# Benthic Habitat Mapping: Port Erin Bay Marine Nature Reserve

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# 1. Introduction

Coastal benthic habitats provide important ecosystem services including food production, nutrient cycling, carbon sequestration and abiotic resources (Hall *et al*., 2002; Barbier *et al*., 2011). Marine Protected Areas (MPAs) offer a means of safeguarding these benthic habitats and their associated functions, promoting increased biodiversity and biomass of commercially-important species (Halpern & Warner, 2002; Beukers-Stewart *et al*., 2005; Howarth *et al*., 2011). In the Isle of Man, 52% of the coastal territorial sea (0-3 nm) is designated within MPAs (defined as Marine Nature Reserves), with the aim of protecting priority habitats such as maerl beds, horse mussel reefs and seagrass, and supporting the fishing industry (DEFA, 2018; Howe, 2018). The most valuable fishery in Manx waters (*Pecten maximus*) is reliant on benthic habitat features such as coarse gravel, hydroids and bryozoans (Brand *et al*., 1980; Harvey *et al*., 1993; Duncan & Emmerson, 2018). Specific assessment of *P. maximus* was undertaken in this study due to its general fishery importance for the island, and the specific importance of Port Erin Bay as a long-term broodstock/larval supply protection area for this species.

Benthic habitat mapping, ideally classifying towards biotope level, is therefore an important tool in marine management with regard to conservation, fisheries sustainability and marine-based resources (Harris & Baker, 2012). The general distribution of benthic habitats in the Manx territorial sea (0-12 nm) is well-established at a coarse scale following the sampling of 154 stations covering the entire extent of the territorial waters, with a spacing of approximately 5km between individual stations (Hinz et al., 2010; White, 2011). However there is an increasing need for finer scale surveys in areas of conservation interest in order to account for some habitats and species that have very restricted distributions and to feed into management and monitoring efforts. This report forms part of an ongoing camera survey project to assess benthic habitats within the Isle of Man's Marine Nature Reserves (MNRs), and presents the results for Port Erin Bay MNR.

# 2. Methods

## 2.1 MNR Location

Port Erin Marine Nature Reserve (MNR) is located on the South West coast of the Isle of Man. Port Erin MNR is the oldest Marine Protected Area within the Isle of Man's territorial waters and was originally closed in 1989 as a fisheries research site. The current MNR extends southwards from Bradda Head to just beyond Bay Fine (Figure 1).

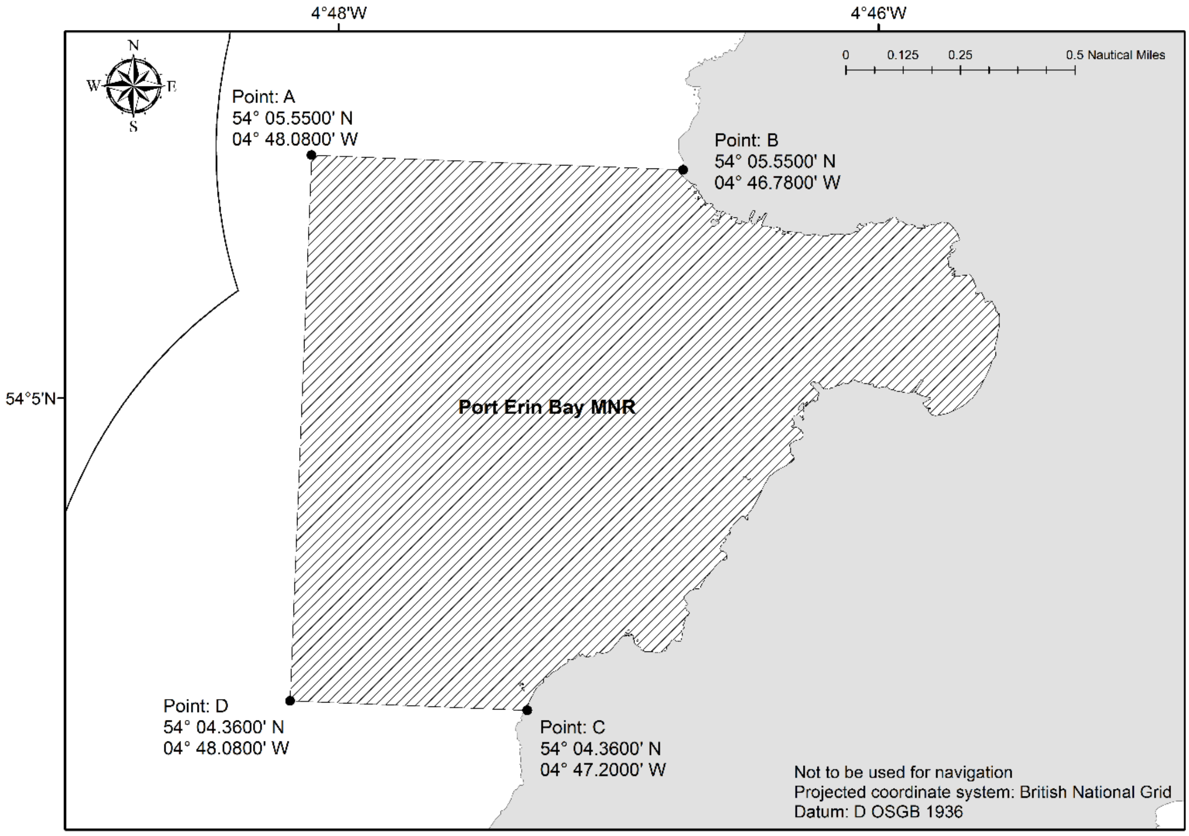


*Figure 1: Map showing the location of Port Erin Marine Nature Reserve*

## 2.2 Data collection

Benthic images were collected using a "video sledge" (Figure 2), consisting of a metal frame on skids towed along the seabed with cameras and lights attached. As surveying took place within an MNR, the sledge was designed to minimise the amount of contact with the seabed. Two cameras in waterproof housings were used throughout the survey: a Canon EOS 400D set to take a flash photograph every 10 seconds (Field of View (FOV) 44x29 cm), and a GoPro HERO3 to capture continuous video footage (FOV ~62x35 cm). These cameras were attached to a raised frame in the centre of the sledge and oriented to face the seabed, along with 2 underwater lights (RSL Ultra 1, 800 + Lux, RovTech Solutions Ltd) to illuminate the sea floor.

*Figure 2: Photograph of the equipment used to collect benthic image data, designed to "ski" along the seabed with minimal damage. Cameras and lights were attached to the central raised unit.*

The Port Erin Bay camera survey took place on June 21st 2016 from the Fisheries Protection Vessel (F.P.V.) Barrule. Twenty three (23) transects were completed within Port Erin Bay MNR (Figure A 1; Table A 1), with the aim of collecting an even distribution of data throughout the area, completed by towing the sledge along the seabed at slow speed (~1 knot) for approximately 10 minutes, providing a 10 minute video clip and 60 still photographs for each transect. To allow photographs to be geo-referenced, GPS data (including time and vessel speed) was recorded every 30 seconds throughout the survey onboard the vessel, in addition to the start and end times of each camera tow.

## 2.3 Image Analysis

From each transect every 6th still photograph was selected for analysis (one per minute of tow), due to time constraints and the general consistency in biotope type along transects, which was relatively homogeneous. Prior to analysis, the photographs were assessed for clarity and quality using a standardised scoring technique adapted from Hannah & Blume (2012) (Table 1).

*Table 1: Scoring system used to determine the suitability of photographs for image anlaysis (Hannah & Blume, 2012).*

| *Table 1:* Score | Visibility | Quality |
|---|---|---|
| 0 | View **completely** obscured by close-up species or suspended sediment | Photograph **completely** blurred or major problems with lighting or camera angle |
| 1 | View **largely** (>50%) obscured by close-up species or suspended sediment | Photograph **largely** (>50%) blurred or some problems with lighting or camera angle |
| 2 | View **partly** (<50%) obscured by close-up species or suspended sediment | Photograph **partly** (<50%) blurred or minor problems with lighting or camera angle |
| 3 | Clear field of view/negligible obstruction | Clear photograph/negligible quality issues |

Any selected images scoring 0 or 1 in either category were omitted and replaced by that directly succeeding or preceding (randomised), assuming the alternative photograph met the given criteria. In rare cases where there were no good quality alternatives available, images scoring 1 in either category were accepted.

