobile fishing as part of the Ramsey Marine Nature Reserve. Horse mussel reefs are long-lived structures that can develop over many years, but they can rapidly reduce to rubble and dead shell by physical impacts such as dredging.

In the background report on maerl for the OSPAR Commission Hall-Spencer et al. (2010) identify substrata loss, smothering, increase in suspended sediment, abrasion and physical disturbance as key threats to maerl. Maerl is vulnerable to anything that decreases available light and impacts on its ability to photosynthesise. Maerl is also very slow to recover from impacts, both in terms of the slow growth of individual maerl nodules and the slow recovery of the maerl bed structure.

Protecting Manx Subtidal Habitats

The Isle of Man has had legislation for Marine Nature Reserves since the Wildlife Act was introduced in 1990. For full information about conservation designations in the Isle of Man please see the Conservation chapter MMEA Chapter 3.7 (Marine and Coastal Conservation).

The Calf of Man was recommended as the Isle of Man's first Marine Nature Reserve in 1992. The Calf of Man Marine Trust was established and after 18 months work to determine the

feasibility of a Marine Nature Reserve for the Calf of Man, a detailed proposal was submitted to the Isle of Man Government (DAFF 1992). The proposal identified the Calf of Man as providing sites both representative of Manx waters and also some unusual and interesting communities not found elsewhere in Manx waters. Unusual features included the extensive beds of the bryozoan hornwrack (*Flustra foliacea*) and the importance of the area for basking sharks.

The land of the Calf of Man has been protected since 1959 as a Bird Observatory and Sanctuary (Garrad 1972) and the Calf Marine Nature Reserve proposal was therefore an extension of an existing terrestrial designation into the marine environment. Protection recommended in the proposal included restricting potting to those fishermen already using the area, prohibiting dredging within the boundaries of the reserve (within the 30m depth contour or out to 500m), a Code of Conduct for anglers and restrictions on boat speed and anchoring. The proposal was eventually rejected after public opposition from a small number of individuals. A voluntary code of conduct was proposed, but was never actively implemented.

The Calf of Man has also been repeatedly mentioned by scientists and consultants as a prime site for a Marine Protected Area. Geffen et al. (2000) described the Calf of Man as "a potential Marine Nature Reserve of Irish Sea, British Isles and possibly European Significance". Various external reviews have recommended sites for protection as Marine Nature Reserves, including Geffen et al. 1990, Hawkins et al. 1990, Gubbay 2000 and Koskinen 2003. The latest round of protection measures now means the waters surrounding the Calf are now protected from mobile fishing. The key role of the Isle of Man in any coherent network of Marine Protected Areas in the Irish Sea has also been highlighted in Roberts et al. 2003.

Table 2. Candidate Marine Nature Reserve Sites identified in 2010 (Gell & Hanley 2010).

Sites	Summary of conservation interest
Ballacash Channel	extensive horse mussel reef, sand bank and other reef features.
Calf of Man	diverse rocky reef habitat, marine protected species.
Kallow Point subtidal and intertidal	limestone pavement with diverse rocky reef habitat. Important area for protected species.
King William's Bank, Bahama Bank, Ballacash Bank	sandbank features, geological interest, fish spawning grounds.
Langness and Derbyhaven	diverse rocky reef habitat, eelgrass, diverse sand/mud habitats
Laxey Bay	eelgrass meadow (protected species), ocean quahog bed (OSPAR priority species), good source of larvae to surrounding
Marine Drive Coast	whales, dolphins and porpoises, important biogenic reef
Niarbyl Bay	basking sharks, whales, dolphins and porpoises. Maerl habitat.
Port Erin Bay	basking sharks, fish nursery area (particularly flatfish), former eelgrass beds, long history of research.
Port St Mary to Peel Coastal Waters	bird breeding, basking sharks, whales, dolphins, porpoises and seals, rocky reef habitat
Ramsey Bay/Gob ny Rona	maerl bed and eelgrass meadows (protected species), kelp forest, sand bank features
Scarlett	kelp forest, geological interest, diverse rocky reef habitat.
Sugarloaf Coast and Caves	diverse rocky reef habitat, bird breeding, basking sharks.
Wart Bank	important for sand eels and associated fish species, trough shell community and geological importance.

