Annex .List of characterising taxa in maerl beds – percentage occurrence in core samples of the biotope.

This list is derived from the Marine Habitat Classification for Britain and Ireland developed by the JNCC who provided [biological comparative tables](https://data.jncc.gov.uk/data/1e129033-5336-4c5a-93fe-fe85f7e72b96/Biological-comparative-tables-0405.xls) allowing a comparison of lists of key species occurring in a user-defined set of biotopes. For the purposes of the present study the species occurring in the core records for six maerl biotopes were extracted and are listed below together with an indication of which biotopes they occurred in. Shading indicates occurrence in more than 40% of the core samples. Attributes of longevity, burrow depth and other characters considered important in terms of the integrity of a maerl bed are also listed: depth below maerl surface ([Wells, 1951](#_ENREF_97), [Keegan, 1974](#_ENREF_51), [Hall-Spencer & Atkinson, 1999](#_ENREF_29)) and in the case of algae the presence of ramifying rhizoids which hold together the maerl matrix. Twenty-five taxa from this list were recorded in the Pladda maerl bed data used in the present analyses (superscript **P**).

|  | Group | SS.SMp.Mrl | SS.SMp.Mrl.Pcal | SS.SMp.Mrl.Pcal.R | SS.SMp.Mrl.Pcal.Nmix | SS.SMp.Mrl.Lcor | SS.SMp.Mrl.Lgla |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Maerl beds | *Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand | *Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand | *Phymatolithon calcareum* maerl beds with Neopentadactyla mixta and other echinoderms in deeper infralittoral clean gravel or coarse sand | *Lithothamnion corallioides* maerl beds on infralittoral muddy gravel | *Lithothamnion glaciale* maerl beds in tide-swept variable salinity infralittoral gravel |
| Number of core biotope records |  | 127 | 88 | 53 | 27 | 16 | 20 |
| Taxon |  |  |  |  |  |  |  |
| *Asterias rubens* P | Starfish | 76 | 77 | 79 | 81 | 44 | 95 |
| *Pagurus bernhardus* | Crustacea | 59 | 67 | 72 | 74 | 31 | 40 |
| *Saccharina latissima* P | Ochrophyta | 54 | 63 | 77 | 44 | 31 | 40 |
| *Dictyota dichotoma* P | Ochrophyta | 50 | 50 | 68 | 26 | 50 | 60 |
| *Plocamium cartilagineum* sensu lato | Rhodophyta | 44 | 53 | 62 | 44 |  |  |
| *Cerianthus lloydii* P | Anemone | 43 | 45 | 49 | 48 | 31 | 35 |
| *Liocarcinus depurator* P | Crustacea | 43 | 51 | 55 | 52 | 38 |  |
| *Steromphala cineraria* | Gastropoda | 40 | 45 | 60 |  |  | 40 |
| *Spirobranchus triqueter* | Polychaete | 40 | 47 | 55 | 37 |  | 40 |
| *Chaetopterus variopedatus* P | Polychaete | 37 | 43 | 42 | 56 | 25 | 25 |
| *Lanice conchilega* | Polychaete | 35 | 40 | 40 | 44 | 31 |  |
| *Echinus esculentus* P | Urchin | 39 | 44 | 43 | 52 |  | 45 |
| *Desmarestia viridis* P | Ochrophyta | 32 | 42 | 55 | 30 |  |  |
| *Ulva* P | Chlorophyta | 31 | 33 | 51 |  | 44 |  |
| *Halarachnion ligulatum* | Rhodophyta | 28 | 33 | 40 | 26 | 44 |  |
| *Nitophyllum punctatum* | Rhodophyta | 32 | 40 | 53 | 22 | 25 |  |
| *Phycodrys rubens* | Rhodophyta | 32 | 40 | 51 | 26 |  | 30 |
| *Anemonia viridis* | Anemone |  |  |  |  | 44 |  |
| *Pecten maximus* P | Bivalve | 27 | 27 |  | 56 | 25 | 25 |
| *Desmarestia aculeata* | Ochrophyta | 28 | 36 | 55 |  |  |  |
| *Carcinus maenas* | Crustacea | 28 | 23 | 38 |  |  | 55 |
| *Gibbula magus* P | Gastropoda | 28 | 34 | 34 | 44 | 31 |  |
| *Buccinum undatum* P | Gastropoda |  |  | 25 |  |  | 40 |
| *Neopentadactyla mixta* P | Holothuria | 28 | 39 | 36 | 48 |  |  |
| *Vertebrata byssoides* | Rhodophyta | 31 | 38 | 49 | 26 | 25 |  |
| *Bonnemaisonia asparagoides* | Rhodophyta | 26 | 33 | 40 | 30 |  |  |
| *Chondrus crispus* | Rhodophyta | 24 | 24 | 38 |  |  | 45 |
