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Benthic Habitat Mapping:
Ramsey 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 Ramsey 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 Ramsey Bay MNR.

2. Methods

2.1 Location

Ramsey Bay was the first designated MNR in Manx waters and is of particular note due to its innovative zoned management design, incorporating 4 habitat protection zones and a fisheries management zone (Figure 1) within which a highly-regulated small-scale scallop fishery occurs annually.

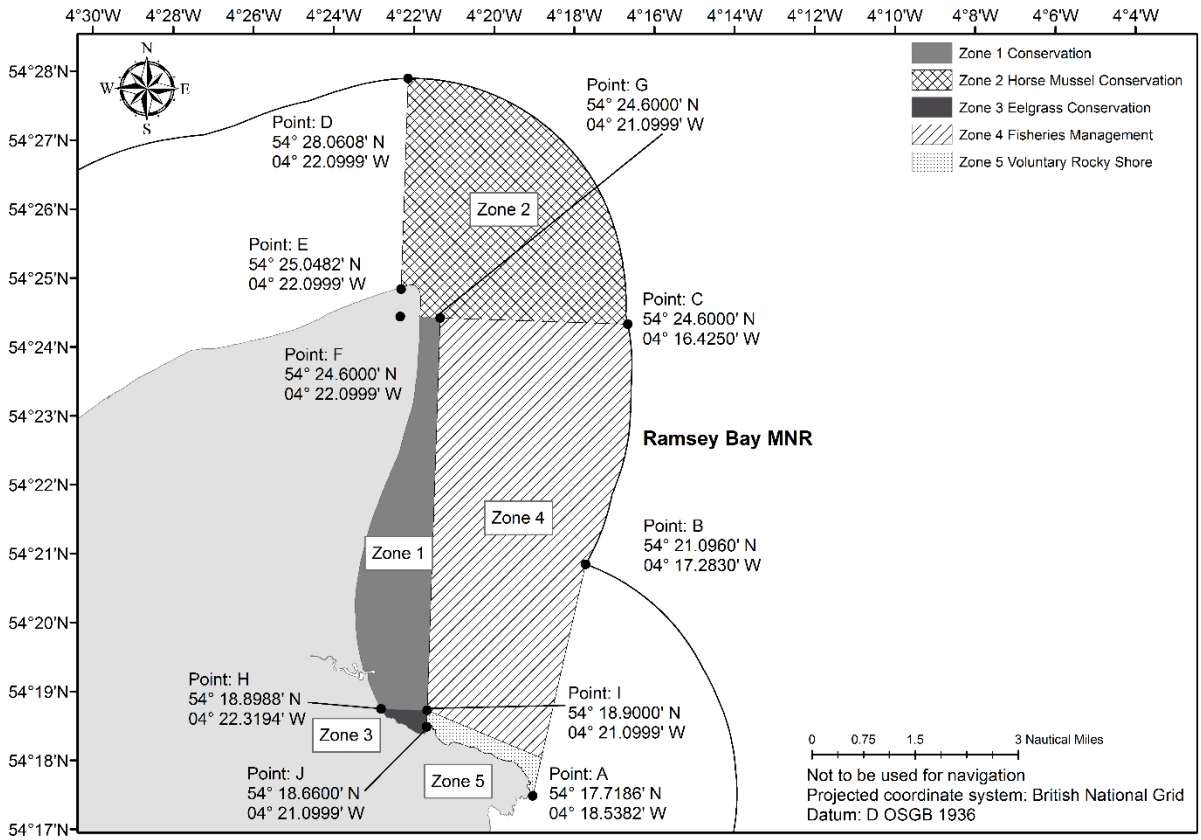

Figure 1: Map showing the location and zones of the Ramsey Bay Marine Nature Reserve.

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 Ramsey Bay camera survey took place over 4 days in June and July 2016 from the Fisheries Protection Vessel (F.P.V.) Barrule. Forty eight (48) transects were completed within Ramsey Bay MNR (Figure 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, and then identifying the species or substrate type directly under each point (centre of each cross). 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 be used in some cases for flora and small faunal species such as encrusting bryozoans.

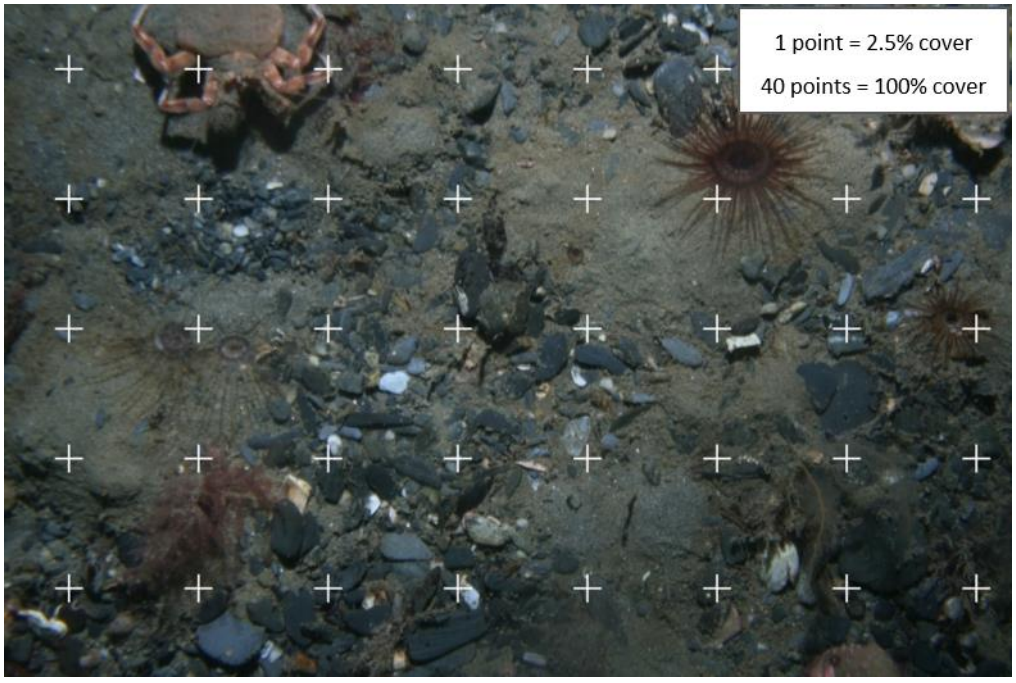

Figure 3: Example image demonstrating the standardised point sampling grid system used to determine percentage cover data. Substrate, flora or sessile fauna found at each of the 40 crosses were identified. The data at each cross was taken to represent 2.5 % cover. In this example, bare sand was identified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

The GoPro footage was examined in 1-minute segments starting with the first analysed image of each transect, resulting in data corresponding to the image coordinates. In each segment, presence-absence data was collected for all species (obvious flora and fauna) to the highest possible taxonomic resolution, and abundance counts recorded for scallops (*Pecten maximus*, *Aequipecten opercularis*) and horse mussels (*Modiolus modiolus*). In cases where the GoPro failed, videos from the live feed camera were analysed instead.

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 472 images and 472 minutes of video footage from Ramsey Bay MNR were analysed. The majority of images were clear and good quality, with 60% scoring 3 in both visibility and quality and only 9% scoring 1 in either category. Most of the video footage was analysed from the GoPro (73%). However 127 minutes were unusable and taken from the live feed camera instead. 117 taxonomic groups of living organisms were identified (Table A 1), including 93 faunal taxa and 24 algal taxa.

The burrowing anemone *Cerianthus lloydii* was the most widespread faunal species, present in 34% of images and 66% of the videos, with an average of 3.5 ± 0.1 individuals per image. Other frequently spotted anemone species included the dahlia anemone *Urticina felina* and daisy anemone *Cereus pedunculatus*, which were present in 19% and 36% of videos respectively. However these species were present in less than 3% of images. Other species found to be relatively widespread from video analyses but present in 5% or less of the images included the common starfish *Asterias rubens,* which was seen in 41% of all videos, the edible sea urchin *Echinus esculentus,* seen in 19% of videos, and dead man's fingers *Alcyonium digitatum,* in 30% of videos. The most frequently sighted fish in images and videos was the dragonet *Callionymus* spp., seen in 11% of the videos.

With regard to algal species, filamentous red algae was the most widespread taxon, seen in 40% of the images and averaging 13.1 ± 0.9% cover. Other frequently occurring algae included filamentous brown algae, which was present in 22% of images and averaged 7.3 ± 0.9% cover, sea belt *Saccharina lattisima* found in 20% of images and averaging 13.3 ± 1.4% cover, and brown fan weed *Dicyota dichotoma* found in 17% of images and averaging 5.9 ± 0.9% cover.

Species richness in Ramsey Bay MNR ranged from 0 to 26 in 1-minute video segments, averaging at 11 taxa per minute of tow. In still images, the number of countable faunal species ranged from 0 to 8, averaging at 2 per image.

3.1 EUNIS Habitats

The EUNIS approach resulted in the identification of 16 distinct habitat classifications in the MNR. These habitats are described in

Table *3* in conjunction with the results of SIMPER analysis, and their distributions across the MNR are displayed in Figure 4.

Table 3: Benthic habitats in Ramsey Bay MNR using the official European classification system (EUNIS) (JNCC, 2015), including the average similarity in percentage cover data within habitat groups and characteristic taxa identified from SIMPER analysis. Full SIMPER results available in Table A 2.