Further sites were also suggested by previous reports, through the consultation process or from the scientific literature but required additional information for future assessment (Table 3).

Table 3. Further identified marine sites of conservation interest.

Site and summary of conservation interest
Douglas Bank Herring Spawning Grounds.
Isle of Man Sandy Mound (large shallow sand area to the east of the Isle of Man).
Maughold inshore waters/ Maughold to Laxey Head.
Jurby bombing range.
Dredge-free zone encircling the Island (varying between 0.5nm to 3nm offshore all around the east of the coast).
Western Irish Sea Front – an oceanographic feature associated with high productivity and concentrations of plankton and protected species (Berry & Jones. undated).
Ross worm (*Sabellaria spinulosa*) south of the Isle of Man (recorded by Bangor University Benthic Survey in 2008).
Offshore Langness horse mussel reef site (thought to have been greatly reduced in density and extent (Holt et al 1998). Live reef areas were recorded at the site in 2010).

In 2008 a new process of stakeholder consultation was launched, with the aim of designating the Isle of Man's first Marine Nature Reserve by 2011. Using the OSPAR Guidelines for the Identification and Selection of Marine Protected Areas in the OSPAR Maritime Area, the following candidate Marine Nature Reserve sites were identified (given in alphabetical order with a brief summary of their conservation interest. See DAFF (2009) and Gell and Hanley (2010) for more details. The process resulted in the designation of Ramsey Marine Nature Reserve in October 2011. Ramsey Marine Nature Reserve is an area of nearly 95km^2, divided into five management zones.

The whole area is protected from aggregate extraction and marine developments would require permission from the Department of Environment, Food and Agriculture, in addition to the normal application process through the Territorial Sea Committee. For further information about Ramsey Marine Nature Reserve see Chapter 3.7, 'Marine and Coastal Conservation'.

In 2012 a Marine Habitat Management Strategy was prepared, which highlights the need to continue to improve protection of vulnerable habitats for biodiversity conservation and to promote sustainable fisheries and compliance with Marine Stewardship Council accreditation of the queen scallop fishery.

As a result of this strategy the remaining 0-3nm has been designated into fisheries management zones and marine conservation zones, resulting in 50% of protected habitats in Manx 0-3nm waters. Future work will look into protecting some areas in the 3-12nm, such as mud habitats.

Conclusion

This chapter gives an overview of the national, regional and international interest of Manx marine habitats that should be considered by those carrying out Environmental Impact Assessments for marine developments in Manx waters.

Priority habitats in Manx waters include the horse mussel reefs, maerl beds and eelgrass meadows. The diverse and extensive rocky reefs of the south of the Island are internationally renowned. Habitats most vulnerable to human impacts include horse mussel reefs that can take decades if not centuries to become established.

Research into Manx marine habitats is ongoing and many gaps in knowledge still remain.

References

Allen D.E. (1984). Flora of the Isle of Man. The Manx Museum and National Trust, Douglas, Isle of Man.

Allison C. (2016). Assessing the association between scallops, *Pecten maximus*, and the benthic ecosystem within the Isle of Man marine reserves. MSc Thesis. Bangor University. 117pp.

Barbera C. et al. (2003). Conservation and management of Northeast Atlantic and Mediterranean Maerl Beds. Aquatic Conservation: Marine and Freshwater Ecosystems.13(S1):65-76.

Berry C. and Jones S. (undated). The Western Irish Sea Front – a potential MPA. WWF Briefing. WWF Bremen. http://www.ngo.grida.no/wwfneap/Publication/briefings/WesternIrish.PDF

Bradshaw C., Veale L.O., Hill A.S. and Brand A.R. (2001). The effect of scallop dredging on Irish Sea benthos: experiments using a closed area. Hydrobiologia 465**:** 129–138.

Bradshaw C., Veale L.O., Hill A.S. and Brand A.R. (2002). The role of scallop-dredge disturbance in long-term changes in Irish Sea benthic communities: a re-analysis of an historical dataset. Journal of Sea Research, 47, 161-184.

Bruce J.R., Colman J.S. and Jones N.S. (1963). Marine Fauna of the Isle of Man. Liverpool University Press, 307pp.

Brun E. (1969). Aggregation of *Ophiothrix fragilis* (Abildgaard) (Echinodermata: Ophiuroidea). *Nytt Magasin for Zoologi*, 17: 153-160.