| *Metacallophyllis laciniata* | Rhodophyta | 24 | 32 | 40 | 22 |  |  |
| *Trailliella intricata* | Rhodophyta | 27 | 27 | 38 |  |  | 40 |
| *Corallina officinalis* | Rhodophyta |  |  | 23 |  |  | 45 |
| *Cystoclonium purpureum* | Rhodophyta |  | 24 | 40 |  |  |  |
| *Dudresnaya verticillata* | Rhodophyta |  |  |  |  | 44 |  |
| *Lomentaria clavellosa* | Rhodophyta | 28 | 34 | 49 |  |  |  |
| *Luidia ciliaris* P | Starfish |  | 24 |  | 41 |  |  |
| *Ophiothrix fragilis* | Starfish | 21 |  |  |  |  | 80 |
| *Ophiocomina nigra* | Starfish |  |  |  |  |  | 65 |
| *Psammechinus miliaris* | Urchin |  |  |  |  |  | 40 |
| *Urticina felina* | Anemone |  |  | 23 |  |  |  |
| *Anthopleura ballii* | Anemone |  |  |  |  | 25 |  |
| *Sagartia elegans* | Anemone |  |  | 21 |  |  |  |
| *Ensis* | Bivalve |  |  |  | 30 |  |  |
| *Circomphalus casina* | Bivalve |  |  | 21 |  |  |  |
| *Mya truncata* | Bivalve |  |  |  |  |  | 25 |
| *Chorda filum* | Ochrophyta | 24 |  | 34 |  | 38 | 35 |
| *Laminaria hyperborea* | Ochrophyta |  | 24 | 26 | 26 |  |  |
| *Cutleria multifida* | Ochrophyta |  |  |  |  | 31 |  |
| *Cladostephus spongiosus* | Ochrophyta |  |  |  |  | 31 |  |
| *Halidrys siliquosa* | Ochrophyta |  |  | 23 |  |  | 25 |
| *Cancer pagurus* P | Crustacea | 29 | 26 | 28 | 22 | 31 | 35 |
| *Anapagurus hyndmanni* | Crustacea |  | 26 | 30 | 26 |  |  |
| *Hyas araneus* P | Crustacea |  |  | 26 |  |  | 35 |
| *Inachus dorsettensis* | Crustacea |  |  |  | 26 |  |  |
| *Atelecyclus rotundatus* | Crustacea |  |  |  | 22 |  |  |
| *Liocarcinus corrugatus* | Crustacea |  |  | 21 |  |  |  |
| *Liocarcinus pusillus* | Crustacea |  |  |  | 22 |  |  |
| *Necora puber* P | Crustacea |  |  | 23 |  |  |  |
| *Antedon bifida* | Crinoid |  |  |  | 33 |  |  |
| *Aplysia punctata* | Gastropoda | 24 | 31 | 38 | 22 |  |  |
| *Tectura virginea* | Gastropoda |  | 22 |  | 37 |  |  |
| *Gibbula tumida* | Gastropoda |  |  |  | 22 |  |  |
| *Ectocarpaceae* | Chlorophyta | 22 | 25 | 34 |  |  |  |
| *Obelia geniculata* P | Hydroid |  |  | 28 |  |  |  |
| *Terebellidae* | Polychaete | 28 | 22 | 23 | 26 | 38 | 35 |
| *Sabella pavonina* | Polychaete |  |  |  |  |  | 25 |
| *Chylocladia verticillata* | Rhodophyta | 24 | 23 | 36 |  | 25 | 25 |
| *Corallinaceae* | Rhodophyta |  | 23 | 21 | 22 |  |  |
| *Rhodophyllis divaricata* | Rhodophyta | 21 | 25 | 28 | 26 |  |  |
| *Carradoriella (was Polysiphonia) elongata* | Rhodophyta |  | 28 | 36 | 22 |  |  |
| *Porphyropsis coccinea* | Rhodophyta |  | 22 | 32 |  |  |  |
| *Calliblepharis ciliata* | Rhodophyta |  |  | 30 |  | 25 |  |
| *Dilsea carnosa* P | Rhodophyta |  | 22 | 36 |  |  |  |
| *Phyllophora crispa* P | Rhodophyta |  | 23 | 28 |  |  |  |
| *Polyides rotundus* | Rhodophyta |  | 24 | 34 |  |  |  |
| *Pterothamnion plumula* | Rhodophyta |  | 22 | 28 |  |  |  |
| *Cryptopleura ramosa* P | Rhodophyta | 24 | 26 | 38 |  |  |  |
| *Hypoglossum hypoglossoides* | Rhodophyta | 21 | 25 | 36 |  |  |  |
| *Phymatolithon purpureum* | Rhodophyta |  |  |  |  | 31 |  |
| *Furcellaria lumbricalis* | Rhodophyta |  |  | 26 |  |  |  |
| *Stenogramme interrupta* | Rhodophyta |  |  |  |  | 25 |  |
| *Gracilaria gracilis* P | Rhodophyta |  |  | 30 |  |  |  |
| *Heterosiphonia plumosa* | Rhodophyta |  |  | 25 |  |  |  |
| *Delesseria sanguinea* P | Rhodophyta |  |  | 25 |  |  |  |
| *Rhodomela confervoides* | Rhodophyta |  |  | 25 |  |  |  |
| *Crossaster papposus* P | Starfish |  | 23 | 25 | 26 |  |  |
| *Marthasterias glacialis* P | Starfish |  |  |  | 26 | 38 | 25 |
| *Henricia* P | Starfish |  |  |  |  |  | 25 |
| *Ophiura albida* | Starfish |  |  |  | 37 |  |  |
| *Clavelina lepadiformis* | Tunicate |  |  |  | 22 |  |  |
| *Ascidiella aspersa* | Tunicate |  |  |  |  |  | 25 |