Eunis habitat Code	EUNIS habitat classification	Images used	Avg. sim.	Characterising taxa
A	**SS.SSa.IFiSa.IMoSa** Infralittoral mobile clean sand with sparse fauna	50	89.3 %	
B	**SS.SSa.IFiSa.ScupHyd** *Sertularia cupressina* and *Hydrallmania falcata* on tide- swept sublittoral sand with cobbles or pebbles.	17	56.7 %	*Sertularia* sp, *Urticina feline, Pagurus bernhardus*
C	**SS.SMx.CMx.FluHyd** *Flustra foliacea* and *Hydrallmania falcate* on tide-swept circalittoral mixed sediment	19	58.1 %	*Nemertesia antennina, Nemertesia ramose, Sertularia sp., Urticina felina*
D	**SS.SCS.ICS.SSh** *Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)*	4	76.5 %	
E	**SS.SSa.IMuSa.AreISa** *Arenicola marina* in infralittoral fine sand or muddy sand.	5	73.5 %	*Saccharina latissimi, Arenicola marina, Nemertesia antennina, Cerianthus lloydii*
F	**SS.SMx.CMx** Circalittoral mixed sediment.	12	71.6 %	*Ophiura albida*
G	**SS.SMx.CMx.ClloMx.Nem** *Cerianthus lloydii* with *Nemertesia spp*. And other hydroids in circalittoral muddy mixed sediment.	43	74.2 %	*Nemertesia antennina, Pecten maximus, Thecate hydroid spp., Aequipecten opercularis, Cerianthus lloydii, Clavelina lepadiformis, Alcyonium digitatum, Asterias rubens, Ophiura spp., Pagurus prideaux*
H	**SS.SCS.CCS** Circalittoral coarse sediment.	21	70.6 %	*Cerianthus lloydii, Tectura virginea, Pomatoceros triqueter, Pecten maximus, Gibbula spp*
I	**SS.SMp.KSwSS.LsacGraFS** *Saccharina latissimi, Gracilaria gracilis and brown seaweeds on full salinity infralittoral sediment.*	51	57.1 %	*Rhodophya spp., Echinus esculentus, Phaeophyceae spp., Cereus pedunculatus, Saccharina latissimi, Asterias rubens, Cerianthus lloydii, Antedon spp., Clavelina lepadiformis*
J	**SS.SMp.KSwSS.LsacR.Mu** Saccharina latissimi with red and brown seaweeds on lower infralittoral muddy mixed sediment.	64	63.5 %	Rhodophya spp., *Saccharina latissimi,* Phaeophyceae spp., *Clavelina lepadiformis, Ophiura* spp.
K	**SS.SMp.KSwSS.LsacR.Sa** Saccharine latissima and filamentous red algae on infralittoral sand.	37	54.2 %	Phaeophyceae spp., Rhodophya spp., *Saccharina latissimi, Cerianthus lloydii, Clavelina lepadiformis, Pomatoceros triqueter*
L	**SS.SMp.KSwSS.LsacR.Gv** Saccharina latissimi and robust red algae on infralittoral gravel and pebbles.	48	56.6 %	Rhodophya spp, Phaeophyceae spp., *Saccharina latissimi, Cerianthus lloydii, Pomatoceros triqueter, Clavelina lepadiformis, Echinus esculentus, Cereus pedunculatus, Asterias rubens, Antedon* spp., *Modiolus modiolus*
M	**IR.MIR.KT.XKTX** Mixed kelp and red seaweeds on infralittoral boulders, cobbles and gravel in tidal rapids.	9	43.8 %	Rhodophya spp, *Saccharina latissimi,* Phaeophyceae spp., *Pomatoceros triqueter Gibbula* spp, *Cerianthus lloydii, Cereus pedunculatus, Urticina felina*

N	**IR.MIR.KT.XKT** Mixed kelp with foliose red seaweeds, sponges and ascidians on sheltered tide-swept infralittoral rock.	10	53.9 %	Rhodophya spp., Echinus esculentus, Phaeophyceae spp., Metridium senile, Saccharina latissimi, Urticina feline, Sertularia sp., Pecten maximus, Cerianthus lloydii, Asterias rubens, Pomatoceros triqueter, Clavelina lepadiformis, Gibbula spp.
O	**SS.SCS.CCS.Nmix** Neopentadactyla mixta in circalittoral shell gravel or coarse sand.	32	54.7 %	Live/ dead Gibbula spp., Corallinaceae, Tectura virginea, Pomatoceros triqueter, Circeis spirillum
P	**SS.SMx.CMx.OphMx** Ophiothrix fragilis and/or Ophiocomina nigra brittlestar beds on sublittoral mixed sediment.	47	75.6 %	*Ophiothrix fragilis, Ophiocomina nigra*

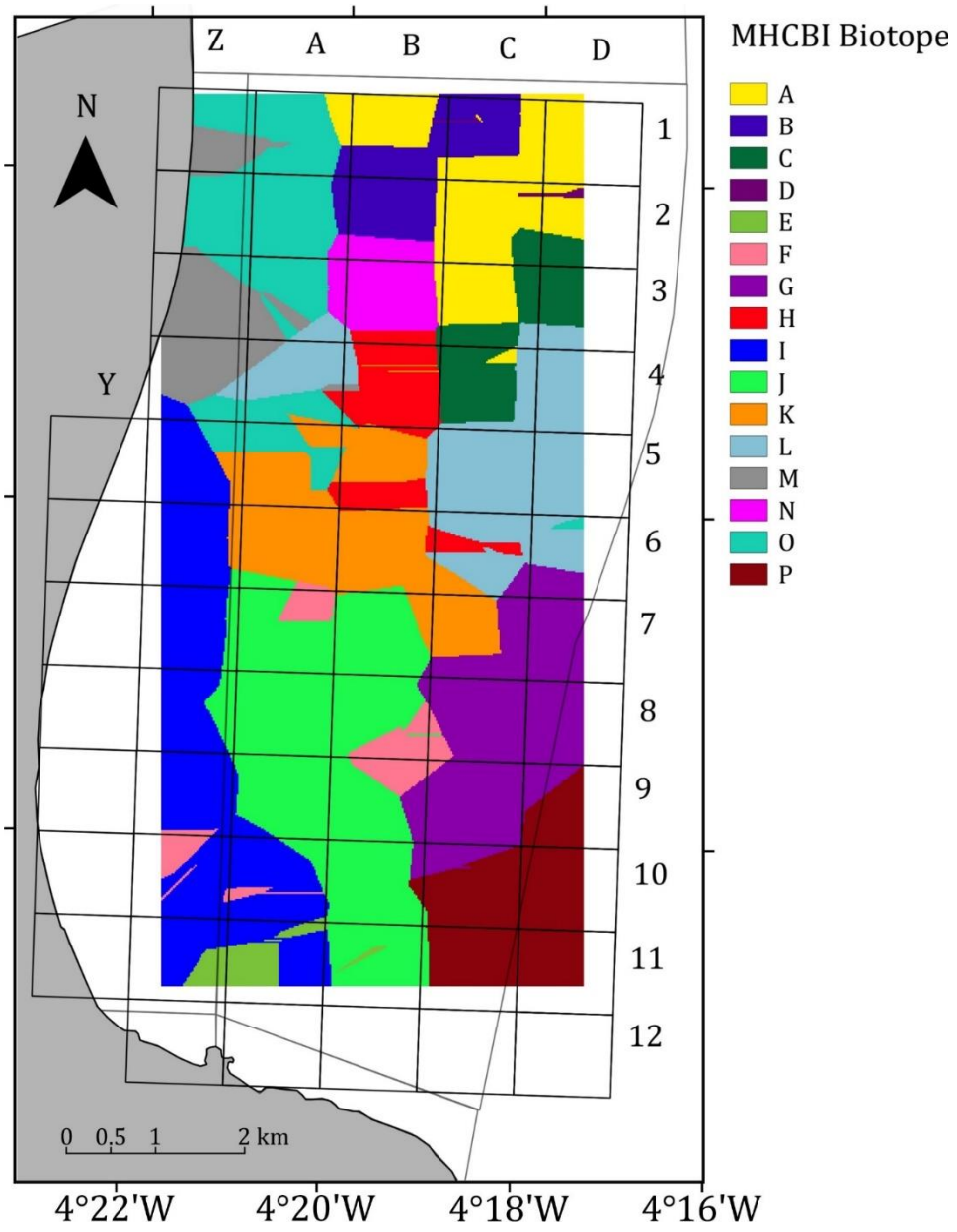

Figure 4: Habitat maps for Ramsey Bay MNR using EUNIS classification approach. Refer to Table 3 for habitat descriptions.

EUNIS habitats significantly varied with regard to percentage cover data (ANOSIM: R = 0.77, $p < 0.001$) and epifaunal community composition (ANOSIM: R = 0.47, $p < 0.001$). There was also significant variation in species richness (Margalef index) across habitats, regardless of whether it was calculated from percentage cover data ($ANOVA^{ln+1}$: $F_{15,435} = 72.69$, $p < 0.001$) or species count data ($ANOVA^{fourth}$: $F_{15,243} = 8.34$, $p < 0.001$). With regard to percentage cover data, greater species richness (Margalef index) was found in algal-dominated habitats, and the lowest in habitats A and P (mobile sand and brittlestar beds), where there was no algae (Figure 5 and Figure 6). Species richness from faunal count data appeared to be more correlated to substrate type, with coarser sediment habitats displaying greater species richness (Figure 5, Figure 6 and Figure 7). Overall, there was a general increase in diversity from the south to the north of the bay, peaking in the northwest of the Fisheries Management Zone (Figure 8).

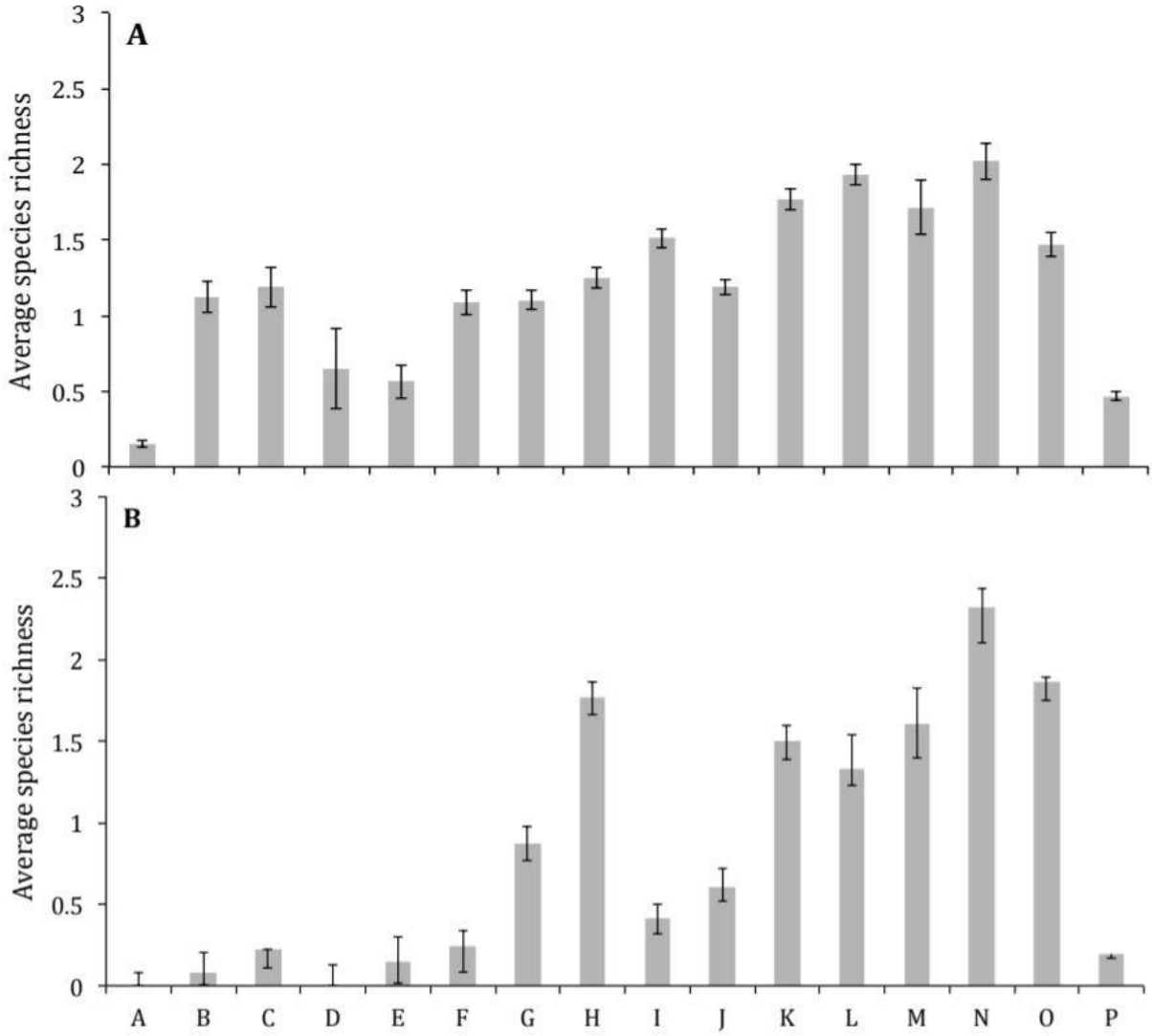

Figure 5: Mean (± S.E.) species richness (Margalef index) by habitat type, based on A) percentage cover data and B) faunal count data. Habitats described in

Table 3.