Bunker F.S.D. and Mercer T. (1988). A survey of the ross coral, *Pentapora foliacea*, around Skomer Marine Nature Reserve in 1986. Field Studies Council, Report to the Nature Conservancy Council.

Butler P.G. (2009). Establishing the *Arctica islandica* archive: Development of the definitive shell-based proxy for the North Atlantic shelf seas. PhD Thesis, School of Ocean Sciences, Bangor University.

Chadwick H.C. (1886). Report on the Ophiuroidea of the LMBC district. In: Herdman, W.A.(ed.) First Report on the fauna of Liverpool Bay and neighbouring seas. pp. 140-143.

Connor D.W., Dalkin M.J., Hill T.O., Holt R.H.F. and Sanderson W.G. (1997). Marine Nature

Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes. Version 97.06. JNCC Report, No. 230.

Cooke R. (2009). Spatial and temporal variations in *Modiolus modiolus* reefs and their associated communities in the Irish Sea. MSc Thesis, Bangor University.

DAFF (1992). The Calf of Man: A proposed Marine Nature Reserve. Consultation Document. Department of Agriculture, Fisheries and Forestry, Douglas, Isle of Man.

Davison D.M. and Hughes D. J. (1998). *Zostera* Biotopes (volume I). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project). 95pp.

Dempster N. (2016). Habitat mapping in Ramsey Marine Nature Reserve. Bangor University. Master's Thesis.

Dickey-Collas M., Nash R. D.M. and Brown J. (2001). The location of spawning of Irish Sea herring (*Clupea harengus*). Journal of the Marine Biological Association of the UK, 81, pp 713-714.

Edwards J. (1993). Lyme Bay – A report on the nature conservation importance of the inshore reefs of Lyme Bay and the effects of mobile fishing gear. Devon Wildlife Trust.

Ellis J.R., Milligan S.P., Readdy L., Taylor N. and Brown M.J. (2012). Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56 pp. http://cefas.defra.gov.uk/publications/techrep/TechRep147.pdf

Eno N.C., MacDonald D.S. and Amos C. (1996). A study on the effects of fish (Crustacean/Mollusc) traps on benthic habitats and species. Joint Nature Conservation Committee. Final Report to the European Commission, Study Contract No 94/076.

Forbes E. (1838). Malacologia Monensis. A Catalogue of the Mollusca inhabiting the Isle of Man. 63 pp. Edinburgh.

Forbes E. (1841a). Natural History. Chapter IV in Quiggin's Illustrated Guide and Visitors' Companion through the Isle of Man. 2nd ed., 200 pp, Douglas. http://www.isle-of-man.com/manxnotebook/fulltext/qg1841/p040.htm

Forbes E. (1841b). A History of British Starfishes and other animals of the Class Echinodermata. 267 pp. London.

Forbes E. and Hanley S.C.T. (1853). A history of British Mollusca and their shells. J. Van Voorst, London. Full text available online: http://www.archive.org/stream/historyofbritish02forb/historyofbritish02forb_djvu.txt

Garner R. (1878). Professor Edward Forbes and his country. *Midland Naturalist*, 1: 67-70.

Garrad L.S. (1972). The Naturalist in the Isle of Man. David & Charles, Newton Abbot.

Geffen A., Hawkins S.J. and Fisher E.M. (1990). The Isle of Man In The Irish Sea: An Environmental Review. Part 1 – Nature Conservation. Irish Sea Forum, Liverpool University Press.

Geffen A.J., Nash R.D.M. and Dickey-Collas M. (2011). Characterisation of herring populations west of the British Isles: an investigation of mixing based on otolith biochemistry. ICES Journal of Marine Science 68(7): 1447-1458.

Gell F.R. and Hanley L. (2010). Developing a Marine Nature Reserve for Ramsey. Full Consultation Document. Department of Environment, Food and Agriculture, Isle of Man Government. 38pp.

Gubbay S. (2000). Review of sites of Marine Nature Conservation Importance around the Isle of Man. A Report to the Manx Wildlife Trust.

Hall-Spencer J.M., Kelly J. and Maggs C.A. (2010). Background document for maerl. OSPAR Commission, 491/2010 36pp.