When selecting taxa for monitoring in maerl beds consideration should be taken of likely changes in distribution caused by climate change, this has been discussed by [Hiscock *et al.* (2001](#_ENREF_39)) with reference to Scotland.

**Life history traits of characterising taxa in maerl beds**

| Taxon | Group | Life span | Burrow depth cm | Source |
| --- | --- | --- | --- | --- |
| *Cerianthus lloydii* | Anemone | 11-20years | 40-44 | [Hall-Spencer & Atkinson (1999](#_ENREF_29)) |
| *Anemonia viridis* | Anemone | N/A |  |  |
| *Urticina felina* | Anemone | 21-50 years |  |  |
| *Anthopleura ballii* | Anemone | N/A |  |  |
| *Sagartia elegans* | Anemone | N/A |  |  |
| *Obelia geniculata* | Hydroid | <1 year |  |  |
| *Spirobranchus triqueter* | Polychaete | 2-3years |  |  |
| *Chaetopterus variopedatus* | Polychaete | up to 3 years | 28 | [Hall-Spencer & Atkinson (1999](#_ENREF_29)) |
| *Lanice conchilega* | Polychaete | ~3 years | 8-10 | [Ropert & Dauvin (2000](#_ENREF_87)) |
| *Terebellidae* | Polychaete |  | >50 | (pers. obs.) |
| *Sabella pavonina* | Polychaete | 10+ | 10-20 | [Wells (1951](#_ENREF_97)), [Dales (1957](#_ENREF_23)) |
| *Pagurus bernhardus* | Crustacea | 6-10years |  |  |
| *Liocarcinus depurator* | Crustacea | N/A |  |  |
| *Carcinus maenas* | Crustacea | 6-10 years |  |  |
| *Cancer pagurus* | Crustacea | 20-50years |  |  |
| *Anapagurus hyndmanni* | Crustacea | N/A |  |  |
| *Hyas araneus* | Crustacea | N/A |  |  |
| *Inachus dorsettensis* | Crustacea | N/A |  |  |
| *Atelecyclus rotundatus* | Crustacea | N/A |  |  |
| *Liocarcinus corrugatus* | Crustacea | N/A |  |  |
| *Liocarcinus pusillus* | Crustacea | N/A |  |  |
| *Necora puber* | Crustacea | 6-10 years |  |  |
| *Steromphala cineraria* | Gastropoda |  |  |  |
| *Gibbula magus* | Gastropoda | N/A |  |  |
| *Buccinum undatum* | Gastropoda | 11-20 years |  |  |
| *Aplysia punctata* | Gastropoda | N/A |  |  |
| *Tectura virginea* | Gastropoda | N/A |  |  |
| *Gibbula tumida* | Gastropoda | N/A |  |  |
| *Pecten maximus* | Bivalve | 15+years |  |  |
| *Ensis* spp | Bivalve | 11-20 years | 32 |  |
| *Circomphalus casina* | Bivalve | N/A |  |  |
| *Mya truncata* | Bivalve | 5+ years | 52 |  |
| *Asterias rubens* | Starfish | 6-10years |  |  |
| Taxon | **Group** | **Life span** | **Burrow depth cm** | **Source** |
| *Luidia ciliaris* | Starfish | 3-5 years |  |  |
| *Ophiothrix fragilis* | Starfish | 6-10 years |  |  |
| *Ophiocomina nigra* | Starfish |  |  |  |
| *Crossaster papposus* | Starfish | 11-20 years |  |  |
| *Marthasterias glacialis* | Starfish |  |  |  |
| *Henricia* | Starfish | 3-5 years |  |  |
| *Ophiura albida* | Starfish | 3-5 years |  |  |
| *Antedon bifida* | Crinoid | 1+ |  |  |
| *Echinus esculentus* | Urchin | 6-10 years |  |  |
| *Psammechinus miliaris* | Urchin | 6-10 years |  |  |
| *Neopentadactyla mixta* | Holothuria | Seasonal torpor and daily change in behaviour | 48 | [Smith & Keegan (1984](#_ENREF_89)), [Konnecker & Keegan (1973](#_ENREF_53)) |