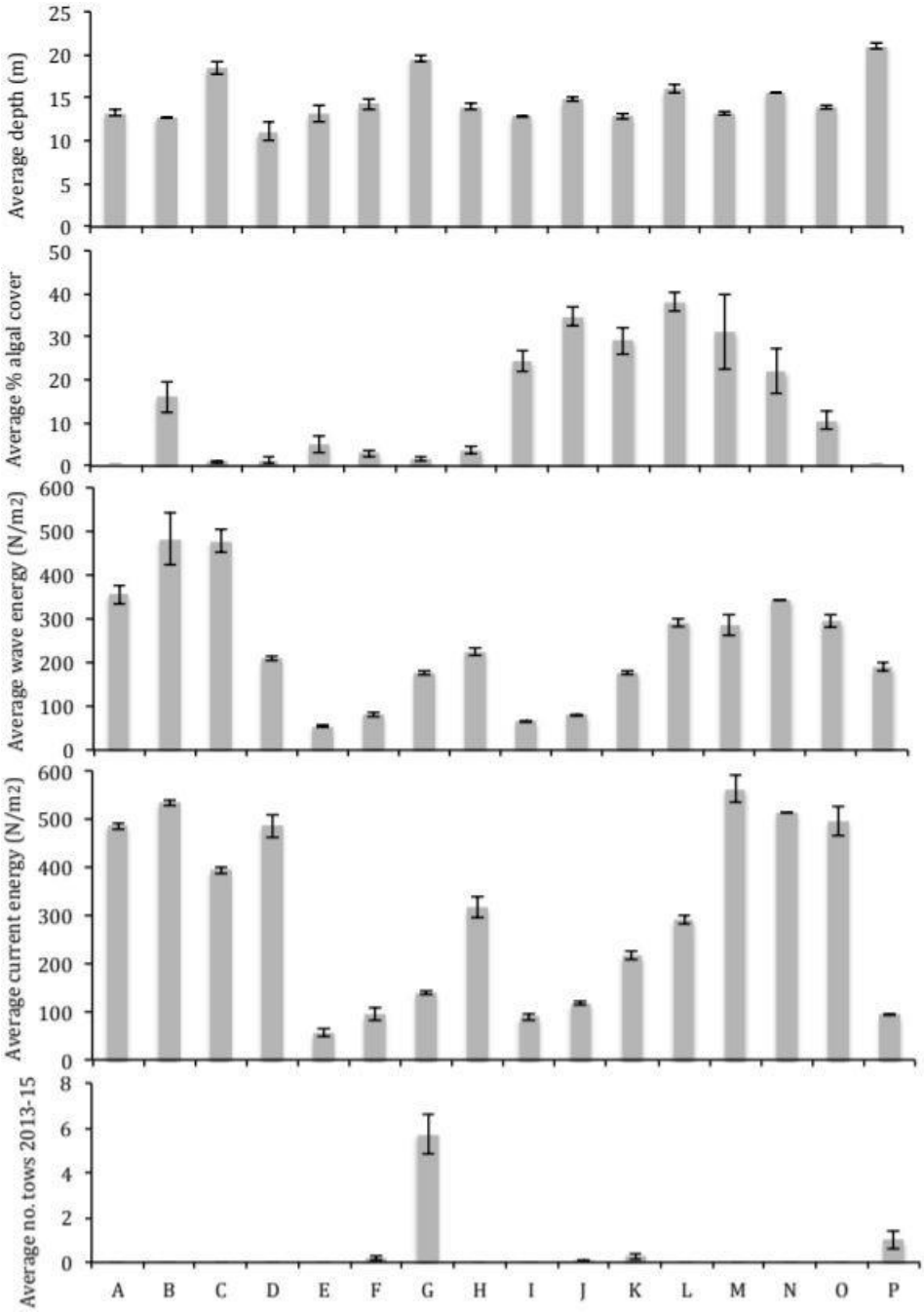

Figure 6: Mean (± S.E.) of environmental parameters across habitats. From top to bottom: depth; algal cover; wave energy; current energy; fishing activity. Habitats described in

Table 3.

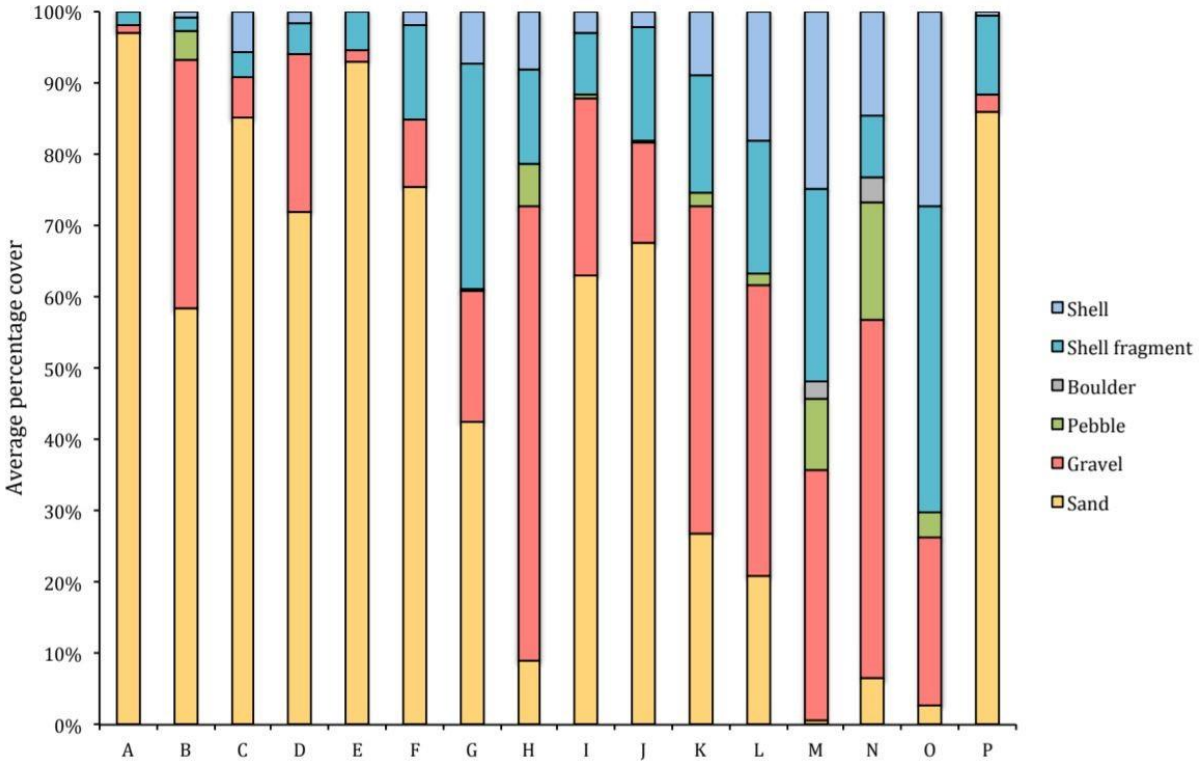

Figure 7: Average percentage cover of sediment types in each habitat type. Habitats described in Table 3.

Taking into consideration all environmental parameters (Figure 6 and Figure 7) [BEST analysis], percentage cover data was best described by a combination of 5 factors: algal cover, total energy (current and wave combined), and the proportions of sand, gravel and shells in the sediment (correlation of 0.70). Faunal count data however was best described by 2 factors: total energy and the amount of sandy substrate (correlation of 0.44).

With regard to fishing intensity, there was little to no interaction with benthic habitat types in Ramsey Bay MNR, with the exception of Habitat G (SS.SMx.CMx.CIloMx.Nem) which was located within the Fishing Ground. There was a significant difference between fished and non-fished areas with regard to species count data (ANOSIM: R = 0.10, p = 0.002) and presence-absence data (ANOSIM: R = 0.18, p < 0.001) but no significant difference based on percentage cover. Species associated with non-fished areas included the keelworm (*Spirobranchus triqueter*), topshells (*Gibbula* spp.), edible urchin (*Echinus esculentus*) and anemones (*Urticina felina*, *Cereus pedunctulatus*). Additionally the majority of algal species had greater abundance in non-fished areas. Conversely, fished areas were characterised by brittlestars *Ophiura* spp., hydroids, dead man's fingers (*Alcyonium digitatum*) and crabs (*Inachus* sp., *Pagurus prideaux*). King and queen scallops were also present in greater numbers in the fished region.

Species of both conservation and commercial interest were identified in Ramsey Bay MNR, including maerl, horse mussels (*Modiolus modiolus*) and scallops (*Pecten maximus*, *Aequipecten opercularis*). Maerl was generally sparse, and most commonly found inshore and towards the north-east of the MNR (Figure 8). Live maerl was present in 15% of images and averaged at 5.4 ± 0.6% cover, while dead maerl occurred in 32% of images and averaged at 8.3 ± 0.8% cover. Horse mussels were only found in 6 grid squares (Figure 8) and generally in low densities, averaging at 2.1 ± 0.5 individuals per

minute of video tow. However there was a localised region (grid square D5) where densities were much higher, averaging at 68.5 ± 7.6 individuals per minute of tow (Figure 8).