In order to extract as much information as possible from each image, accounting for substrate type, species abundance and community composition, 3 types of data were recorded during image analysis:

- Presence of floral and faunal taxa, to the highest possible taxonomic resolution, and species level where possible;
- Abundance counts for faunal taxa;
- Point sampling to determine the percentage cover of benthic physical substrate, flora and fauna types.

Point sampling, a well-established technique in benthic ecology (Ninio *et al*., 2003; Ryan, 2004; Wakeford *et al*., 2008), involved overlaying a grid of points onto each photograph (Figure 3) using the ImageJ software package (Schneider *et al*., 2012), with each point representing an equal proportion of the image. Species or substrate type directly under each point (centre of each cross) were then identified. Physical substrate was described in broad categories (sand, gravel, shell, pebble/cobble, boulder) and species were identified to the highest possible taxonomic resolution. Most fauna could be identified to species or genus level, although descriptive categories (e.g. filamentous red algae) had to be used in some cases for flora and small faunal species such as encrusting bryozoans.

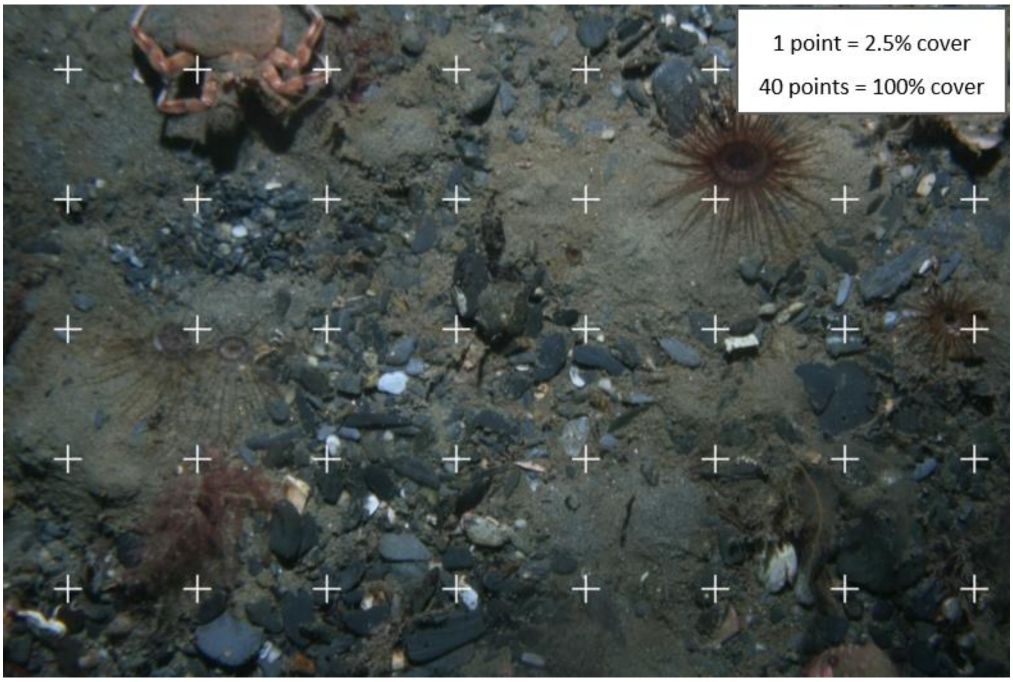


*Figure 3: Example image demonstrating the standardised point sampling grid system used to determine percentage cover data. Substrate, flora or sessile fauna found at each of the 40 crosses were identified. The data at each cross was taken to represent 2.5 % cover. In this example, bare sand was identified at 10 crosses, with each cross taken to represent 2.5% image cover, then bare sand was equivalent to 25% cover in this image.*

In order to account for any rarer species missed in the point sampling data, the presence of all faunal and floral taxa in each photograph was also recorded, as well as the total abundance of each countable faunal taxon.

## 2.4 Habitat Classification

Images were categorised into habitat types using the EUNIS habitat classification system (JNCC, 2015). The EUNIS system is a hierarchical classification procedure, which distinguishes habitats firstly into broad substrate categories before incrementally adding more detail regarding the biological community (Table 2). The expandable EUNIS habitat list on the JNCC website (https://mhc.jncc.gov.uk/) was used to qualitatively assign habitats based on a combination of video footage and still images. Each analysed image was assigned a EUNIS habitat code to the appropriate resolution (level 4, 5 or 6) based on the species present.

*Table 2: Example of the EUNIS hierarchical approach to habitat classification.*

| Level | Category | Example | Code |
|---|---|---|---|
| Level 1 | Environment | Marine | – |
| Level 2 | Broad habitat type | Sublittoral sediment | SS |
| Level 3 | Habitat complex | Sublittoral mixed sediment | SS.SMx |
| Level 4 | Biotope complex | Circalittoral mixed sediment | SS.SMx.CMx |
| Level 5 & 6 | Biotope and sub-biotope | *Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment | SS.SMx.CMx.ClloMx.Nem |

## 2.5 Video Analysis and Scallop Densities

Scallops (*Pecten maximus*) were counted from the video footage in one minute sections starting with the first analysed image of each transect, providing abundance counts corresponding to each image/GPS coordinate. Scallops that were at the edges of the video frame and therefore not fully visible were recorded as fractions (e.g. half an individual = 0.5), so as not to overestimate densities on the seabed. Scallop densities were calculated by dividing the total number of individuals (*n*) in a section of video by the area of seabed swept (captured) in the footage:

Density = *n* / area swept (video width*transect length)

## 2.6 Mapping and Data Analysis

A dataset containing the GPS coordinates of all analysed images and their corresponding habitat designations was imported into ArcGIS, and Euclidean allocation used to create a habitat map. Analysis of similarities (ANOSIM) was used to test whether image data (species presence, faunal abundance and percentage cover) significantly differed between habitats. Similarity percentage analysis (SIMPER) was subsequently applied to the image data (species presence, faunal abundance and percentage cover) to identify the species/substrate types that were characteristic of each habitat type.

Mean species richness, faunal abundance (summed), floral percentage cover (summed) and scallop density were then compared across the different habitats using analysis of variance (ANOVA), or Kruskal-Wallis tests where the parametric assumptions for ANOVA were not met. Only living taxa were considered in this analysis; records of, for example; dead maerl, empty worm tubes and mollusc egg masses, were excluded.

# 3. Results

A total of 279 photographs inside Port Erin Bay MNR were analysed for percentage cover and species data. The majority of these images were clear and good quality, with 60% scoring 3 in both visibility and quality and only 4% scoring 1 in either category. Using these images, 137 taxa of living organisms were identified (Table A 2), including 36 algae (26%), 23 molluscs (17%), 21 cnidarians (15%), 13 echinoderms (10%), 10 annelids (7%), 9 bryozoans (7%), 9 tunicates (7%), 8 crustaceans (6%), 5 sponges (4%) and 3 fish (2%). The majority of faunal taxa (78%) were identified to species or genus level, while most algal species had to be categorised into broad descriptive categories, e.g. encrusting brown algae.

The most common taxa in Port Erin Bay MNR, each found in >20% of the images, were hydroid/bryozoan turfs, calcareous tube worms, *Lithothamnion* crusts, fine red algae, the brittlestars *Ophiura albida* and *Ophiocomina nigra*, and the anemone *Cerianthus lloydii*. The most common (countable) faunal species by total abundance were *Cerianthus lloydii* (176), *Balanomorpha* spp. (barnacles) (168), *Clavelina lepadiformis* (167), *Ophiura albida* (150) and *Ophiocomina nigra* (125). Species richness in individual images ranged from 0 to 16 taxa (Figure 4Figure 5), averaging at 6 taxa per image.