| *Clavelina lepadiformis* | Tunicate | 1-2years | Seasonal decline of zooids |  |
| *Ascidiella aspersa* | Tunicate | 3-5years |  |  |
| *Plocamium cartilagineum* sensu lato | Rhodophyta | Perennial | rhizoids |  |
| *Halarachnion ligulatum* | Rhodophyta | Annual +perennial crust |  |  |
| *Nitophyllum punctatum* | Rhodophyta | Annual |  |  |
| *Phycodrys rubens* | Rhodophyta | Perennial |  |  |
| *Vertebrata byssoides* | Rhodophyta | Perennial | Rhizoids |  |
| *Bonnemaisonia asparagoides* | Rhodophyta | Annual gametophyte |  |  |
| *Chondrus crispus* | Rhodophyta | Perennial |  |  |
| *Metacallophyllis laciniata* | Rhodophyta | Perennial |  |  |
| *Bonnemaisonia hamifera Trailliella* phase | Rhodophyta | Annual | Tangled filaments |  |
| *Corallina officinalis* | Rhodophyta | Perennial |  |  |
| *Cystoclonium purpureum* | Rhodophyta | Annual |  |  |
| *Dudresnaya verticillata* | Rhodophyta | Annual |  |  |
| *Lomentaria clavellosa* | Rhodophyta | Annual |  |  |
| *Chylocladia verticillata* | Rhodophyta | Annual |  |  |
| *Rhodophyllis divaricata* | Rhodophyta | Annual |  |  |
| *Carradoriella (*was *Polysiphonia) elongata* | Rhodophyta | Annual |  |  |
| Taxon | **Group** | **Life span** | **Burrow depth cm** | **Source** |
| *Porphyropsis coccinea* | Rhodophyta | Annual |  |  |
| *Calliblepharis ciliata* | Rhodophyta | Perennial | Rhizoids |  |
| *Dilsea carnosa* | Rhodophyta | Perennial |  |  |
| *Phyllophora crispa* | Rhodophyta | Perennial |  |  |
| *Polyides rotunda* | Rhodophyta | Annual |  |  |
| *Pterothamnion plumula* | Rhodophyta | Annual |  |  |
| *Cryptopleura ramosa* | Rhodophyta | Annual |  |  |
| *Hypoglossum hypoglossoides* | Rhodophyta | Annual |  |  |
| *Phymatolithon purpureum* | Rhodophyta | Perennial |  |  |
| *Furcellaria lumbricalis* | Rhodophyta | Annual |  |  |
| *Stenogramme interrupta* | Rhodophyta | Perennial |  |  |
| *Gracilaria gracilis* | Rhodophyta | Perennial |  |  |
| *Heterosiphonia plumosa* | Rhodophyta | Perennial | Rhizoids |  |
| *Delesseria sanguinea* | Rhodophyta | Perennial |  |  |
| *Rhodomela confervoides* | Rhodophyta | Perennial |  |  |
| *Saccharina latissima* | Ochrophyta | 3-5years |  |  |
| *Dictyota dichotoma* | Ochrophyta | Annual |  |  |
| *Desmarestia viridis* | Ochrophyta | Annual |  |  |
| *Desmarestia aculeata* | Ochrophyta | Annual |  |  |
| *Chorda filum* | Ochrophyta | Annual |  |  |
| *Laminaria hyperborea* | Ochrophyta | 11-20 years |  |  |
| *Cutleria multifida* | Ochrophyta | Annual+crustose |  |  |
| *Cladostephus spongiosus* | Ochrophyta | Perennial |  |  |
| *Halidrys siliquosa* | Ochrophyta | 3+years |  | [Moss & Lacey (1963](#_ENREF_72)) |
| *Ulva* | Chlorophyta | Annual |  |  |
| *Ectocarpaceae* | Chlorophyta | Annual |  |  |

Notes:

N/A – information not available

Life span: unless otherwise indicated information derived from [MarLIN (2006](#_ENREF_60))