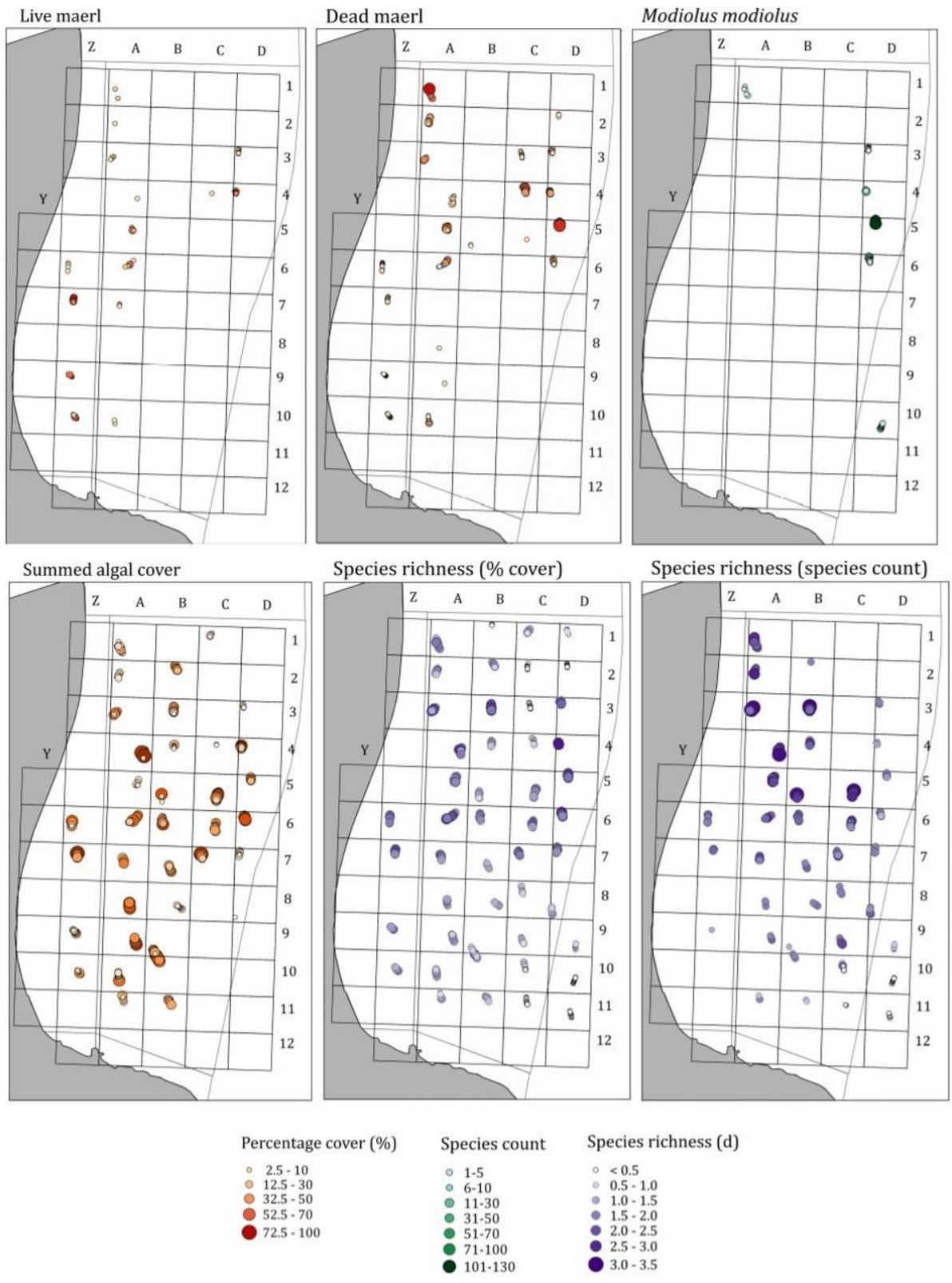

Figure 8: Spatial distributions of BAP (Biodiversity Action Plan) priority species, total algal cover and Margalef species richness (from percentage cover and species count data) across Ramsey Bay MNR.

3.2 Scallop densities

With regard to scallops, a total of 335 *P. maximus* and 564 *A. opercularis* were identified from video footage in Ramsey Bay MNR. Both species were most common within the Northern Fishing Ground (Box 2,Figure 9), with 61% of king scallops and 88% of queenies found in this area. Abundance significantly varied between habitat types for both species (*P. maximus*: $F_{15,456} = 21.04$, $p < 0.001$; *A. opercularis*: $F_{15,456} = 23.50$, $p < 0.001$), with the highest abundances found in Habitat G (SS.SMx.CMx.CllоMx.Nem) (Figure 10). No correlations to other environmental variables were found (depth, substrate type, algal cover, wave/current energy or fishing intensity).

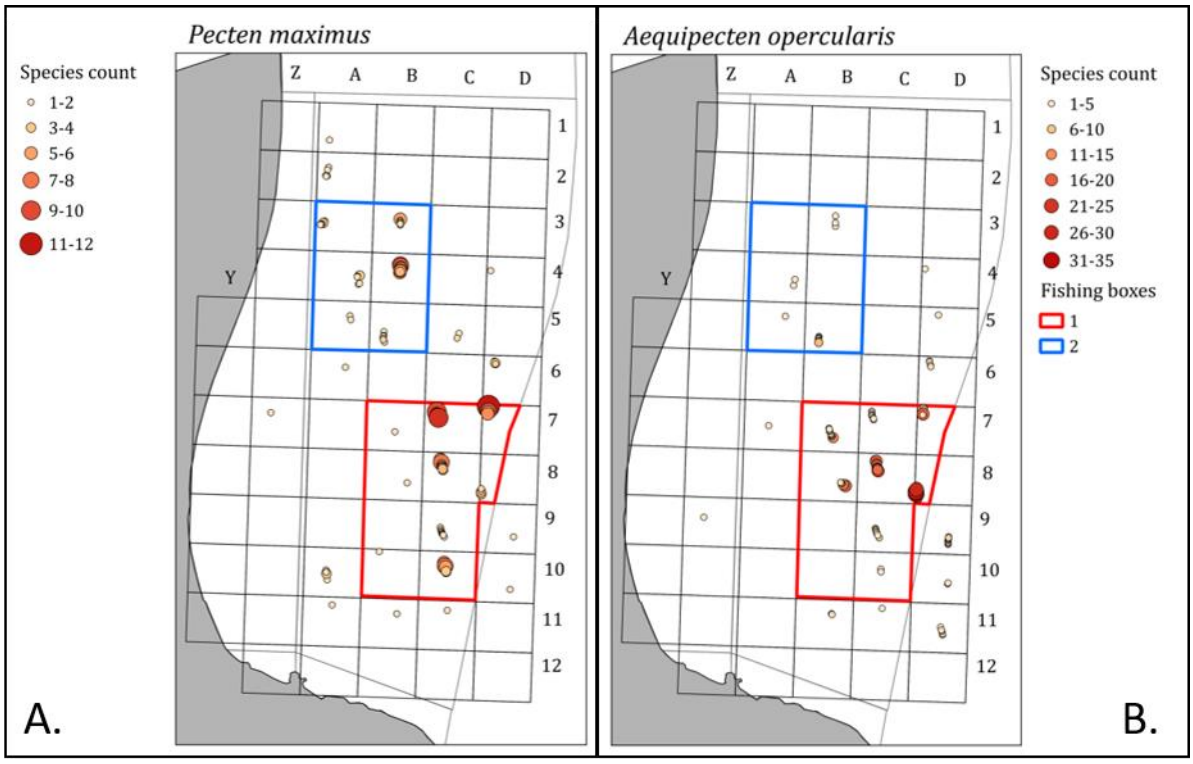

Figure 9: Distribution of scallops in Ramsey Bay MNR (abundance counts from 1-minute video segments). A) Pecten maximus; B) Aequipecten opercularis.

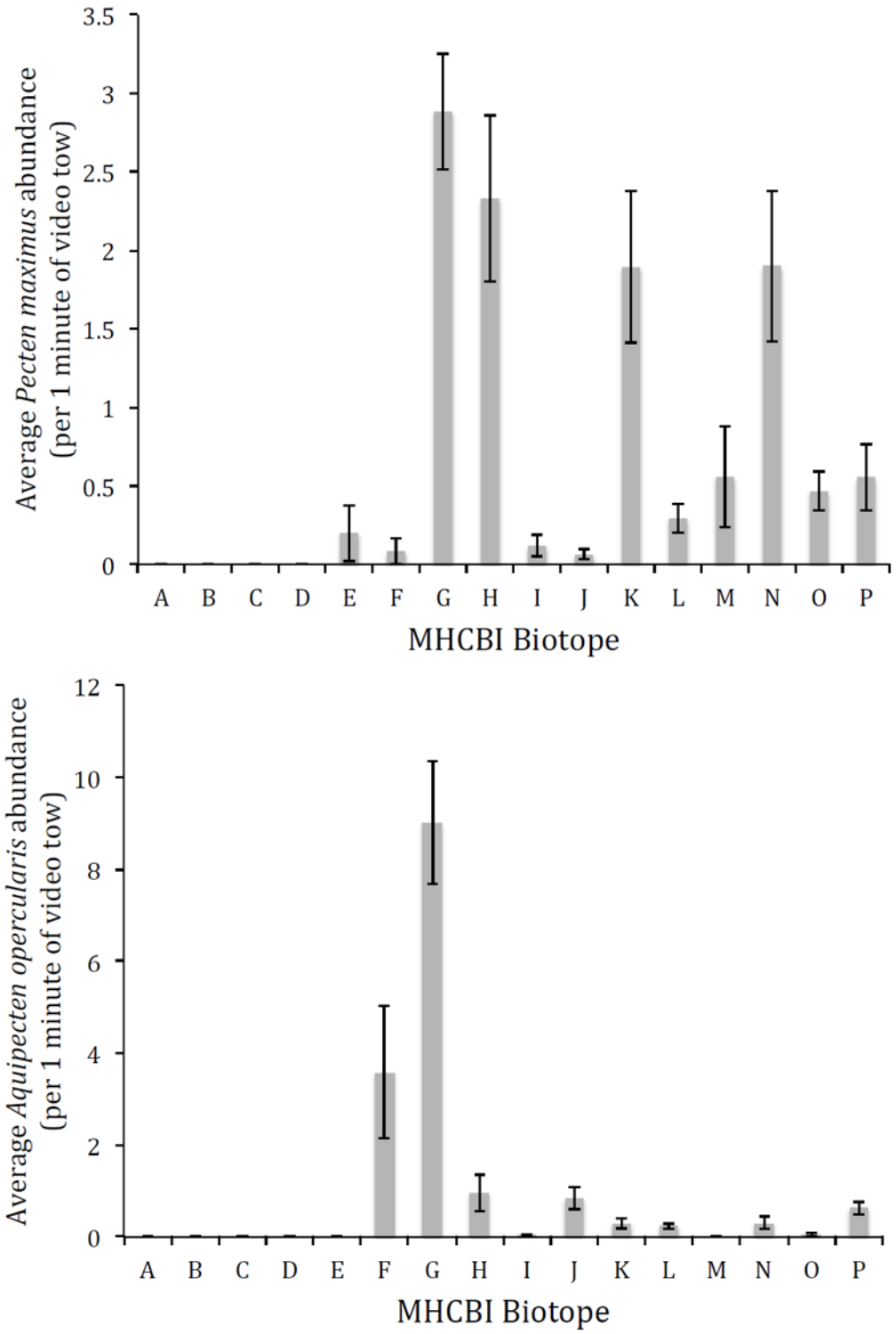

Figure 10: Mean (± S.E.) scallop abundances per minute of video in each habitat. Habitats described in Table 3

4. Discussion

Ramsey Bay MNR contains a diverse range of benthic habitats, from sparse sandy areas to rocky reefs. Most common were mixed and coarse sediment habitats, and algal-dominated habitats. Brittlestar beds (SS.SMx.CMx.OphMx) were present at the south-east of the bay. *Modiolus modiolus* (Horse

mussles) was a characteristic species of habitat SS.SMp.KSwSS.LsacR.Gv, located offshore towards the boundary of the MNR. Maerl was also present in the bay but in sparse densities and mostly inshore. In comparison to other MNRs, epifaunal species richness in Ramsey Bay was higher than Laxey Bay and comparable to Port Erin and Niarbyl.