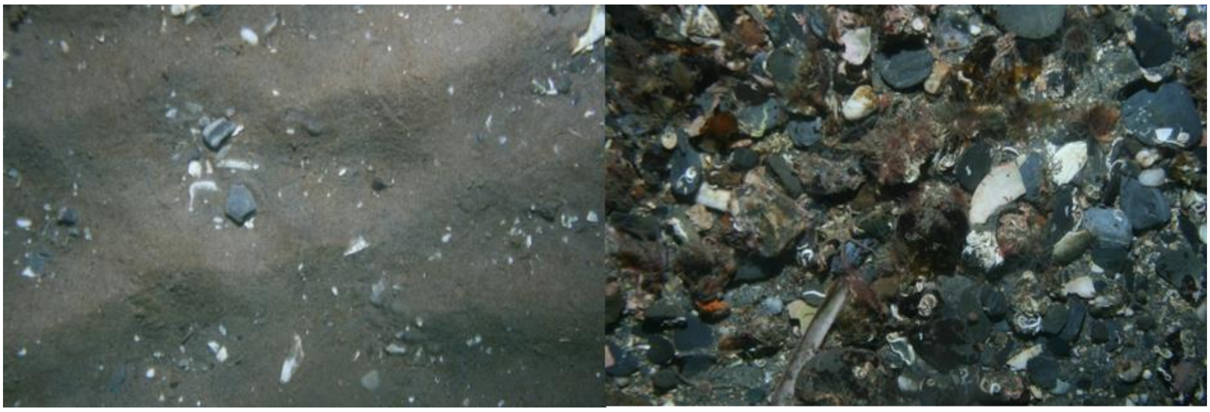

*Figure 4: Low epifaunal species richness (0) – left; High epifaunal species richness (16) – right.*

## 3.1 EUNIS Habitats

The EUNIS approach resulted in the identification of 9 distinct habitat classifications in the MNR. ANOSIM confirmed that these habitats significantly differed from each other with regard to percentage cover (R = 0.67, $p < 0.001$), species composition [presence-absence] (R = 0.49, $p < 0.001$) and epifaunal abundances (R = 0.16, $p < 0.001$). The habitats are listed in Table 3 in conjunction with the results of SIMPER analysis, and their distribution across the MNR is displayed in Figure 6. More detailed descriptions of these habitats are available in the appendix, along with images showing their primary characteristics.

Table 3: *Benthic habitat classifications in Port Erin Bay MNR using the European classification system (EUNIS) (JNCC, 2015), including the total number of images and the average similarity in percentage cover data between images within each habitat group (full SIMPER results for percentage cover in Table A ). Characterising taxa were those contributing the most towards the statistical similarity in species composition (presence-absence data) within habitats. Note: Habitat number aligns with the numbers used in Figure 5.*

| Eunis habitat number | EUNIS habitat classification | Images used | Avg. sim. | Characterising taxa |
|---|---|---|---|---|
| **1** | **SS.SCS.CCS** Circalittoral coarse sediment | 47 | 64% | Calcareous tube worms, *Lithothamnion* crusts, hydroid/bryozoan turfs |
| **2** | **SS.SMx.CMx** Circalittoral mixed sediment | 81 | 73% | Calcareous tube worms, hydroid/bryozoan turfs, *Lithothamnion* crusts, *Ophiocomina nigra*, thin red algae, *Ophiura albida* |
| **3** | **SS.SMx.CMx.ClloMx.Nem** *Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment | 46 | 57% | Hydroid/bryozoan turfs, calcareous tube worms, *Cerianthus lloydii*, *Ophiura albida*, thin red algae, *Ophiocomina nigra*, encrusting algae, *Nemertesia antennina* |
| **4** | **SS.SMx.CMx.FluHyd** *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment | 18 | 63% | Hydroid/bryozoan turfs, *Ophiocomina nigra*, *Ophiura albida*, tube worms, *Hydrallmania falcata* |
| **5** | **SS.SSa.CMuSa** Circalittoral muddy sand | 16 | 75% | *Amphiura filiformis*, burrowing polychaetes, thin red algae |
| **6** | **SS.SSa.IMuSa** Infralittoral muddy sand | 17 | 80% | Burrowing polychaetes, brown algae film |
| **7** | **SS.SSa.IFiSa.IMoSa** Infralittoral mobile clean sand with sparse fauna | 8 | 84% | No consistently occurring taxa |
| **8** | **SS.SMp.KSwSS.LsacR.CbPb** Red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles | 31 | 60% | Hydroid/bryozoan turfs, calcareous tube worms, *Cerianthus lloydii*, filamentous red algae, *Laminaria* spp., *Dictyota dichotoma*, thin red algae, *Clavelina lepadiformis*, *Ophiura albida*, *Cellepora pumicosa*, *Gibbula* spp. |
| **9** | **SS.SMp.KSwSS.LsacR.Gv** *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles | 15 | 33% | Thin brown algae, *Saccharina latissima*, filamentous green and brown algae, *Chorda filum*, hydroid/bryozoan turfs, *Plocamium cartilagineum* |

Mean species richness varied significantly across the EUNIS habitats (Figure *5*) ($F_{(8,270)} = 27.8$, $p < 0.001$), ranging from 2 species per image in SS.SSa.IFiSa.IMoSa (Infralittoral mobile clean sand with sparse fauna) to 11 species per image in SS.SMp.KSwSS.LsacR.CbPb (red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles). SS.SMp.KSwSS.LsacR.CbPb also contained the highest mean epifaunal abundance (11 individuals per image), while algal cover peaked in SS.SMp.KSwSS.LsacR.Gv (*Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles) (Figure 5). Overall, there were significant differences in both epifaunal abundance ($X^2 = 106$, df = 8, $p < 0.001$) and algal percentage cover ($X^2 = 107$, df = 8, $p < 0.001$) across the habitats.