**Additional maerl bed infaunal taxa listed by** [**Hall-Spencer & Atkinson (1999**](#_ENREF_29)**)**

| Species | Group | Life span years | Burrow depth cm | Source |
| --- | --- | --- | --- | --- |
| *Upogebia deltaura* | Crustacea | 4 | 40-60 | [Kevrekidis *et al.* (1997](#_ENREF_52)) |
| *Lutraria sp* | Bivalve |  | 40 |  |
| *Moerella donacina* | Bivalve |  | 28 |  |
| *Clausinella fasciata* | Bivalve |  | 28 |  |
| *Tapes rhomboides* | Bivalve |  | 40 |  |
| *Dosinia exoleta* | Bivalve | 20 | 28 |  |
| *Thyone fusus* | Holothuria |  | 40 |  |
| *Thyonidium drummondii* | Holothuria |  | 40 |  |

Annex . Functional traits available for characterising taxa in maerl beds.

Of the taxa listed in Annex 1, the following species have functional traits listed on BIOTIC ([MarLIN, 2006](#_ENREF_60)).

| Functional trait | |  | Taxon | |
| --- | --- | --- | --- | --- |
| FoodType | FertilizationType |  | *Urticina felina* | *Circomphalus casina* |
| Size | Dispersal potential Larvae |  | *Cerianthus lloydii* | *Mya truncata* |
| Flexibility | Larval Settling Time |  | *Sagartiogeton undatus* | *Henricia oculata* |
| Fragility | Reproductive Location |  | *Sagartia elegans* | *Psammechinus miliaris* |
| Habit | Biogeographic Range |  | *Lanice conchilega* | *Asterias rubens* |
| Bioturbator | Depth Range |  | *Pomatoceros triqueter* | *Ophiothrix fragilis* |
| GrowthRate | Migratory |  | *Chaetopterus variopedatus* | *Echinus esculentus* |
| Dispersal potential adult | Biozone |  | *Atelecyclus rotundatus* | *Neopentadactyla mixta* |
| Dependency | Development mechanism |  | *Liocarcinus pusillus* | *Antedon bifida* |
| Sociability | Environmental position |  | *Liocarcinus depurator* | *Ophiura albida* |
| Regeneration | feeding method |  | *Cancer pagurus* | *Thyone fusus* |
| Life Span | Growth form |  | *Pisidia longicornis* | *Luidia ciliaris* |
| Time to maturity | Mobility |  | *Carcinus maenas* | *Crossaster papposus* |
| Generation Time | Physical preference |  | *Inachus dorsettensis* | *Clavelina lepadiformis* |
| Reproductive Frequency | Reproductive type |  | *Pagurus bernhardus* | *Pomatoschistus minutus* |
| Reproductive Season | Salinity |  | *Necora puber* | *Callionymus lyra* |
| Larval Settlement Period | Substratum |  | *Pecten maximus* | *Laminaria hyperborea* |
| Fecundity | Water flow |  | *Buccinum undatum* | *Chorda filum* |
| Egg Size | Wave exposure |  | *Chlamys varia* | *Halidrys siliquosa* |

Full details of the characters of each functional trait are provided in the [Biological Traits Information Catalogue](http://www.marlin.ac.uk/biotic/imgs/BioticGlossaries.pdf).

Information on additional functional traits for some taxa may be available on the [Arctic Traits Database](https://www.univie.ac.at/arctictraits/about)

Additional traits for taxa can also be derived from a search of relevant literature. The final selection of functional traits to be used for further study would be made taking account of traits which are relevant to the functioning of healthy maerl bed systems and which are likely to be impacted by the implementation of particular management measures, or the lack of them.Annex . Life form and functional groups for algae in two Scottish maerl beds

This list is derived from the list of algae recorded from maerl beds in the Sound of Barra ([Bunker *et al.*, 2018](#_ENREF_14)) and around Arran ([Mercer *et al.*, 2018](#_ENREF_64)). These two surveys were selected to illustrate the diversity of algal taxa in Scottish maerl beds since the surveys were undertaken by broadly the same group of surveyors familiar with field identification of alga. The classification into life forms and functional groups follows [Peña & Bárbara (2010](#_ENREF_81)) who used the definitions of [Steneck & Dethier (1994](#_ENREF_91)) to define functional groups. Algal diversity was high at both the Barra site (86 taxa) and in maerl beds around Arran (53 taxa) and is considered an important component of the maerl bed community.