With regard to commercial species, scallops (both *Pecten maximus* and *Aequipecten opercularis*) were present in high abundance in both the Northern and Southern Fishing Grounds (Box 1 and Box 2; Figure 9) and The Garden. *Pecten maximus* densities in video tows reached as high as 36 individuals per 100m^2, surpassed only by Port Erin MNR, which has been closed for 30 years. *Aequipecten opercularis* density was generally low, averaging 6 per 100m^2 throughout the MNR, but increasing significantly (>20 per 100m^2) in 4 tows, peaking at 101 per 100m^2. Other species of commercial interest that were recorded were *Buccinum undatum* and *Cancer pagurus*.

The data from our MNRs will feed into management efforts and provides useful baseline information with regard to species records and future monitoring.

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6. Appendix

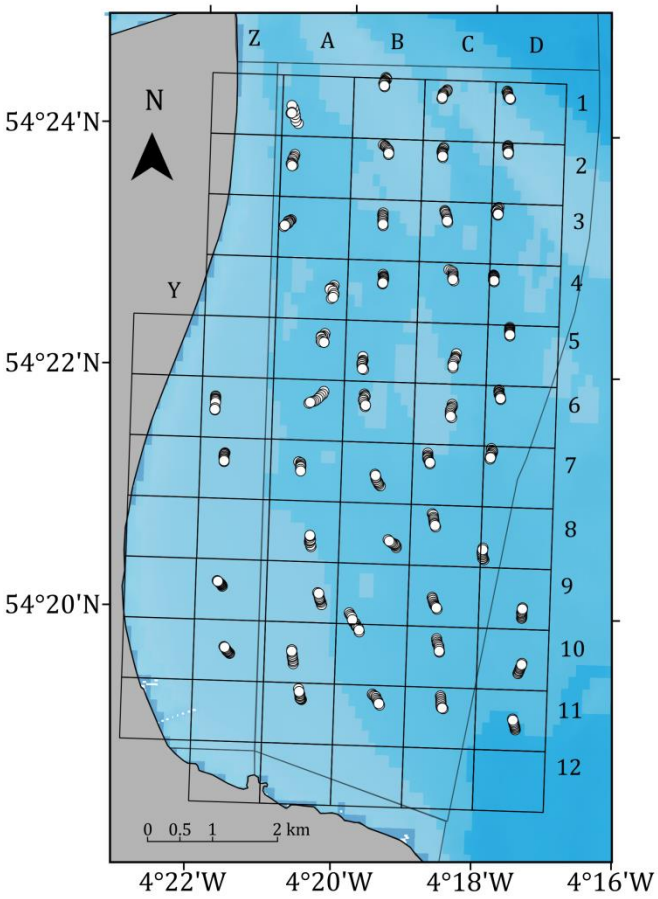

Figure A 1: Map of the camera tow transects used to collect videos and images of the seabed inside Ramsey Bay MNR.

Table A 1: List of taxa identified from benthic photographs taken inside Ramsey Bay MNR.

Latin name	Common name
Aequipecten opercularis	Queen scallop
Alcyonidium gelatinosum	Encrusting bryozoan
Alcyonium digitatum	Dead man's finger
Anemonia viridis	Snakelocks anemone
Antedon spp.	Feather star spp.
Arenicola marina	Lug worm
Arthropoda sp.	Marine stick insect sp.
Ascidiacea spp.	Sea squirt spp.
Asterias rubens	Common starfish
Brachyura sp.	Crab sp.
Branching brown hydroid sp.	Branching brown hydroid sp.
Branching Rhodophya sp.	Branching red algae sp.
Buccinum undatum	Common whelk
Bugula flabellata	Erect spiral bryozoan
Calliblepharis ciliata	Red fringed weed
Callionymus spp.	Dragonet spp.
Calliostoma zizyphinum	Painted topshell
Cancer pagurus	Edible crab
Capnea sanguinea	Imperial anemone
Caridea sp.	Shrimp sp.
Cereus pedunculatus	Daisy anemone
Ceriantharia tube	Tube anemone tube
Cerianthus lloydii	Burrowing anemone
Cerianthus lloydii	Tube anemone
Chorda filum	Bootlace weed
Chwyrnwr coch	Red gurnard
Circeis spirillum	Coiled tubeworm
Clavelina lepadiformis	Light bulb sea squirt
Corallinaceae crust	Pink paint weed
Coryphella spp.	Pink tinted sea slug spp.
Crossaster papposus	Common sunstar
Cryptopleura ramosa	Fine-veined crinkle weed
Cuthona caerulea	Blue tinted sea slug
Dead Corallinaceae	Dead maerl
Delesseria sanguinea	Sea beech
Dendrochirotacea spp.	Sea cucumber spp.
Dictyota dichotoma	Brown fan weed
Dilsea carnosa	Red rags
Diplecogaster bimaclatus	Two-spotted clingfish
Ebalia sp.	Small crab sp.
Echinoida sp.	Urchin sp.

Latin name	Common name
Echinus esculentus	Edible sea urchin
Elongate Phaeophyceae sp.	Elongate brown algae sp.
Elongate Rhodophya sp.	Elongate red algae sp.
Filamentous Chlorophyta spp.	Filamentous green algae spp.
Filamentous Phaeophyceae spp.	Filamentous brown algae spp.
Filamentous Rhodophya spp.	Filamentous red algae spp.
Filamentous transparent algae sp.	Filamentous transparent algae sp.
Fine bryozoan sp.	Fine bryozoan sp.
Fine Rhodophya spp.	Fine red algae spp.
Fish spp.	Fish spp.
Flat Phaeophyceae sp.	Flat brown algae sp.
Flat Rhodophya spp.	Flat red algae spp.
Flustra foliacea	Hornwrack
Forked Chlorophyta sp.	Forked green algae sp.
Forked Rhodophyta sp.	Forked red algae sp.
Forked transparent algae sp.	Forked transparent algae sp.
Forked transparent algae sp.	Forked transparent algae sp.
Gibbula spp.	Topshell spp.
Gibbula umbilicalis	Flat topshell
Henricia spp.	Henricia starfish spp.
Hydroid/ bryozoan turf	Hydroid/ bryozoan turf
Inachus sp.	Hairy spider crab sp.
Kelp spp.	Kelp spp.
Laminaria sp.	Cleft kelp sp.
Lanice conchilega	Sand mason worm
Large Docoglossa sp.	Large limpet sp.
Leptasterias muelleri	Northern starfish
Limacea clavigera	Sea slug
Limanda limanda	Dab
Liocarcinus corrugatus	Wrinkled swimming crab
Liocarcinus depurator	Harbour crab
Liocarcinus spp.	Liocarcinus crab spp.
Live Corallinaceae	Live maerl
Lophius piscatorius	Monkfish
Lotidae sp.	Rockling sp.
Lumpenus lampretaeformis	Snake blenny
Macropodia spp.	Spider crab spp.
Marthasterias glacialis	Spiny star
Metridium senile	Plumose anemone
Modiolus modiolus	Horse mussel
Myxicola infundibulum	Fanworm
Necora puber	Velvet swimming crab
Nemertesia antennina	Antenna hydroid
Nemertesia ramosa	Branched antenna hydroid
Octopus vulgaris	Common octopus
Ophiocomina nigra	Black brittlestar
Ophiothrix fragilis	Common brittlestar

Latin name	Common name
Ophiura albida	Serpent's table brittlestar
Ophiura ophiura	Serpent star
Ophiura spp.	Serpent brittlestar spp.
Ophiuroidea spp.	Brittlestar spp.
Paguridae spp.	Hermit crab spp.
Pagurus bernhardus	Common hermit crab
Pagurus prideaux	Anemone hermit crab
Pecten maximus	King scallop
Pink-tip Rhodophya sp.	Pink-tip red algae sp.
Plathelminthes sp.	Flatworm sp.
Pleuronectiformes spp.	Flatfish spp.
Polyplacophora spp.	Chiton spp.
Pomatoceros triqueter	Keeled Tubeworm
Pomatoschistus pictus	Painted goby
Pomatoschistus sp.	Goby sp.
Prosobranchia spp.	Snail spp
Retracted Actiniaria spp.	Retracted anemone spp.
Sabella pavonina	Peacock worm
Sabellidae sp.	Feather-duster worm sp.
Saccharina latissima	Sea belt
Scyliorhinus canicula	Common catshark
Sertularia sp.	Squirrel's tail hydroid sp.
Small Docoglossa spp.	Small limpet spp.
Small Echinoidea sp.	Small urchin sp.
Small fish spp.	Small fish spp.
Speckled Actiniaria spp.	Speckled anemone spp.
String weed sp.	String weed sp.
Striped Annelida sp.	Striped worm sp.
Tectura virginea	White tortoiseshell limpet
Thecate hydroid spp.	Thecate hydroid spp.
Tubulariidae hydroid spp.	Pipe hydroid spp.
Ulva spp.	Sea lettuce spp.
Urticina felina	Dahlia anemone
White bushy hydroid sp.	White bushy hydroid sp.

Table A 2: SIMPER analysis on percentage cover data for the habitats identified using the EUNIS procedure.

Taxa/Substratum	No.Sites	Av.Abund	Cont %	Cum.Cont %
Group A: average similarity 89.32%	50			
Sand		9.83	97.80	97.80
Group B: average similarity 56.72%	17			
Sand		5.77	39.29	39.29
Gravel		5.08	31.25	70.54
Sertularia sp.		2.94	15.91	86.45
Filamentous Phaeophyceae spp.		1.81	4.62	91.07
Group C: average similarity 58.11%	19			
Sand		7.57	58.37	58.37
Dead Corallinaceae		3.02	16.78	75.15
Shell		1.28	5.82	80.97
Nemertesia antennina		1.61	4.17	85.14
Sertularia sp.		0.99	3.22	88.36
Hydroid/bryozoan turf		1.10	2.52	90.89
Group D: average similarity 76.48%	4			
Sand		7.72	42.66	55.78
Gravel		5.62	30.71	95.93
Group E: average similarity 73.50%	5			
Sand		9.30	83.17	83.17
Shell fragment		1.94	10.60	93.77
Group F: average similarity 71.55%	12			
Sand		7.64	48.59	48.59
Shell fragment		3.74	21.35	69.94
Gravel		3.00	15.91	85.85
Hydroid/bryozoan turf		2.10	8.82	94.68
Group G: average similarity 74.17%	43			
Sand		6.28	35.60	35.60
Shell fragment		5.03	27.88	63.49
Gravel		3.88	18.97	82.46
Shell		2.06	9.64	92.10
Group H: average similarity 70.61%	21			
Gravel		7.42	44.59	44.59
Shell fragment		3.37	18.96	63.55
Shell		2.96	14.53	78.08
Sand		2.40	9.65	87.73
Cerianthus lloydii		1.30	4.69	92.42
Group I: average similarity 57.07%	51			
Sand		5.76	34.31	34.31
Gravel		3.24	15.04	49.35
Hydroid/bryozoan turf		2.97	14.88	64.23
Shell fragment		2.06	9.49	73.72
Dead Corallinaceae		1.52	6.76	80.48
Saccharina latissima		2.27	6.63	87.11
Live Corallinaceae		1.34	3.50	90.61