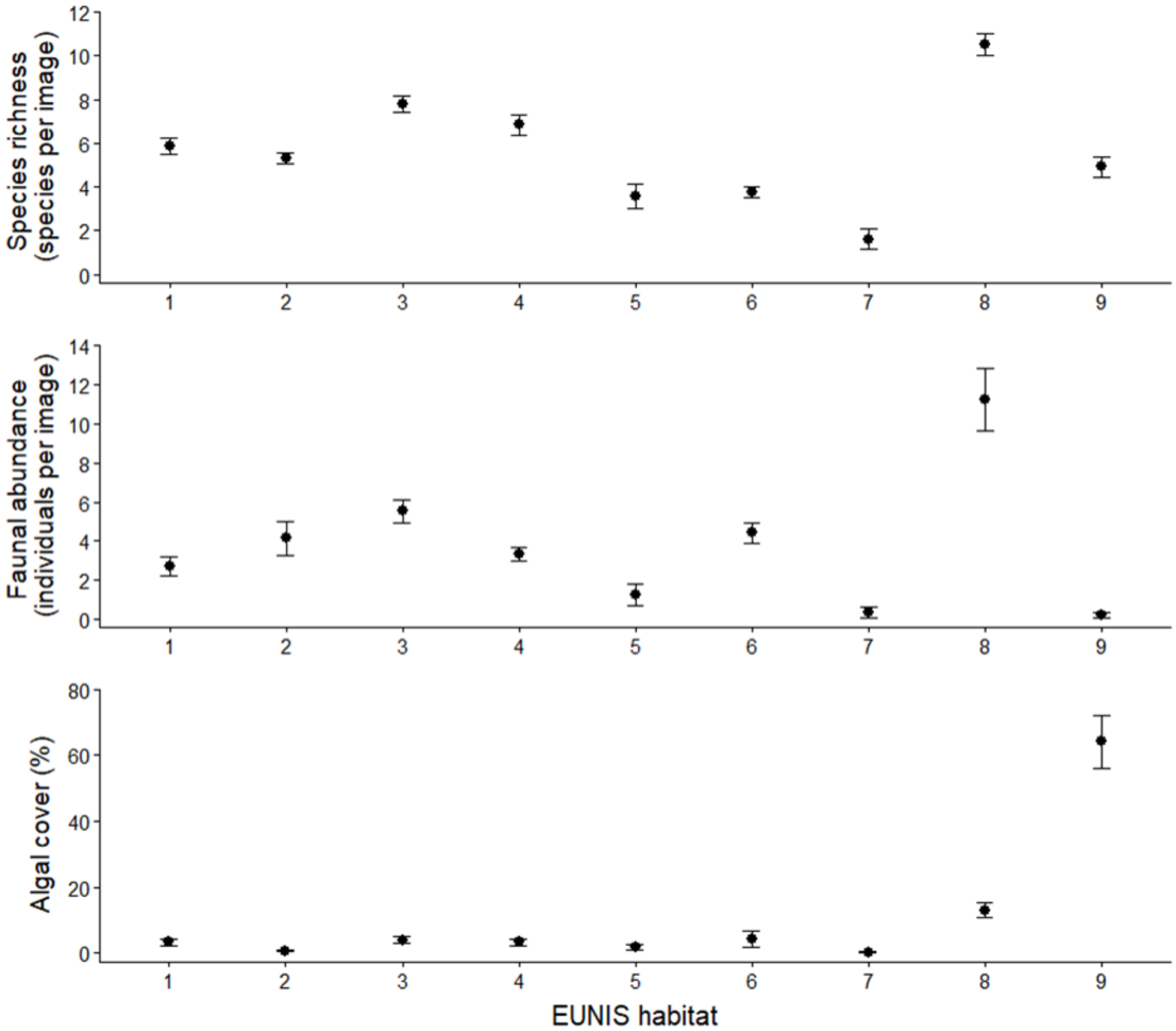


*Figure 5: Mean (± S.E.) species richness, epifaunal abundance and algal cover in images (n = 8-81) across the 9 habitats identified using the EUNIS habitat classification system (JNCC, 2015). Eunis habitat numbers: 1 = SS.SCS.CCS; 2 = SS.SMx.CMx; 3 = SS.SMx.CMx.ClloMx.Nem; 4 = SS.SMx.CMx.FluHyd; 5 = SS.SSa.CMuSa; 6 = SS.SSa.IMuSa; 7 = SS.SSa.IFiSa.IMoSa; 8 = SS.SMp.KSwSS.LsacR.CbPb; 9 = SS.SMp.KSwSS.LsacR.Gv.*

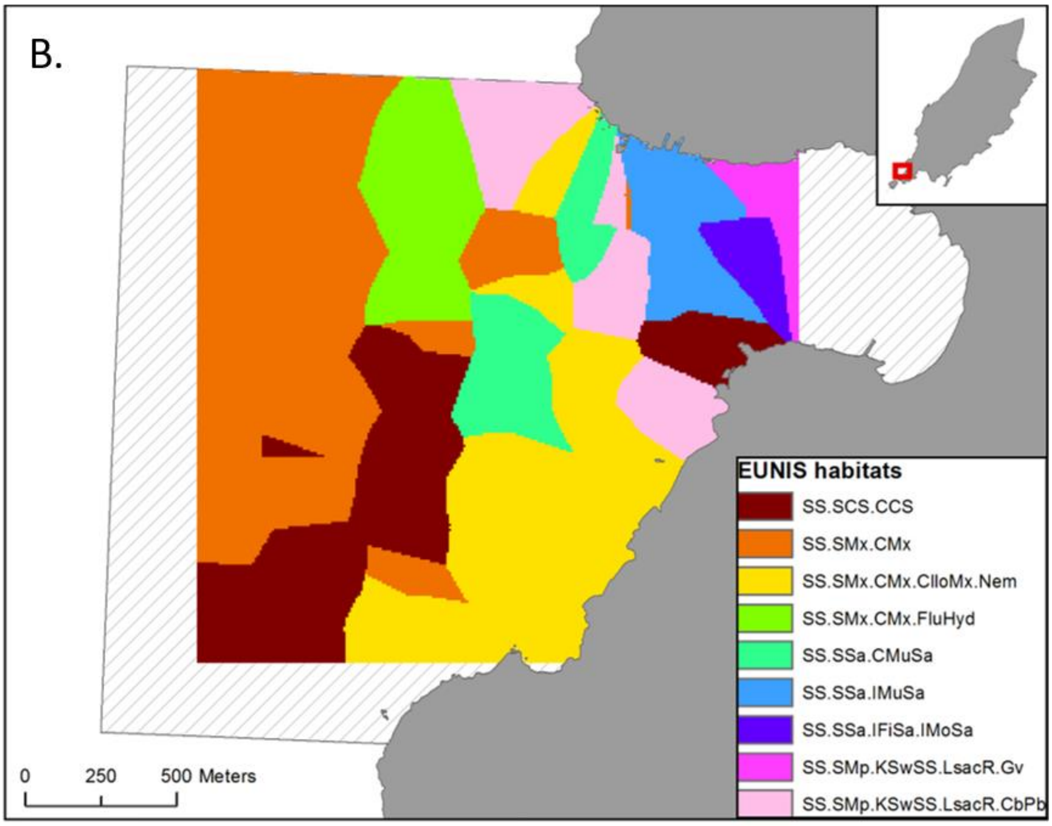


*Figure 6: Habitat maps for Port Erin Bay MNR using the EUNIS habitat classification approach. Refer to Table 3 for habitat descriptions.*

## 3.2 Scallop densities

The mean density of scallops in each of the 23 ten-minute video tows (100-150 $m^2$ area swept per tow) ranged from 0 to 92 per $100m^2$ (Figure 7A), with an overall average of 27 scallops per $100m^2$ throughout the survey area. There was significant spatial variation across EUNIS habitats (ANOVA: $F_{(8,270)} = 11.03$, $p < 0.001$) (Figure 7B), with the highest densities found in circalittoral gravel (SS.SCS.CCS) and circalittoral mixed sediment habitats characterised by hydroids and bryozoans (SS.SMx.CMx.ClloMx.Nem, SS.SMx.CMx.FluHyd).