| **Species** | **Life form group** | **Functional Group** | **Phylum** | **Barra** | **Arran** |
| --- | --- | --- | --- | --- | --- |
| Acrosorium | 1 | Foliose | Rhodophyta |  | P |
| Ahnfeltia plicata | 2 |  | Rhodophyta | P |  |
| Apoglossum ruscifolium | 1 | Foliose | Rhodophyta |  | P |
| Asparagopsis armata falk | 1 | Filamentous | Rhodophyta | P |  |
| Asparagopsis armata gam | 1 | Terete | Rhodophyta | P | P |
| Bonnemaisonia hamifera gam | 3 | Terete | Rhodophyta | P | P |
| Bonnemaisonia hamifera Trailliella phase | 1 | Filamentous | Rhodophyta | P | P |
| Bonnemaisonia asparagopsis | 3 | Terete | Rhodophyta | P | P |
| Calliblepharis spp | 3 | Corticate-Foliose | Rhodophyta | P |  |
| Callithamnion | 1 | Filamentous | Rhodophyta | P | P |
| Ceramium spp | 1 | Filamentous | Rhodophyta | P x3 | PxP |
| Chondria dasyphylla | 3 | Terete | Rhodophyta | P |  |
| Chondrus crispus | 1 | Terete | Rhodophyta | P | P |
| Cordylecladia erecta | 2 | Terete | Rhodophyta | P |  |
| Chylocladia verticillata | 1 | Terete | Rhodophyta | P | P |
| Coccotylus truncatus | 2 | Terete | Rhodophyta |  | P |
| Compsothamnion thuyoides | 1 | Filamentous | Rhodophyta |  | P |
| Corallina officinalis | 2 | Articulated calcarous | Rhodophyta | P | P |
| Corallinaceae | 2 | crust | Rhodophyta | P | P |
| Cruoria cruoriaeformis | 2 | crust | Rhodophyta |  | P |
| Cryptopleura ramosa | 1 | Foliose | Rhodophyta | P | P |
| Cystoclonium purpureaum | 2 |  | Rhodophyta | P |  |
| Dasysiphonia japonica | 1 | Filamentous | Rhodophyta | P | P |
| Delesseria sanguinea | 2 | Foliose | Rhodophyta | P | P |
| Dilsea carnosa | 2 | Corticate-Foliose | Rhodophyta |  | P |
| Dudresnaya verticillata | 1 | Filamentous | Rhodophyta | P | P |
| Furcellaria lumbricalis | 2 | Terete | Rhodophyta | P |  |
| Gelidiella calcicola | 2 | Filamentous | Rhodophyta | P | P |
| Gracilariales | 3 | Terete | Rhodophyta | 2 spp |  |
| Grateloupia turuturu | 2 | Foliose | Rhodophyta | P |  |
| Griffithsia corallinoides | 3 | Filamentous | Rhodophyta | P |  |
| Halarachnion ligulatum | 3 | Filamentous | Rhodophyta | P | P |
| Halurus flosculosus | 3 | Filamentous | Rhodophyta | P |  |
| Heterosiphonia plumosa | 3 | Filamentous | Rhodophyta | P |  |
| Hypoglossum hypoglossoides | 3 | Foliose | Rhodophyta | P | P |
| Jania spp | 2 | articulated calcarous | Rhodophyta | P |  |
| Lomentaria articulata | 3 | Filamentous | Rhodophyta | P |  |
| Lomentaria clavellosa | 3 | Filamentous | Rhodophyta | P | P |
| Lomentaria orcadensis | 3 | Filamentous | Rhodophyta |  | P |
| Membranoptera alata | 3 |  | Rhodophyta |  | P |
| Melanothamnus harveyi | 1 | Filamentous | Rhodophyta |  | P |
| Nitophyllum punctatum | 1 | Foliose | Rhodophyta | P |  |
| Odonthalia dentata | 3 | Corticate-Foliose | Rhodophyta |  | P |
| Palmaria palmata | 2 | Corticate-Foliose | Rhodophyta | P | P |
| Peyssonnelia | 2 | crust | Rhodophyta | 2 spp | P |
| Phyllophora crispa | 2 | Terete | Rhodophyta | P | P |
| Plocamium spp | 3 | Corticate-Foliose | Rhodophyta | 3 spp |  |
| Polyides rotunda | 2 | Terete | Rhodophyta | P | P |
| Carradoriella (Polysiphonia) elongata | 2 | Filamentous | Rhodophyta |  | P |
| Leptosiphonia (Polysiphonia) brodiei | 3 | Filamentous | Rhodophyta | P |  |