Hardy F.G. and Guiry M.D. (2003). A check-list and atlas of the seaweeds of Britain and Ireland. pp. [i]-x, 1-435. London: British Phycological Society.

Hawkins S.J., Geffen A.J. and Fisher E.M. (1990). The status of marine nature conservation in the Isle of Man. A report to the Isle of Man Government. Port Erin Marine Laboratory, University of Liverpool.

Haywood M. And Hextall B. (2014). Gansey *Zostera* Survey; A survey of a newly identified *Zostera* bed. 7pp.

Herdman W.A. (1919). Summary of the history and work of the Liverpool Marine Biology Committee. Annex to Thirty-third Annual Report of the Liverpool Marine Biology Committee. Liverpool.

Hill A.S., Veale L.O., Pennington D., Whyte S.G., Brand A.R. and Hartnoll R.G. (1999). Changes in Irish Sea benthos: possible effects of forty years of dredging. Estuarine and Coastal Shelf Science 48:739–750.

Hinz H., Murray L.G., Gell F., Hanley L., Horton N., Whiteley H. and Kaiser M.J. (2010). Seabed habitats around the Isle of Man. Fisheries & Conservation report No. 12, Bangor University. pp.29. http://fisheries-conservation.bangor.ac.uk/iom/reports.php.en?menu=2&catid=10723&subid=10814

Hinz H., Murray L. and Kaiser M.J. (2008). Side-scan-sonar survey of the horse mussel (*Modiolus modiolus*) beds off the Point of Ayre (August 2008). Fisheries & Conservation report No. 4, Bangor University. Pp. 19. http://fisheries-conservation.bangor.ac.uk/iom/reports.php.en?menu=2&catid=10723&subid=10814

Holt T.J. and Shalla S.H.A. (1997 unpublished). Pre- and post-drilling survey of block IOM 112/19. A report to Elf Enterprise Caledonia Ltd. Port Erin Marine Laboratory, University of Liverpool.

Holt T.J., Shalla S.H.A. and Brand A.R. (1996 unpublished). Site survey of block IOM 112/19. A report to Elf Enterprise Caledonia Ltd. Port Erin Marine Laboratory, University of Liverpool.

Holt T., Hartnoll R.G., Hawkins S.J. and Jones D.R. (1997). The sensitivity of marine communities to man-induced change. In Nature Conservation and the Irish Sea, Irish Sea Forum Seminar Report No.15.

Holt T.J., Rees E.I., Hawkins S.J. and Seed R. (1998). Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs.

Hughes D.J. (1998). Subtidal brittlestar beds (volume IV). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project). 78 Pages.

Jones N.S. (1950). Marine bottom communities. Biological Reviews, 25(3): 283-313.

Jones N.S. (1951). The bottom fauna of the south of the Isle of Man. J. Anim. Ecol., 20: 132-144.

Jones N.S., Kain J.M. and Stride A.H. (1965). The movement of sand waves on Wart Bank, Isle of Man. Marine Geology 3: 329-336.

Jenkins S.R., Beukers-Stewart B. and Brand A.R. (2001). The impact of scallop dredging on benthic megafauna: a comparison of damage levels in captured and non-captured organisms. Marine Ecology Progress Series 215: 297-301.

Kaiser M.J., Ramsay K., Richardson C.A., Spence F.E. and Brand A.R. (2000). Chronic fishing disturbance has changed shelf sea benthic community structure. *Journal of Animal Ecology*, 69: 494–503.

Kamenos N.A., Moore P.G. and Hall-Spencer J.M. (2004a). Nursery-area function of maerl grounds for juvenile queen scallops *Aequipecten opercularis* and other invertebrates. Marine Ecology-Progress Series 274, 183-189.

Kamenos N.A., Moore P.G. and Hall-Spencer J.M. (2004b). Attachment of the juvenile queen scallop (*Aequipecten opercularis* (L.)) to Maerl in mesocosm conditions; juvenile habitat selection. Journal of Experimental Marine Biology and Ecology 306, 139-155.

Kamenos N.A., Moore P.G. and Hall-Spencer J.M. (2004c). Maerl grounds provide both refuge and high growth potential for juvenile queen scallops (*Aequipecten opercularis* L.). Journal of Experimental Marine Biology and Ecology 313, 241-254.