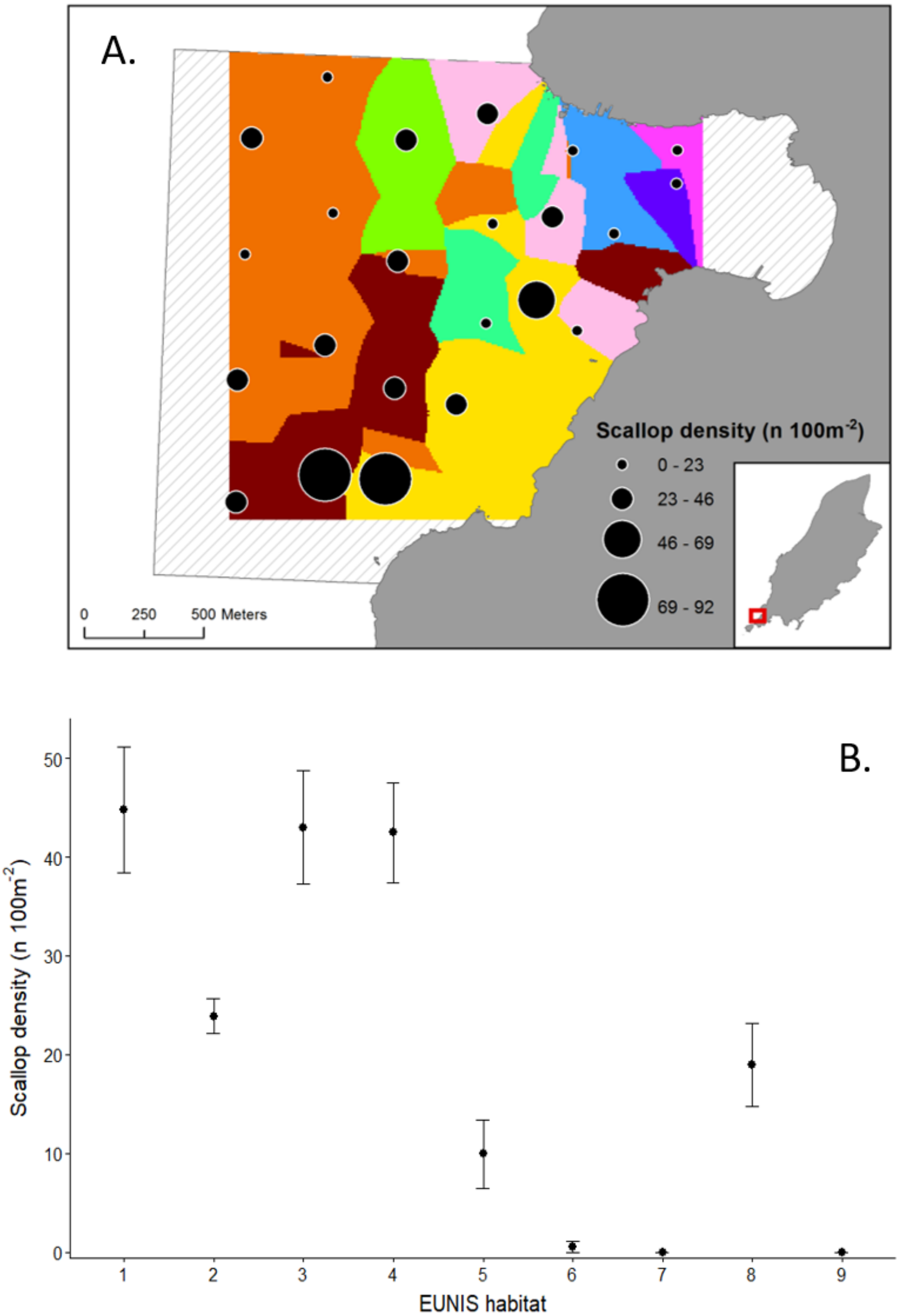


*Figure 7: A) EUNIS habitat map overlaid with the average scallop densities from each video transect; B) Mean (± S.E.) scallop density by EUNIS habitat type (1-minute video data): 1 = SS.SCS.CCS; 2 = SS.SMx.CMx; 3 = SS.SMx.CMx.ClloMx.Nem; 4 = SS.SMx.CMx.FluHyd; 5 = SS.SSa.CMuSa; 6 = SS.SSa.IMuSa; 7 = SS.SSa.IFiSa.IMoSa; 8 = SS.SMp.KSwSS.LsacR.CbPb; 9 = SS.SMp.KSwSS.LsacR.Gv.*

## 4. Discussion

Port Erin Bay MNR contains a range of benthic habitats from sparse sand to algal-dominated stony substrate. The majority of the closed area is characterised by mixed or coarse sediments, and the most common types were encrusting/turf species (hydroid/bryozoan turf, calcareous tube worms, coralline crusts) under both classification types. Encrusting coralline algae and dead maerl were common (each present in about a third of the images); however live maerl nodules were very rare, only recorded in 4 images. In comparison to other MNRs, epifaunal species richness in Port Erin Bay was higher than Laxey Bay and comparable to Niarbyl and Ramsey (Garratt *et al*., 2022a; 2022b; 2022c).

With regard to commercial species, scallops (*Pecten maximus*) were widespread and abundant in Port Erin MNR, present in all but one video transect and 777 individuals recorded in total. Port Erin Bay is the oldest marine protected area in Manx waters and contains a much higher density of *Pecten maximus* than any other region around the island. Originally established as an aquaculture and fisheries research area in 1989, Port Erin MNR has subsequently become a recognised site for enhancing local recruitment due to the high density of adult scallops and associated Allee effects (Beukers-Stewart *et al*., 2005). Public and specific stakeholder acceptance of, and compliance with, marine protected areas may be enhanced by data, such as those presented here, that can be shown to provide multiple ecological and economic benefits.

Other species of commercial interest that were identified, but uncommon, were *Aequipecten opercularis* and *Buccinum undatum*, although these species typically tend to be naturally distributed slightly further offshore.

More generally, the biotope habitat and biodiversity data from this study will contribute directly to management efforts of the MNRs, and provides useful baseline information with regard to species records and future monitoring and management.

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# 6. Appendix

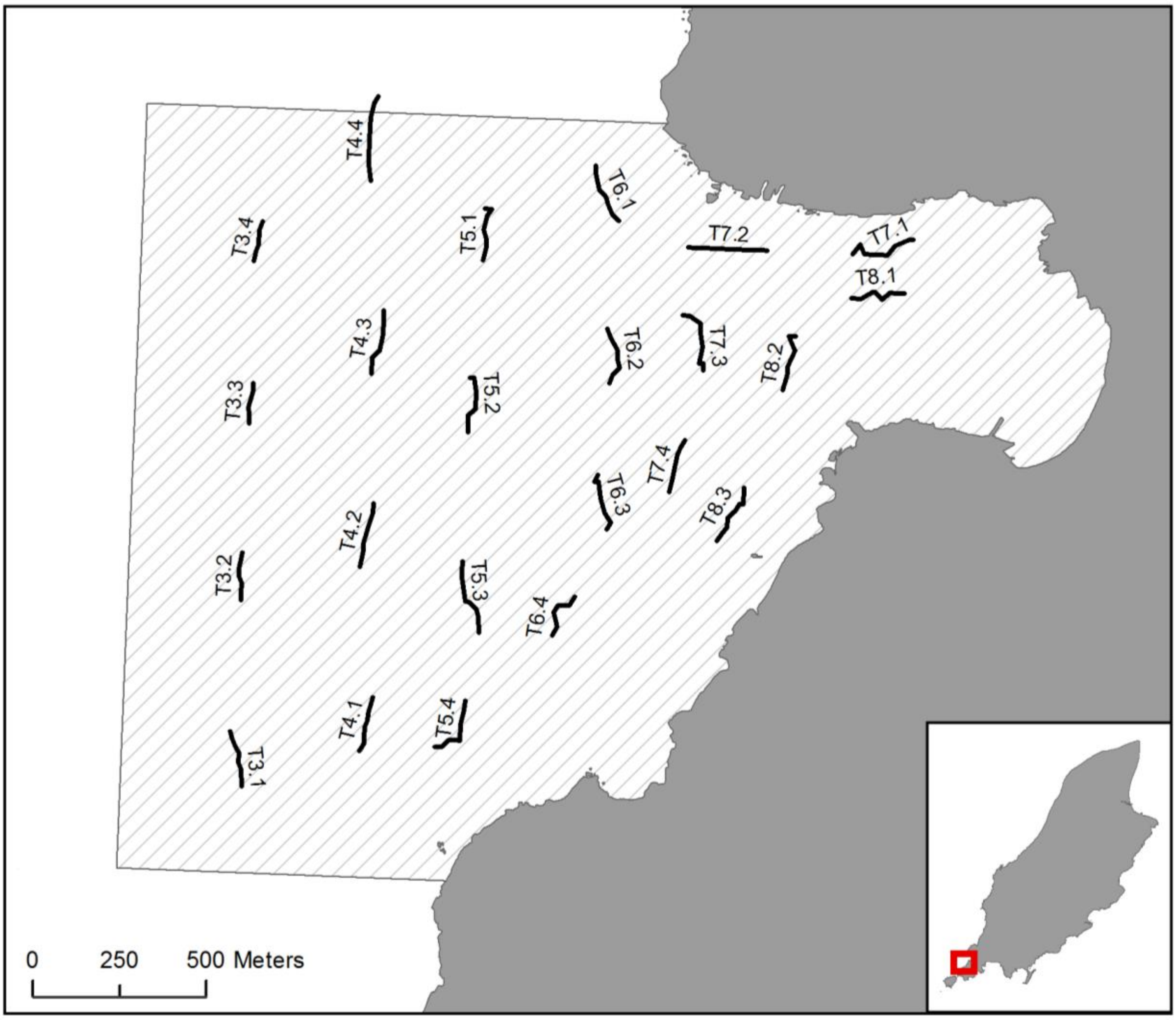


*Figure A 1: Map of the camera tow transects used to collect videos and images of the seabed inside Port Erin Bay MNR. Start and end coordinates for each tow are available in Table A 1.*

*Table A 1*: Start and end coordinates (decimal degrees) of camera tows (vessel position).