| Leptosiphonia (Polysiphonia) fibrillosa | 3 | Filamentous | Rhodophyta | P |  |
| Polysiphonia stricta | 1 | Filamentous | Rhodophyta | P | P |
| Vertebrata (Polysiphonia) fucoides | 2 | Filamentous | Rhodophyta | P | P |
| Vertebrata (Polysiphonia) nigra | **2** | Filamentous | Rhodophyta | P |  |
| Porphyra sp | 1 | Foliose | Rhodophyta | P |  |
| Pterosiphonia spp | 3 | Filamentous | Rhodophyta |  | P |
| Pterothamnion plumula | 1 | Filamentous | Rhodophyta |  | P |
| Pterothamnion spp | 3 | Filamentous | Rhodophyta | P |  |
| Ptilothamnion sphaericum | 3 | Filamentous | Rhodophyta | P |  |
| Rhodomela confervoides | 2 | Terete | Rhodophyta | P |  |
| Rhodophyllis divaricata | 3 | Foliose | Rhodophyta | P |  |
| Rhodophyta encrusting | 2 | crust | Rhodophyta |  | P |
| Scinaia | 1 | Terete | Rhodophyta | P |  |
| Spermothamnion repens | 3 | Filamentous | Rhodophyta | P |  |
| Spermothamnion strictum | 1 | Filamentous | Rhodophyta | P | P |
| Sphondylothamnion multifidum | 3 | Filamentous | Rhodophyta |  | P |
| Spyridia | 3 | Filamentous | Rhodophyta | P |  |
| Vertebrata byssoides | 3 | Filamentous | Rhodophyta | P |  |
| Aglaozonia stadium | 2 | crust | Ochrophyta |  | P |
| Arthrocladia villosa | 1 | Terete | Ochrophyta | P |  |
| Asperococcus bullosus | 1 | Corticate-Foliose | Ochrophyta | P |  |
| Asperococcus fistulosus | 1 | Corticate-Foliose | Ochrophyta | P |  |
| Chorda filum | 1 | Terete | Ochrophyta | P |  |
| Cladostephus spongiosus | 3 |  | Ochrophyta | P |  |
| Cladostephus spongiosus f. verticillatus | 3 |  | Ochrophyta | P |  |
| Colpomenia peregrina | 1 | Corticate-Foliose | Ochrophyta |  | P |
| Cutleria multifida | 1 | Corticate-Foliose | Ochrophyta | P | P |
| Desmarestia aculeata | 1 | Corticate-Foliose | Ochrophyta | P | P |
| Desmarestia ligulata | 1 | Leathery | Ochrophyta |  | P |
| Desmarestia viridis | 1 | Terete | Ochrophyta | P |  |
| Dictyota dichotoma | 1 | Foliose | Ochrophyta | P | P |
| Ectocarpus fasciculatus | 1 | Filamentous | Ochrophyta | P |  |
| Eudesme virescens | 1 |  | Ochrophyta | P |  |
| Halosiphon tomentosus | 1 | Filamentous | Ochrophyta | P |  |
| Halidrys siliquosa | 2 | Leathery | Ochrophyta |  | P |
| Laminaria hyperborea | 2 | Leathery | Ochrophyta | P |  |
| Mesogloia vermiculata | 1 |  | Ochrophyta | P |  |
| Saccharina latissima | 2 | Leathery | Ochrophyta | P | P |
| Saccorhiza polyschides | 2 | Leathery | Ochrophyta |  | P |
| Sphacelaria cirrosa | 2 | Filamentous | Ochrophyta | P |  |
| Chaetopteris plumosa | 2 | Filamentous | Ochrophyta | P | P |
| Sphacelaria sp | 2 |  | Ochrophyta |  | P |
| Sporochnus pedunculatus | 1 | Filamentous | Ochrophyta | P |  |
| Chaetomorpha linum | 1 | Filamentous | Chlorophyta | P |  |
| Cladophora albida | 1 | Filamentous | Chlorophyta | P |  |
| Cladophora hutchinsiae | 1 | Filamentous | Chlorophyta | P |  |
| Cladophora lehmanniana | 1 | Filamentous | Chlorophyta | P |  |
| Cladophora rhodolithicola | 2 | Filamentous | Chlorophyta | P |  |
| Cladophora rupestris | 1 | Filamentous | Chlorophyta | P |  |
| Ulva | 1 | Foliose | Chlorophyta | P | P |
| Ulva clathrata | 1 | Filamentous | Chlorophyta | P |  |
| Ulva lactuca | 1 | Foliose | Chlorophyta |  | P |
| Ulva (tubular) | 1 | Filamentous | Chlorophyta | P |  |
|  |  |  | Total taxa | **86** | **53** |