Taxa/Substratum	No.Sites	Av.Abund	Cont %	Cum.Cont %
Group J: average similarity 62.50%	64			
Sand		6.21	39.26	39.26
Filamentous Rhodophya spp.		4.01	21.78	61.04
Shell fragment		2.49	12.26	73.30
Gravel		2.37	10.28	83.59
Hydroid/bryozoan turf		1.98	8.21	91.80
Group K: average similarity 54.18%	37			
Gravel		4.42	23.70	23.70
Sand		3.78	20.62	44.32
Shell fragment		2.94	15.55	59.86
Filamentous Rhodophya spp.		2.79	11.66	71.53
Hydroid/bryozoan turf		1.80	6.01	77.54
Filamentous Phaeophyceae spp.		1.95	5.39	82.93
Shell		1.57	4.81	87.74
Cerianthus lloydii		0.97	3.35	91.09
Group L: average similarity 56.64%	48			
Filamentous Rhodophya spp.		4.62	24.18	24.18
Gravel		3.48	15.19	39.37
Shell		2.42	10.27	49.64
Sand		2.41	10.04	59.68
Shell fragment		2.34	9.33	69.01
Dictyota dichotoma		2.00	7.41	76.41
Dead Corallinaceae		2.46	7.29	83.71
Cerianthus lloydii		1.46	5.71	89.42
Hydroid/bryozoan turf		1.34	4.38	93.80
Group M: average similarity 43.79%	9			
Shell fragment		3.41	20.10	20.10
Gravel		3.56	17.33	37.43
Filamentous Rhodophya spp.		3.06	15.85	53.28
Shell		3.32	14.65	67.93
Pebble		1.46	6.36	74.28
Hydroid/bryozoan turf		1.20	5.64	79.92
Saccharina latissima		1.65	5.46	85.38
Dictyota dichotoma		1.82	4.96	90.34
Group N: average similarity 53.85%	10			
Gravel		5.78	33.02	33.02
Pebble		2.89	12.89	45.91
Shell		2.57	12.64	58.55
Shell fragment		2.03	8.60	67.16
Filamentous Rhodophya spp.		2.11	6.40	73.56
Sand		1.77	5.37	78.94
Filamentous Phaeophyceae spp.		1.06	3.32	82.25
Saccharina latissima		1.39	2.90	85.15
Hydroid/ bryozoan turf		1.15	2.77	87.92
Thecate hydroid spp.		1.09	2.75	90.67
Group O: average similarity 54.67%	32			
Shell fragment		5.05	31.26	31.26
Shell		4.09	24.06	55.31
Gravel		3.58	17.25	72.56
Dead Corallinaceae		3.12	14.52	87.08
Hydroid/bryozoan turf		1.01	2.54	89.62
Filamentous Rhodophya spp.		1.04	2.09	91.71
Group P: average similarity 75.63%	47			
Ophiuroidea spp.		7.33	54.33	54.33
Sand		5.72	39.03	93.36

Habitat code: SS.SSa.IFiSa.IMoSa (A)

Habitat description: Infralittoral mobile clean sand with sparse fauna

Wave exposure: Exposed to sheltered
Tidal streams: Strong to very weak
Substratum: Medium to fine sand
Zone: Infralittoral
Depth range: 0 – 20 m

Description of RMNR habitat: In tide swept areas, mobile sand with very few faunal and floral species present. Occasional aggregations of pebbles and rounded gravels were observed. Found at depths between 9 and 20 m.
Habitat in grid squares B1, C1, C2, C3, C4, D1, D2

Figure A 2: EUNIS Habitat SS.SSa.IFiSa.IMoSa

Habitat code: SS.SSa.IFiSa.ScupHyd (B)

Habitat description: *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles

Wave exposure: Moderately exposed to sheltered
Tidal streams: Strong to very weak
Substratum: Medium to fine sand, with cobbles and pebbles
Zone: Infralittoral and circalittoral
Depth range: 0 – 20 m

Description of RMNR habitat: TideAswept sandy substrate, with some cobbles, at depths of 12 to 14 m. Flora included *Hydrallmania falcate, Sertularia* spp. and *Flustra foliacea*. Faunal species were found at low abundances, and included tolerant species such as *Alycyonium digitatum, Cerianthus lloydii*, *Urticina felina, Pagurus* spp., *Asterias rubens, and Callionymus* spp.
Habitat in grid square B2, C1

Figure A 3: EUNIS Habitat SS.SSa.IFiSa.ScupHyd

Habitat code: SS.SMx.CMx.FluHyd (C)

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

Wave exposure: Extremely exposed to moderately exposed
Tidal streams: Strong to moderately strong
Substratum: Boulders, cobbles or pebbles with gravel and sand
Zone: Circalittoral
Depth range: 5 – 50 m

Description of RMNR habitat: Similar to SS.SSa.IFiSa.ScupHyd habitat, however was less disturbed by currents and found in deeper water (between 15 and 16 m). Mixed sandy substrate with *Nemertesia* spp. *Sertularia* spp., *Flustra foliacea* and *Alcyonidium gelatinosum*. Fauna included conspicuous species such as *Urticina felina, Cerianthus lloydii, Echinus esculentus, Alcyonium digitatum*, and *Pagurus* spp.
Habitat in grid squares C4, D3

Figure A 4: EUNIS Habitat SS.SMx.CMx.FluHyd

Habitat code: SS.SCS.ICS.SSh (D)

Habitat description: Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)

Wave exposure: Extremely exposed to exposed
Tidal streams: Moderately strong
Substratum: Shingle and/or pebbles
Zone: Infralittoral
Depth range: 5 – 50 m

Description of RMNR habitat: Mobile clean gravels and pebbles, with a lack of associated fauna and flora, found at depths between 9 and 13 m.
Habitat in grid square C1, D2

Figure A 5: EUNIS Habitat SS.SCS.ICS.SSh

Habitat code: SS.Ssa.IMuSa.AreISa (E)

Habitat description: *Arenicola marina* in infralittoral fine sand or muddy sand

Wave exposure: Moderately exposed to extremely sheltered
Tidal streams: Moderately strong to very weak
Substratum: Fine to very fine sand and muddy sand
Zone: Infralittoral
Depth range: 0 – 20 m

Description of RMNR habitat: Fine sand to nonAcohesive muddy sand in shallow water between 12 and 18 m. The characteristic species of the habitat was *Arenicola marina*. Although quite faunally sparse, other species found included *Cerianthus lloydii, Cereus pedunculatus, Asterias rubens, Pagurus* spp., *Liocarcinus* spp. and *Lanice conchilega*. Few seaweeds were observed in the habitat.
Habitat in grid squares A11, B11

Figure A 6: EUNIS Habitat SS.Ssa.IMuSa.AreISa

Habitat code: SS.SMx.CMx (F)

Habitat description: Circalittoral mixed sediment

Wave exposure: Moderately exposed to very sheltered
Tidal streams: Moderately strong to very weak
Substratum: Mixed sediment (with stones and shells)
Zone: Circalittoral
Depth range: 5 – 50 m

Description of RMNR habitat: Mixed sediment, with a lack of algal species, found at depths between 11 and 17 m. Species included *Ophiura* spp., *Clavelina lepadiformis*, *Cereus pedunculatus*, *Aequipecten opercularis, Pagurus* spp*., Alcyonium digitatum, Asterias rubens, Cerianthus lloydii,* and *Pecten maximus*.
Habitat in grid squares A7, A10, B8, Z10

Figure A 7: EUNIS Habitat SS.SMx.CMx

Habitat code: SS.SMx.CMx.ClloMx.Nem (G)

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 to very weak
Substratum: Sandy, muddy gravel with surficial cobbles, pebbles and shells
Zone: Infralittoral to circalittoral
Depth range: 10 – 30 m

Description of RMNR habitat: Mixed sediment with surface shells and a lack of algal species, at depths from 17 to 24 m. Sparse covering of hydroids such as *Nemertesia antennina* and *N. ramosa*. Characteristic species included *Cerianthus lloydii*, *Clavelina lepadiformis*, *Ophiura* spp., *Alcyonium digitatum*, *Pagurus prideaux*, and *Asterias rubens*. Both *Aequipecten opercularis* and *Pecten maximus* were found in this habitat.
Habitat in grid squares C8, C9, C10, D7, D8

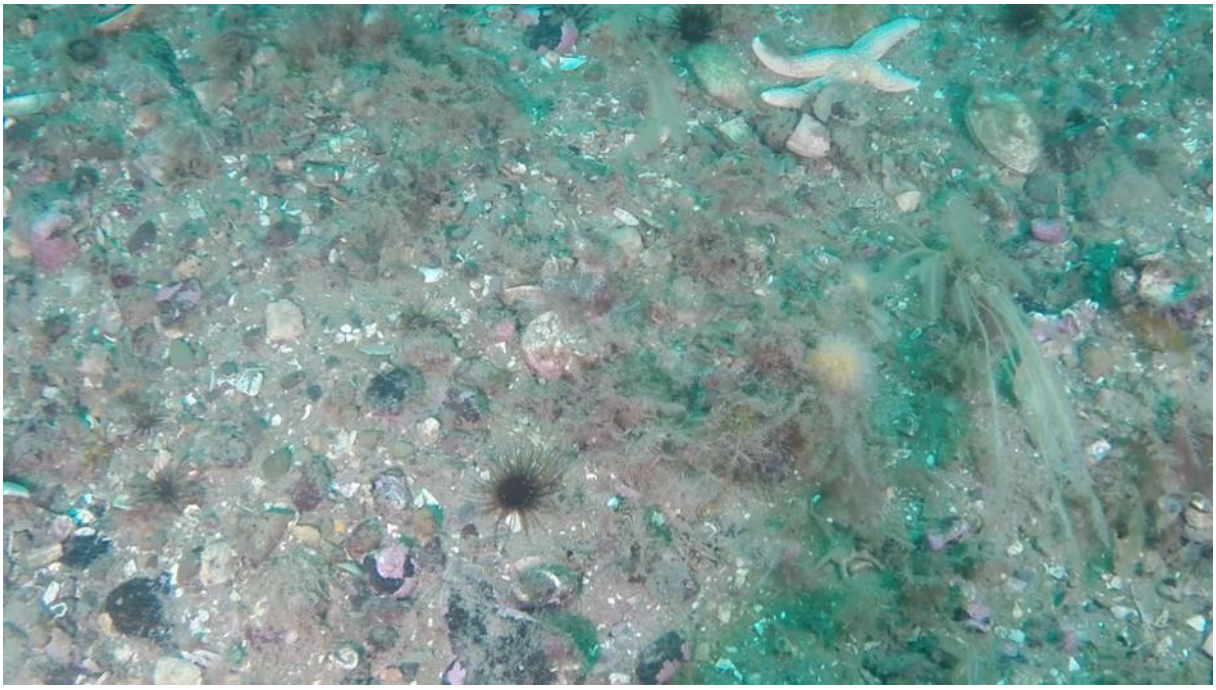

Figure A 8: EUNIS Habitat SS.SMx.CMx.ClloMx.Nem

Habitat code: SS.SCS.CCS (H)