| **Tow** | **Start** | **End** |
|---|---|---|
| T3.1 | 54.07505°N, 4.79722°W | 54.07639°N, 4.79779°W |
| T3.2 | 54.07961°N, 4.79767°W | 54.08111°N, 4.79748°W |
| T3.3 | 54.08434°N, 4.79745°W | 54.08582°N, 4.79729°W |
| T3.4 | 54.08871°N, 4.79738°W | 54.09018°N, 4.79719°W |
| T4.1 | 54.07601°N, 4.79195°W | 54.07770°N, 4.79150°W |
| T4.2 | 54.08088°N, 4.79222°W | 54.08262°N, 4.79184°W |
| T4.3 | 54.08587°N, 4.79214°W | 54.08756°N, 4.79167°W |
| T4.4 | 54.09085°N, 4.79258°W | 54.09304°N, 4.79238°W |
| T5.1 | 54.09032°N, 4.78765°W | 54.08880°N, 4.78743°W |
| T5.2 | 54.08591°N, 4.78780°W | 54.08419°N, 4.78750°W |
| T5.3 | 54.08116°N, 4.78771°W | 54.07930°N, 4.78687°W |
| T5.4 | 54.07752°N, 4.78749°W | 54.07622°N, 4.78879°W |
| T6.1 | 54.09135°N, 4.78265°W | 54.09008°N, 4.78127°W |
| T6.2 | 54.08735°N, 4.78201°W | 54.08576°N, 4.78174°W |
| T6.3 | 54.08343°N, 4.78203°W | 54.08195°N, 4.78160°W |
| T6.4 | 54.08023°N, 4.78276°W | 54.07902°N, 4.78360°W |
| T7.1 | 54.08979°N, 4.76841°W | 54.08942°N, 4.77151°W |
| T7.2 | 54.08936°N, 4.77492°W | 54.08942°N, 4.77840°W |
| T7.3 | 54.08760°N, 4.77851°W | 54.08610°N, 4.77768°W |
| T7.4 | 54.08439°N, 4.77822°W | 54.08308°N, 4.77883°W |
| T8.1 | 54.08841°N, 4.76872°W | 54.08828°N, 4.77124°W |
| T8.2 | 54.08722°N, 4.77379°W | 54.08556°N, 4.77401°W |
| T8.3 | 54.08325°N, 4.77560°W | 54.08198°N, 4.77653°W |

*Table A 2*: List of taxa identified from benthic photographs taken inside Port Erin Bay MNR.

| Phylum | Taxon | Phylum | Taxon |
|---|---|---|---|
| Sponges | *Cliona celata* | Annelids | *Eupolymnia nebulosa* |
| | *Polymastia boletiformis* | | *Lanice conchilega* |
| | Orange encrusting sponge | | *Myxicola infundibulum* |
| | Orange finger sponge spp. | | *Protula tubularia* |
| | Small yellow sponge spp. | | *Tubulanus annulatus* |
| Cnidarians | *Adamsia palliata* | | *Sabellidae* spp. |
| | *Alcyonium digitatum* | | *Serpulidae* spp. |
| | *Cerianthus lloydii* | | *Spirorbidae* spp. |
| | *Corymorpha nutans* | | Burrowing polychaete spp. |
| | *Cyanea lamarckii* | Molluscs | *Acteon tornatilis* |
| | *Edwardsia claparedii* | | *Aequipecten opercularis* |
| | *Epizoanthus couchii* | | *Buccinum undatum* |
| | *Hydrallmania falcata* | | *Calliostoma zizyphinum* |
| | *Mesacmaea mitchellii* | | *Chamelea striatula* |
| | *Nemertesia antennina* | | *Clausinella fasciata* |
| | *Nemertesia ramosa* | | *Edmundsella pedata* |
| | *Obelia geniculata* | | *Euspira nitida* |
| | *Peachia cylindrica* | | *Fjordia browni* |
| | *Kirchenpaueria pinnata* | | *Fjordia lineata* |
| | *Rhizocaulus verticillatus* | | *Gibbula cineraria* |
| | *Halecium* spp. | | *Gibbula magus* |
| | *Ceriantharia* spp. | | *Lutraria lutraria* |
| | Branching hydroid spp. | | *Pecten maximus* |
| | Bushy hydroid spp. | | *Pleurobranchus membranaceus* |
| | Hydroid/bryozoan turf | | *Gibbula* spp. |
| | Unidentified hydroid spp. | | *Leptochiton* spp. |
| Bryozoans | *Bugula flabellata* | | *Tonicella* spp. |
| | *Cellepora pumicosa* | | *Veneridae* spp. |
| | *Flustra foliacea* | | Brown limpet spp. |
| | *Plagioecia patina* | | Grey nudibranch spp. |
| | *Alcyonidium* spp. | | Large limpet spp. |
| | *Cellaria* spp. | Echinoderms | *Amphiura filiformis* |
| | Leafy bryozoan spp. | | *Asterias rubens* |
| | Red encrusting bryozoan | | *Crossaster papposus* |
| | White encrusting bryozoan | | *Henricia oculata* |
| Crustaceans | *Ebalia tumefacta* | | *Labidoplax digitata* |
| | *Inachus phalangium* | | *Luidia ciliaris* |
| | *Liocarcinus depurator* | | *Marthasterias glacialis* |
| | *Macropodia rostrata* | | *Neopentadactyla mixta* |
| | *Pagurus bernhardus* | | *Ophiocomina nigra* |
| | *Pagurus prideaux* | | *Ophiothrix fragilis* |
| | *Palaemon* spp. | | *Ophiura albida* |
| | Balanomorpha spp. | | *Ophiura ophiura* |
| | | | *Porania pulvillus* |

| Phylum | Taxon | Phylum | Taxon |
| --- | --- | --- | --- |
| Tunicates | *Ascidia conchilega* | Algae | *Alaria esculenta* |
| | *Ascidiella aspersa* | | *Chorda filum* |
| | *Ciona intestinalis* | | *Chordaria flagelliformis* |
| | *Clavelina lepadiformis* | | *Delesseria sanguinea* |
| | *Corella parallelogramma* | | *Desmarestia aculeata* |
| | *Dendrodoa grossularia* | | *Dictyota dichotoma* |
| | *Phallusia mammillata* | | *Fucus serratus* |
| | *Ascidia* spp. | | *Odonthalia dentata* |
| | Small translucent sea squirt spp. | | *Phycodrys rubens* |
| Fish | *Agonus cataphractus* | | *Plocamium cartilagineum* |
| | *Callionymus lyra* | | *Saccharina latissima* |
| | *Pomatoschistus* spp. | | *Vertebrata byssoides* |
| | | | *Chaetomorpha* spp. |
| | | | *Laminaria* spp. |
| | | | *Lithothamnion* crust |
| | | | *Ulva* spp. |
| | | | Brown algae film |
| | | | Brown string weed spp. |
| | | | Bushy Rhodophyta spp. |
| | | | Dark red encrusting algae |
| | | | Encrusting brown algae |
| | | | Fine transparant algae spp. |
| | | | Filamentous Chlorophyta spp. |
| | | | Filamentous Phaeophyceae spp. |
| | | | Filamentous Rhodophyta spp. |
| | | | Fine Rhodophyta spp. |
| | | | Flat Phaeophyceae spp. |
| | | | Flat Rhodophyta spp. |
| | | | Forked Rhodophyta spp. |
| | | | Green algae turf |
| | | | Maerl |
| | | | Robust flat Phaeophyceae spp. |
| | | | Robust flat Rhodophyta spp. |
| | | | Robust long Rhodophyta spp. |
| | | | Slippery Rhodophyta spp. |