Kennington K. (2011). Ramsey Bay Marine Nature Reserve Base-Line Survey (August 2011). Preliminary Report. DEFA, Isle of Man.

Knight M. and Parke M.W. (1931). Manx Algae. Liverpool Marine Biological Committee, Memoir 30, 155pp. Liverpool University Press.

Koskinen M. (2004). Selecting sites for Marine Protected Areas in Isle of Man Coastal Waters. MRes Placement Project Report to DAFF.

Lambert G.I., Hiddink J., Hintzen N.T., Hinz H., Kaiser M.J, Murray L. and Jennings S. (2012). Implications of using alternate methods of Vessel Monitoring System (VMS) data analysis to describe fishing activities and impacts. ICES Journal of Marine Science.

May L. (2015). Identifying habitat associations of European lobster, *Homarus gammarus* (L.) and brown crab, *Cancer Pagurus* (L.) in an Isle of Man marine protected area. MSc thesis. Bangor University. 78pp.

Mitchell A., Mellor A., Strong J. and Service M. (2008). Broadscale seabed habitat survey of a sandbank to the east of the Isle of Man. JNCC Report No. 40.

Mitchell M. and Hextall B. (1994). Dive Isle of Man. Underwater World Publications.

Morrow C.C., Picton B.E. and Bishop J.D.D. (1993). A Sublittoral Survey of the Calf of Man. Calf Marine Trust.

MWDW (2007). Annual report. http://www.mwdw.net/.

MWDW (2008). Annual report. http://www.mwdw.net/.

OSPAR (2008). OSPAR List of Threatened and/or Declining Species and Habitats. OSPAR 2008-6.

Perry C. and Roriston P. (2009). Survey of *Modiolus modiolus* reef south of Douglas Harbour, Isle of Man. Report to DAFF Wildlife and Conservation Grants Scheme.

Rees I. (2009). Assessment of *Modiolus modiolus* beds in the OSPAR area. OSPAR Background Document for *Modiolus modiolus.* OSPAR/JNCC.

Roberts C.M., Gell F.R. and Hawkins J.P. (2003). Protecting Nationally Important Marine Areas in the Irish Sea Pilot Project Region. Report to the Department of the Environment, Food and Rural Affairs, UK.

Sanderson B., McGregor B. and Brierley A. (1994). Dive sites and marine life of the Calf of Man and neighbouring area. IMMEL Publishing, London.

Smith W.C. (1923). A short history of the Irish Sea herring fisheries during the eighteenth and nineteenth centuries. Special Publications 1, Port Erin Biological Station. The University of Liverpool Press Ltd and Hodder and Stoughton Ltd London.

Tmmink A.J. (1994). Ecology of eelgrass beds in the Isle of Man. BSc Thesis, Port Erin Marine Laboratory, Liverpool University.

Tomlinson P. (2008). Manx Marine User Guide. DAFF Wildlife and Conservation Division Technical Report.

Veale L. et al. (unpublished). Report of the survey of seabed communities off the east coast of the Point of Ayre. Isle of Man sublittoral survey Phase 2. Port Erin Marine Laboratory, Isle of Man.

Veale L., Thompson R. and Bates M. (1998). Isle of Man sublittoral survey 1994-1997. Port Erin Marine Laboratory, Isle of Man.

Veale L., Thompson R. and Bates M. (1999). Isle of Man sublittoral survey 1994-1997. In Monitoring the Marine and Coastal Environment. Irish Sea Forum Seminar Report No. 22.

White S. (2011). Biotope distribution and susceptibility to fishing pressure. MSc Thesis, Bangor University.

Other websites:

http://www.manxbiodiversity.org/MBRP.html. Manx Biodiversity Partnership. Last accessed 20/08/2018.

http://www.nbn.org.uk/ National Biodiversity Network (NBN). Last accessed 20/10/2018.

http://qsr2010.ospar.org/en/qsr_assessments.html. OSPAR Quality Status Report. Last accessed 20/08/2018.

http://www.seasearch.co.uk/. Seasearch. Last accessed 20/08/2018.

http://www.ukmpas.org/. UK Marine Protected Area Centre (formally UK Marine SACs project website: http://www.ukmarinesac.org.uk/). Last accessed 20/08/2018.