Habitat description: Circalittoral coarse sediment

Wave exposure: Exposed to moderately exposed
Tidal streams: Moderately strong to very weak
Substratum: Coarse sand and gravel with a minor finer sand fraction
Zone: Infralittoral to circalittoral
Depth range: 10 – 50 m

Description of RMNR habitat: Pebbles and gravels overlying sediment substrate, with a lack of algal species. Species included *Cerianthus lloydii*, *Pomatoceros triqueter*, *Gibbula* spp., *Tectura virginea*, *Clavelina lepadiformis*, *Pecten maximus, Aequipecten opercularis*, and *Asterias rubens*. Found at depths between 11 and 17 m.
Habitat in grid squares A4, B4, B5, C6

Figure A 9: EUNIS Habitat SS.SCS.CCS

Habitat code: SS.SMp.KSwSS.LsacGraFS (I)

Habitat description: *Saccharina latissima*, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment

Wave exposure: Moderately exposed to extremely sheltered
Tidal streams: Moderately strong to weak
Substratum: Muddy sand with pebbles
Zone: Infralittoral, circalittoral, sublittoral fringe
Depth range: 0 – 10 m

Description of RMNR habitat: Shallow waters between 11 and 14 m, with muddy sand. *Saccharina latissima* was characteristic of this habitat, although did not occur at high abundances. The red algae *Gracilaria gracilis* and green algae *Ulva* spp. were also observed in this habitat. A variety of faunal species including *Pomatoceros triqueter, Arenicola marina, Clavelina lepadiformis, Ophiura* spp., *Cerianthus lloydii, Pagurus* spp. and *Asterias rubens* were present.
Habitat in grid squares A10, A11, Z6, Z7, Z9, Z10

Figure A 10: EUNIS Habitat SS.SMp.KSwSS.LsacGraFS

Habitat code: SS.SMp.KSwSS.LsacR.Mu (J)

Habitat description: *Saccharina latissima* with red and brown seaweeds on lower infralittoral muddy mixed sediment

Wave exposure: Moderately exposed to extremely sheltered
Tidal streams: Moderately strong to very weak
Substratum: Muddy gravelly mixed sediment
Zone: Infralittoral
Depth range: 5 – 20 m

Description of RMNR habitat: Mixed substrate dominated by sand, with occasional *Saccharina latissima* and a sparse covering of red algae. *Cerianthus lloydii*, *Clavelina lepadiformis, Cereus pedunculatus, Ophiura* spp., and *Asterias rubens* can be found in this habitat. This habitat was found at depths from 11 to 18 m.
Habitat in grid squares A7, A8, A9, B7, B8, B9, B10, B11

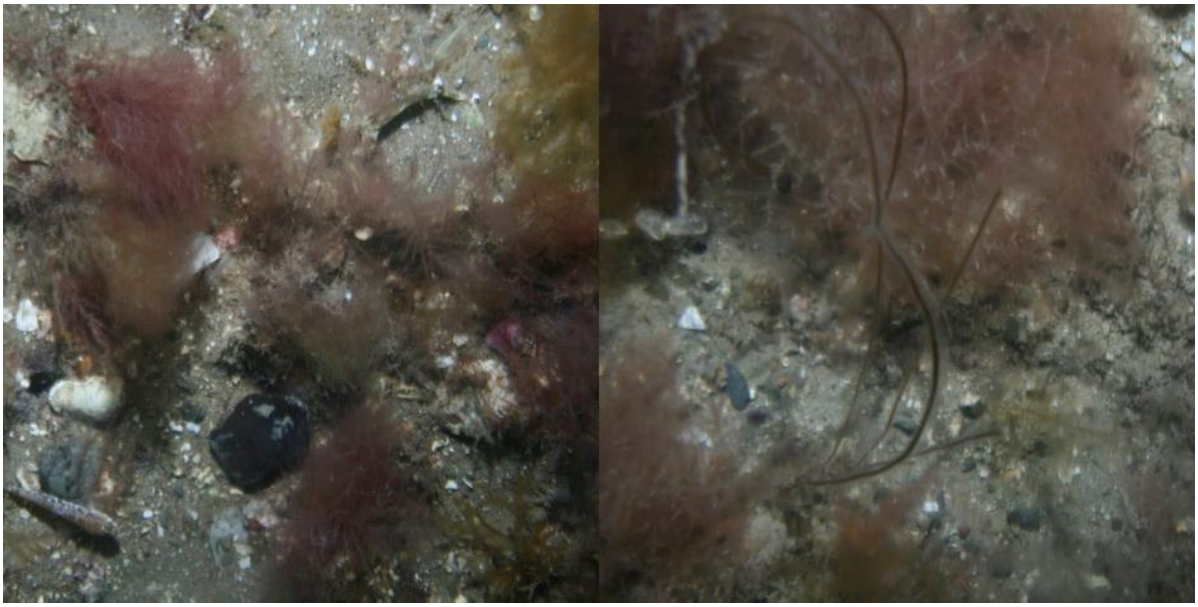

Figure A 11: EUNIS Habitat SS.SMp.KSwSS.LsacR.Mu

Habitat code: SS.SMp.KSwSS.LsacR.Sa (K)

Habitat description: *Saccharina latissima* and filamentous red algae on infralittoral sand

Wave exposure: Moderately exposed to very sheltered
Tidal streams: Moderately strong to very weak
Substratum: Sand with some gravel
Zone: Infralittoral
Depth range: 0 – 20 m

Description of RMNR habitat: Mixed sediments, with a higher gravel content than SS.SMp.KSwSS.LsacR.Mu habitat. Occasional *Saccharina latissima* were seen, with a sparse covering of red algae. Species found in this habitat included *Cerianthus lloydii, Clavelina lepadiformis, Pomatoceros triqueter*, *Asterias rubens, Pecten maximus* and *Alcyonium digitatum*. Found at depths ranging from 10 to 17 m.
Habitat in grid squares A5, A6, B4, B5, B6, C7

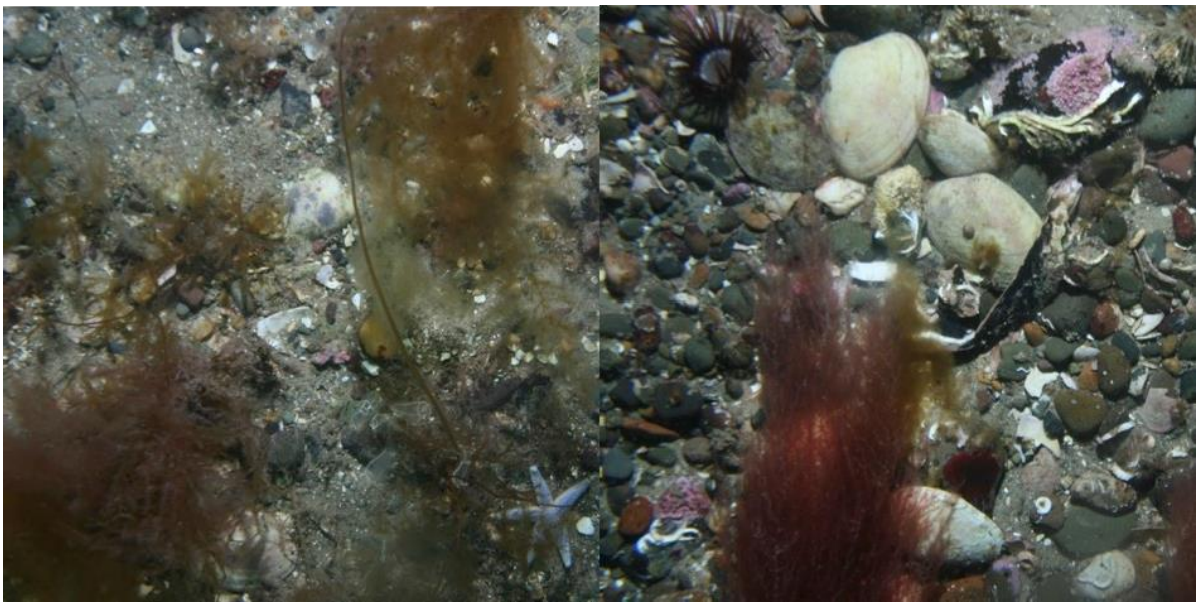

Figure A 12:EUNIS Habitat SS.SMp.KSwSS.LsacR.Sa

Habitat code: SS.SMp.KSwSS.LsacR.Gv (L)

Habitat description: *Saccharina latissima* and robust red algae on infralittoral gravel and pebbles

Wave exposure: Moderately exposed to very sheltered
Tidal streams: Moderately strong to very weak
Substratum: Gravel and coarse sand with some pebbles
Zone: Infralittoral
Depth range: 0 – 20 m

Description of RMNR habitat: Mixed sediments made up of pebbles, gravel and shells overlaying sand, at depths from 11 to 26 m. Characteristic of this habitat were *Saccharina latissima*, red algae and brown algae. Red algae species included *Delesseria sanguinea* and Corallinaceae, while brown algae included *Dictyota dichotoma*. Species associated with this habitat were *Cerianthus lloydii, Pomatoceros triqueter, Clavelina lepadiformis, Echinus esculentus, Cereus pedunculatus, Asterias rubens, Antedon* spp*., Alycyonium digitatum, Pagurus* spp. and *Gibbula* spp.
Habitat in grid squares A4, C5, C6, D4, D5, D6

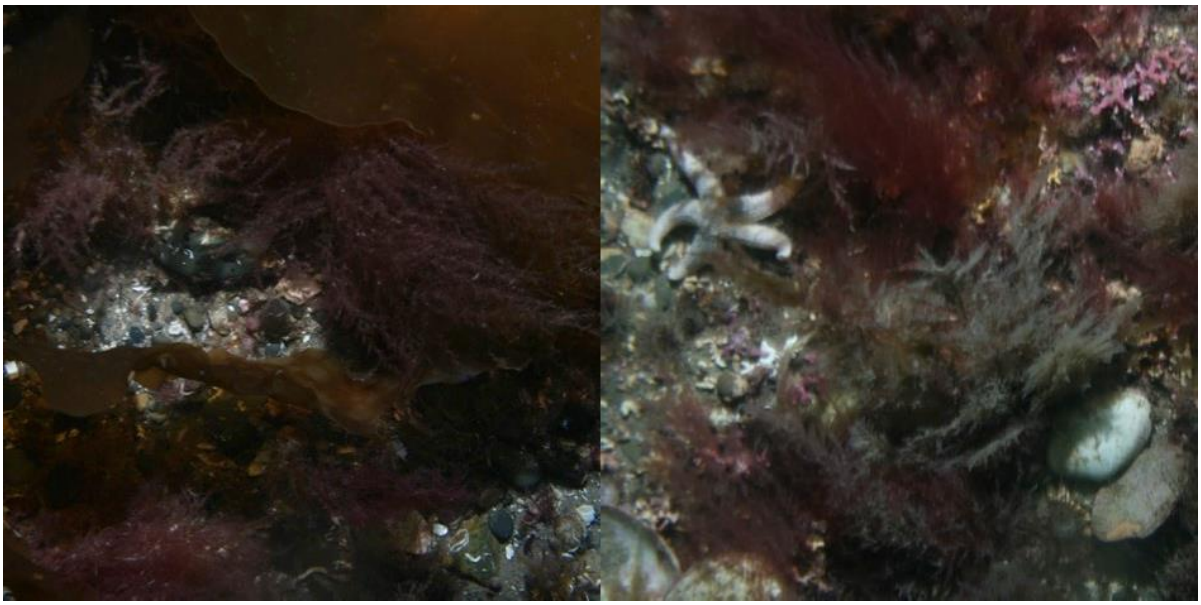

Figure A 13: EUNIS Habitat SS.SMp.KSwSS.LsacR.Gv

Habitat code: IR.MIR.KT.XKTX (M)