*Table A 3: SIMPER analysis on percentage cover data for the 9 habitats identified using the EUNIS procedure.*

| Substrate/taxon | Av.%cover | Av.Sim | Sim/SD | Contrib% | Cum.% |
|---|---|---|---|---|---|
| **SS.SCS.CCS: average similarity 63.59%** | | | | | |
| Gravel | 50.05 | 31.58 | 3.19 | 49.66 | 49.66 |
| Dead shell | 29.31 | 21.72 | 2.92 | 34.15 | 83.81 |
| Pebble | 7.61 | 4.06 | 0.71 | 6.39 | 90.20 |
| Hydroid/bryozoan turf | 3.99 | 2.98 | 0.71 | 4.69 | 94.89 |
| Dead maerl | 3.31 | 1.47 | 0.45 | 2.32 | 97.21 |
| **SS.SMx.CMx: average similarity 73.14%** | | | | | |
| Gravel | 53.77 | 36.42 | 5.85 | 49.79 | 49.79 |
| Dead shell | 29.81 | 24.31 | 3.38 | 33.24 | 83.03 |
| Sand | 8.30 | 8.08 | 1.32 | 11.05 | 94.08 |
| Pebble | 3.51 | 2.11 | 0.55 | 2.88 | 96.96 |
| **SS.SMx.CMx.ClloMx.Nem: average similarity 56.70%** | | | | | |
| Sand | 39.08 | 19.13 | 1.52 | 33.75 | 33.75 |
| Gravel | 25.76 | 14.52 | 1.78 | 25.60 | 59.35 |
| Pebble | 14.40 | 9.81 | 1.52 | 17.31 | 76.66 |
| Dead shell | 5.71 | 6.44 | 1.38 | 11.35 | 88.01 |
| Hydroid/bryozoan turf | 4.35 | 4.16 | 0.97 | 7.34 | 95.35 |
| **SS.SMx.CMx.FluHyd: average similarity 62.53%** | | | | | |
| Sand | 57.08 | 30.52 | 3.05 | 48.81 | 48.81 |
| Gravel | 15.83 | 11.18 | 1.95 | 17.89 | 66.70 |
| Dead shell | 10.97 | 9.47 | 1.59 | 15.14 | 81.84 |
| Hydroid/bryozoan turf | 5.69 | 7.34 | 1.69 | 11.74 | 93.58 |
| *Ophiocomina nigra* | 3.33 | 1.46 | 0.47 | 2.33 | 95.91 |
| **SS.SSa.CMuSa: average similarity 74.81%** | | | | | |
| Sand | 89.22 | 65.39 | 8.14 | 87.42 | 87.42 |
| *Amphiura filiformis* | 5.21 | 5.55 | 0.73 | 7.42 | 94.84 |
| Dead shell | 3.55 | 3.19 | 0.65 | 4.27 | 99.10 |
| **SS.SSa.IMuSa: average similarity 79.68%** | | | | | |
| Sand | 87.06 | 66.69 | 7.40 | 83.69 | 83.69 |
| Brown algae film | 7.35 | 11.61 | 1.28 | 14.56 | 98.26 |
| **SS.SSa.IFiSa.IMoSa: average similarity 84.49%** | | | | | |
| Sand | 95.63 | 80.27 | 7.00 | 95.00 | 95.00 |
| **SS.SMp.KSwSS.LsacR.CbPb: average similarity 59.73%** | | | | | |
| Pebble | 39.52 | 22.60 | 2.93 | 37.83 | 37.83 |
| Gravel | 24.27 | 16.12 | 2.47 | 26.99 | 64.82 |
| Hydroid/bryozoan turf | 7.26 | 7.22 | 1.72 | 12.09 | 76.91 |
| Dead shell | 5.97 | 5.45 | 1.21 | 9.13 | 86.04 |
| Sand | 5.08 | 1.96 | 0.57 | 3.28 | 89.32 |
| *Dictyota dichotoma* | 2.50 | 1.85 | 0.43 | 3.10 | 92.42 |
| *Cerianthus lloydii* | 3.36 | 1.78 | 0.59 | 2.98 | 95.40 |
| **SS.SMp.KSwSS.LsacR.Gv: average similarity 33.09%** | | | | | |
| Flat Phaeophyceae spp. | 20.00 | 7.28 | 0.99 | 22.00 | 22.00 |
| *Saccharina latissima* | 12.83 | 6.56 | 0.53 | 19.83 | 41.82 |
| Pebble | 15.00 | 4.90 | 0.64 | 14.82 | 56.65 |
| Gravel | 9.00 | 4.56 | 0.77 | 13.79 | 70.44 |
| String weed spp. | 10.83 | 3.33 | 0.44 | 10.08 | 80.51 |
| Sand | 7.33 | 2.24 | 0.46 | 6.78 | 87.29 |
| Fine transparent algae spp. | 5.33 | 2.10 | 0.44 | 6.35 | 93.64 |
| Filamentous Phaeophyceae | 3.00 | 0.44 | 0.24 | 1.32 | 94.96 |
| Hydroid/bryozoan turf | 3.10 | 0.43 | 0.24 | 1.31 | 96.27 |

**Habitat code:** SS.SCS.CCS

**Habitat description: Circalittoral coarse sediment**

Wave exposure: Exposed to moderately exposed
Tidal streams: Moderately strong (1-3 kn) to very weak (negligible)
Substratum: Coarse sand and gravel with a minor finer sand fraction
Zone: Lower infralittoral to circalittoral
Depth: 10-50 m

Coarse gravel and pebbles overlying sand, with some dead maerl and shell. Biological community consisting predominately of robust species such as calcareous tube worms, *Lithothamnion* crusts, encrusting bryozoans and barnacles. Frequent hydroids (*Nemertesia* spp., *Rhizocaulus verticillatus, Kirchenpaueria pinnata*) and occasional red algae and *Laminaria* strands. Other faunal species included *Ophiocomina nigra*, *Ophiura albida, Pecten maximus*, *Gibbula* spp., *Euspira* spp., *Lituraria lituraria* and *Lanice conchilega*. This habitat was found mostly in the south-west of the MNR, in depths ranging from 10 to 30 m.

*Figure A 2: EUNIS Habitat Code SS.SCS.CCS*

**Habitat code:** SS.SMx.CMx

**Habitat description: Circalittoral mixed sediment**

Wave exposure: Moderately exposed to very sheltered
Tidal streams: Moderately strong (1-3 kn) to very weak (negligible)
Substratum: Mixed sediment (with stones and shells)
Zone: Circalittoral
Depth: 5-50 m

Mixed substrates of sand, poorly-sorted shell fragments, gravel and occasional pebbles. Small weathered fragments of maerl often present. Similar in species composition to SS.SCS.CCS, but with a marked reduction in the abundance of encrusting species due to the switch from stoney material to sand and shell. Biological community dominated by hydroids and bryozoans, including mixed turfs and erect species (*Nemertesia* spp., *Flustra foliacea*, *Kirchenpaueria pinnata*), as well as brittlestars (*Ophiura albida, Ophiocomina nigra*, *Ophiura ophiura*) and sparse calcareous tube worms. Occasional red algae species, *Lithothamnion* crusts, *Epizoanthus couchii* and *Clavelina lepadiformis*. This was the most frequently occurring habitat in the MNR (29% of analysed images), and was found in depths between 10 and 30 m.

*Figure A 3: EUNIS Habitat Code SS.SMx.CMx*

**Habitat code:** SS.SMx.CMx.ClloMx.Nem

**Habitat description: *Cerianthus lloydii* with *Nemertesia* spp. And other hydroids in circalittoral muddy mixed sediment**

Wave exposure: Moderately exposed to very sheltered
Tidal streams: Moderately strong (1-3 kn) to very weak (negligible)
Substratum: Sandy muddy gravel with surficial cobbles, pebbles and shells
Zone: Lower infralittoral to circalittoral
Depth: 10-30 m

Muddy sand with pebbles and shell fragments. Biological community dominated by *Cerianthus lloydii*, *Nemertesia* spp. and hydroid turfs. Brittlestars (*Ophiura albida, Ophiocomina nigra*) were also abundant in this habitat, and calcareous tube worms colonised large shells and cobbles where present. Other frequent taxa included thin red algae, *Saccharina latissima*, *Pecten maximus* and *Marthasterias glacialis*. Occasional worm casts were also recorded. This was the most common habitat in the intermediate depth range of the MNR, found between 12 and 20 m and mostly towards the south.

*Figure A 4: EUNIS Habitat Code SS.SMx.CMx.ClloMx.Nem*

**Habitat code:** SS.SMx.CMx.FluHyd

**Habitat description: *Flustra foliacea* and *Hydrallmania falcate* on tide-swept circalittoral mixed sediment**

Wave exposure: Exposed to moderately exposed
Tidal streams: Strong (3-6 kn) to moderately strong (1-3 kn)
Substratum: Boulders, cobbles or pebbles with gravel and sand
Zone: Circalittoral
Depth: 5-50 m

Tide-swept mixed sandy sediment with cobbles. Biological community dominated by hydroids (*Nemertesia* spp., *Hydrallmania falcata*), brittlestars (*Ophiura albida, Ophiocomina nigra*) and bryozoans (*Flustra foliacea*, *Alcyonidium diaphanum, Cellaria* spp.). Emergent worm tubes frequently seen in sandy patches and *Pomatoceros triqueter* on cobbles. Some robust red algal species and strands of kelp also present. This habitat occurred offshore towards the north of the MNR, between 25 and 28 m depth.

*Figure A 5: EUNIS Habitat Code SS.SMx.CMx.FluHyd*

**Habitat code:** SS.SSa.CMuSa

**Habitat description: Circalittoral muddy sand**

Wave exposure: Exposed to moderately exposed
Tidal streams: Moderately strong (1-3 kn) to very weak (negligible)
Substratum: Fine to very fine sand with a fine silt fraction
Zone: Circalittoral
Depth: 10-50 m

Non-cohesive muddy sand with fine shell fragments. Biological community dominated by abundant *Amphiura filiformis*, with occcasional red algae and worm casts. This habitat occurred offshore, mostly towards the centre of the MNR, between 25 and 28 m depth.

*Figure A 6: EUNIS Habitat Code SS.SSa.CMuSa*

**Habitat code:** SS.SSa.IMuSa

## Habitat description: Infralittoral muddy sand

Wave exposure: Moderately exposed to sheltered
Tidal streams: Moderately strong (1-3 kn) to very weak (negligible)
Substratum: Fine to very fine sand with a silt fraction
Zone: Infralittoral
Depth: 0-20 m

Non-cohesive muddy sand with sparse shell fragments. Biological community dominated by burrowing polychaetes and surficial brown algae film. This habitat occurred inshore from 10 to 14 m depth.

*Figure A 7: EUNIS Habitat Code SS.SSa.IMuSa*

**Habitat code:** SS.SSa.IFiSa.IMoSa

**Habitat description: Infralittoral mobile clean sand with sparse fauna**

Wave exposure: Exposed to sheltered
Tidal streams: Strong (3-6 kn) to very weak (negligible)
Substratum: Medium to fine sand
Zone: Infralittoral
Depth: 0-20 m

Shallow mobile sand with shell fragments and pebbles. Sparse biological community consisting of occasional burrowing polychaetes, hydroids and strands of algae. This habitat occurred inshore between 6 and 8 m depth.

*Figure A 8: EUNIS Habitat Code SS.SSa.IFiSa.IMoSa*

**Habitat code:** SS.SMp.KSwSS.LsacR.CbPb

**Habitat description: Red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles**

Wave exposure: Extremely exposed to sheltered
Tidal streams: Moderately strong (1-3 kn) to weak (<1 kn)
Substratum: Small boulders, cobbles and pebbles with gravel
Zone: Infralittoral
Depth: 0-30 m

Mobile cobbles and pebbles overlying gravelly sand, with shells and boulders and diverse biological communities of algae and epifauna. Foliose and filamentous seaweeds (both red and brown) were highly common in this habitat, along with turfs of hydroids and bryozoans and scattered but frequent occurances of *Saccharina latissima* and *Laminaria* spp. Cobbles were colonised by encrusting fauna (calcareous tube worms, bryozoans, *Lithothamnion* crusts, barnacles), with *Cerianthus lloydii* in the spaces inbetween. Other common faunal species included *Ophiura albida*, *Clavelina lepadiformis, Gibbula* spp., *Alcyonium digitatum* and *Euspira* spp. This habitat occurred across the entrance to the bay, between 10 and 20 m depth.

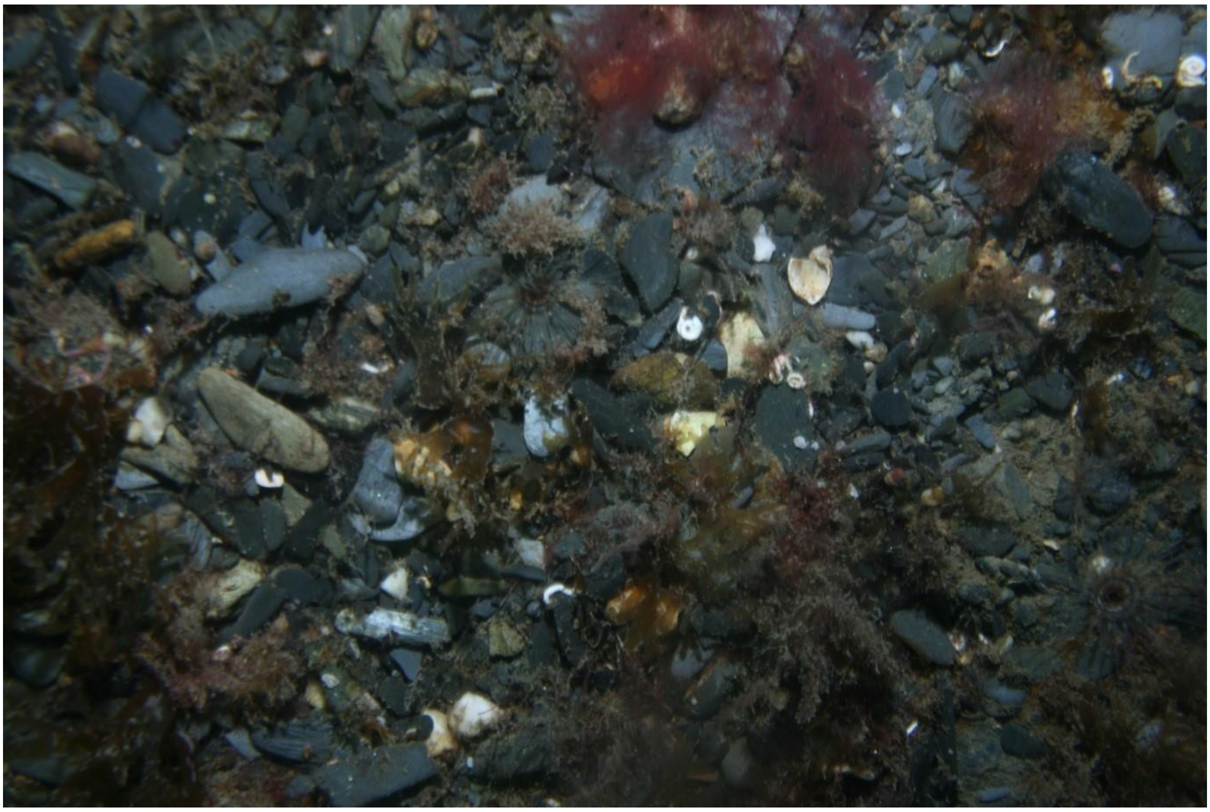

*Figure A 9: EUNIS Habitat Code SS.SMp.KSwSS.LsacR.CbPb*

**Habitat code:** SS.SMp.KSwSS.LsacR.Gv

**Habitat description: *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles**

Wave exposure: Moderately exposed to very sheltered
Tidal streams: Moderately strong (1-3 kn) to very weak (negligible)
Substratum: Gravel and coarse sand with some pebbles
Zone: Infralittoral
Depth: 0-20 m

Shallow sandy gravel with some pebbles. Biological community dominated by dense *Saccharina latissima* and robust red algae (e.g. *Plocamium cartilagineum, Vertebrata byssoides, Delesseria sanguinea*). Other characteristic taxa included *Chorda filum* and filamentous algae (both green and brown), with occasional hydroids, *Gibbula* spp. and *Lithothamnion* crusts. This habitat occurred inshore between 5 and 8 m depth.

*Figure A 10: EUNIS Habitat Code SS.SMp.KSwSS.LsacR.Gv*