Habitat description: Mixed kelp and red seaweeds on infralittoral boulders, cobbles and gravel in tidal rapids

Wave exposure: Sheltered to extremely sheltered
Tidal streams: Very strong to moderately strong
Substratum: Boulders, cobbles and gravel
Zone: Infralittoral
Depth range: 0 – 10 m

Description of RMNR habitat: Mixed substrate, with boulders, cobbles, gravel and sand. Mixture of *Saccharina latissima* and *Laminaria hyperborean*, and red and brown seaweeds. Brown algae such as *Dictyota dichotoma* and *Chorda filum*, and red algae such as *Delesseria sanguinea* were present. Differed from the similar IR.MIR.KT.XKT habitat with the presence of maerl between boulders. Characteristic species found in this habitat included *Pomatoceros triqueter, Gibbula* spp., *Cerianthus lloydii, Cereus pedunculatus*, *Metridium senile* and *Urticina felina*. Other present species were *Anemonia viridis*, *Pagurus* spp., *Echinus esculentus, Asterias rubens,* and *Sabella* spp. This habitat was seen at depths between 12 and 15 m.
Habitat in grid squares A1, A3, A4

Figure A 14: EUNIS Habitat IR.MIR.KT.XKTX

Habitat code: IR.MIR.KT.XKT (N)

Habitat description: Mixed kelp with foliose red seaweeds, sponges and ascidians on sheltered tide-swept infralittoral rock

Wave exposure: Sheltered to extremely sheltered
Tidal streams: Very strong to moderately strong
Substratum: Boulders, cobbles and gravel
Zone: Infralittoral
Depth range: 0 – 10 m

Description of RMNR habitat: Mixed substrate, with boulders, cobbles, gravel and sand, at depths between 15 and 16 m. Mixture of the kelps *Saccharina latissima* and *Laminaria hyperborean*, and red and brown seaweeds. Brown algae such as *Dictyota dichotoma* and *Chorda filum*, and red algae such as *Delesseria sanguinea* were found. Species present included *Cerianthus lloydii, Pomatoceros triqueter*, *Gibbula* spp., *Ophiura* spp., *Echinus esculentus, Anemonia viridis*, *Metridium senile, Urticina felina, Pecten maximus, Asterias rubens, Clavelina lepadiformis* and *Sabella* spp.
Habitat in grid square B3

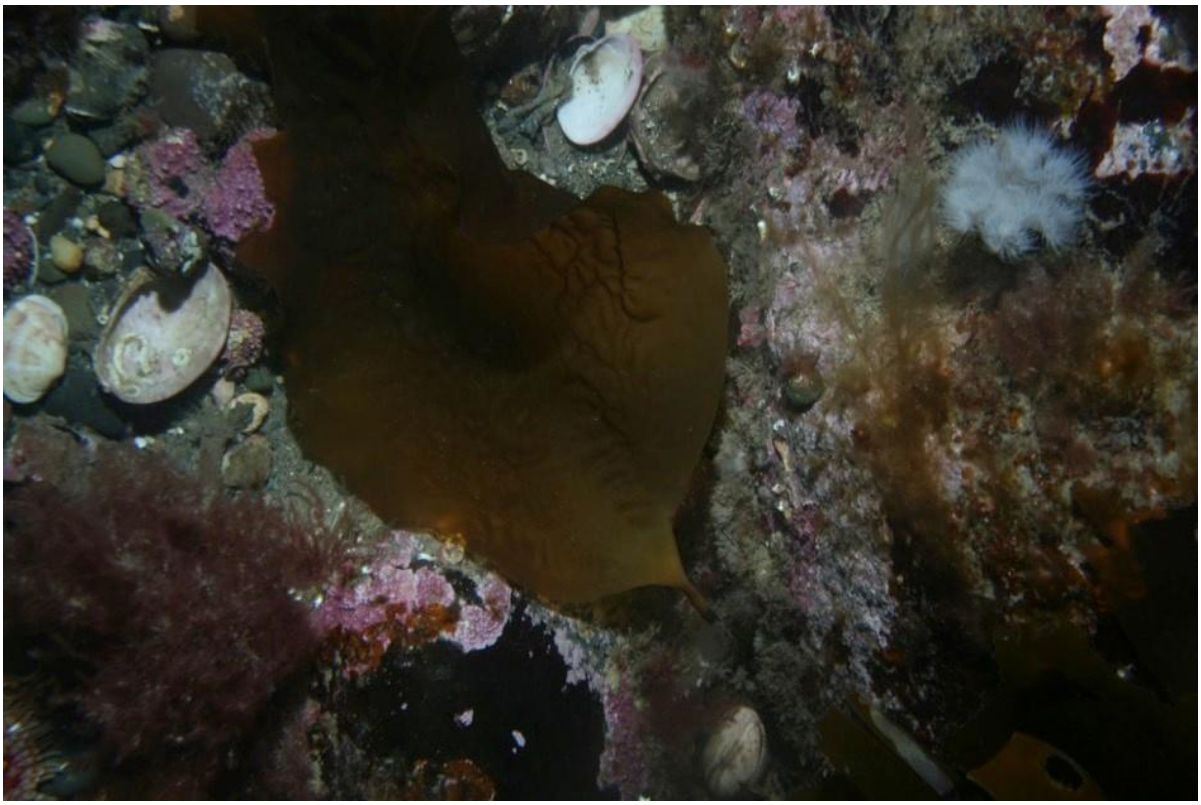

Figure A 15: EUNIS Habitat IR.MIR.KT.XKT

Habitat code: SS.SCS.CCS.Nmix (O)

Habitat description: *Neopentadactyla mixta* in circalittoral shell gravel or coarse sand

Wave exposure: Exposed to moderately exposed
Tidal streams: Moderately strong to very weak
Substratum: Clean shell and stone gravel, very coarse sand with a finer sand fraction
Zone: Infralittoral and circalittoral
Depth range: 10 – 50 m

Description of RMNR habitat: Clean shells, maerl and stone gravel, occasionally with coarse sand. Species associated with this habitat included *Neopentadactyla mixta*, *Pomatoceros triqueter*, *Gibbula* spp. and *Tectura virginea*, *Cerianthus lloydii, Urticina felina, Clavelina lepadiformis, Pecten maximus, Asterias rubens* and *Cereus pedunculatus*. Present at lower abundances were *Lanice conchilega, Ophiura albida, Pagurus* spp., *Callionymus* spp. and *Echinus esculentus*. Seaweeds were found at low abundances, and included filamentous red algae. This habitat was seen at depths between 12 and 19 m.
Habitat in grid squares A1, A2, A3, A4, A5, D6

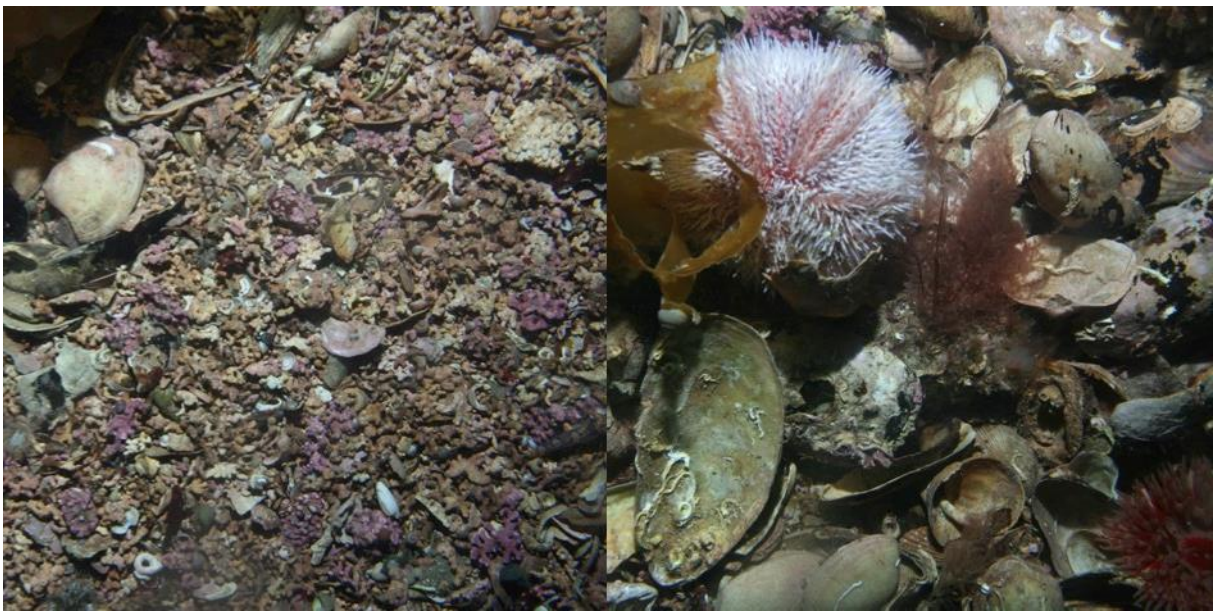

Figure A 16: EUNIS Habitat SS.SCS.CCS.Nmix

Habitat code: SS.SMx.CMx.OphMx (P)

Habitat description: *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment

Wave exposure: Moderately exposed to sheltered
Tidal streams: Strong to weak
Substratum: Mixed sediment, frequently with pebbles and cobbles
Zone: Circalittoral
Depth range: 5 – 50 m

Description of RMNR habitat: Brittlestar beds of varying densities composed largely of *Ophiothrix fragilis*, with *Ophiocomina nigra* making up a smaller component of the community. Other characteristic faunal species found in this habitat included *Cerianthus lloydii,* A*lcyonium digitatum, Aequipecten opercularis*, and *Pagurus* spp. Other species present in lower abundances were *Asterias rubens*, *Echinus esculentus*, and *Urticina felina*. Hydroids such as *Nemertesia* spp. were seen occasionally in the habitat. In less dense brittlestar beds *Ophiura* spp. and *Pecten maximus* were present. This community was found on sandy to mixed substrate at depths between 17 and 25 m.
Habitat in grid squares C10, C11, D9, D10, D11

Figure A 17: EUNIS Habitat SS.SMx.CMx.OphMx