Annex . Procedures for the analysis of drop imagery

The following recommendations for the analysis of underwater drop imagery follow those provided by [Turner *et al.* (2016](#_ENREF_95)) and (Morris-Webb & Stamp, 2015).

* Brief review of image for quality and suitability in relation to the analytical methods to be used. Any image deemed not to be of sufficient quality should not analysed.
* Initial viewing of the still images to divide the tow into sections considered to represent different seabed habitat types. Habitat types covering less than 25 m2 should be considered as incidental patches in a habitat mosaic. Each set of still images and the associated video section represent the data for one sample.

Analysis of imagery:

* For each image set (stills and associated video) categorise quality as good / moderate / poor. This will have a bearing on the quality of the data it is possible to extract from the image.
* Habitats to be described in one sentence for each set (sample) of stills and associated video.
* Epibenthic taxa to be identified to the to the lowest taxonomic level possible and counted or their percentage cover estimated (colonial / encrusting epibenthic species). All taxa to be enumerated per section of stills and associated video, before conversion to SACFOR using [Marine Nature Conservation Review (MNCR) guidelines](https://mhc.jncc.gov.uk/media/1009/sacfor.pdf) ([Hiscock, 1996](#_ENREF_37)). See ([Turner *et al.*, 2016](#_ENREF_95)) p9 for a schematic illustrating the appearance of various percentage cover levels. It is recommended that similar charts are generated for the percentage cover categories used in the SACFOR scale. It is useful to collate a reference collection of taxon images to further standardise across surveys.
* A spreadsheet must be developed listing all taxa recorded using the latest taxonomy showing which size category has been used and whether the species was counted or estimated using percentage cover. A modification of this spreadsheet can be used to convert counts to the SACFOR scale further ensuring consistency of data recording. It is necessary to standardise the approach to recording large, mobile taxa where only one or two individuals are seen in a sample. For example one starfish such as *Luidia ciliaris,* classified in the size category >15 cm in area of 100 m2 would be regarded as “*frequent*” on the SACFOR scale. In such instances the taxon should be recorded as “*present*”.
* Taxonomic nomenclature to follow the most recent taxonomy as in the [European Register of Marine Species](http://www.marbef.org/data/erms.php)
* Substrate composition to be estimated as per MNCR categories ([Connor *et al.*, 2004](#_ENREF_22)), see [Turner *et al.* (2016](#_ENREF_95)) p 11 for a schematic scaling various sediment size categories in a 1 m2 view of the seabed.
* Note the presence of litter and possible evidence for seabed disturbance.
* Where identification of taxa is uncertain, a note should be made and comments provided, stating the reason for the uncertainty (e.g. blurred image, partially concealed from view, cannot be identified by image alone).
* Biotopes to be assigned to the highest resolution possible using the [JNCC on-line Marine Habitat Classification v15.03](https://mhc.jncc.gov.uk/) with the aim of matching biotopes at level four or five of the classification hierarchy. Since the surveys will be targeting maerl biotopes there should be minimal issues with defining biotopes. The minimum survey area required to distinguish a biotope is 5 m x 5 m ([Connor *et al.*, 2004](#_ENREF_22)).
* All data to be entered into a proforma spreadsheet broadly based on the [MNCR sublittoral survey form](https://mhc.jncc.gov.uk/media/1035/shabform_2017.pdf) and [accompanying guidance](https://mhc.jncc.gov.uk/media/1038/mncrform_guidance.pdf) but with additional fields added to record features not included on this form.
* A final check to be made to ensure that all above information has been recorded and is correct for each sample.

It is essential that all personnel conducting monitoring surveys are provided with the sampling protocol to be followed along with copies of the resources which have been generated in order to standardise the deliverables from the survey.

To include:

* Image analysis guidance document ([Turner *et al.*, 2016](#_ENREF_95)).
* Resources such as representative sediment scales, % cover scales, proforma spreadsheet listing all features to be recorded for the survey.
* Reference collection of taxon images used in maerl monitoring.

It must be ensured that deliverables conform to the project specification and that summary data for each survey are reviewed with reference to previous surveys so that assessment of bed status and any changes occurring are immediately highlighted. So often historical data for a survey area are not made readily available at the start of a new survey and are not evaluated in the light of new data.

Annex . SIMPER analysis – Broadscale biotope analysis, South Arran, 2014

Although the main investigative aim was to determine whether or not differences could be detected over time in areas classed as maerl bed biotopes, data gathered from several survey areas around south Arran in 2014 were analysed initially to determine whether SACFOR data could differentiate between biotopes. This was undertaken owing to the immediate availability of data from 2014 for the south Arran area. If the SACFOR data alone could not determine different areas supporting different biological communities, then the technique may not have had the sensitivity to detect more subtle shifts within biotopes and a different investigative approach would be required. Samples were only included in the analysis from biotopes occurring at least five times in the overall dataset or if they were classed as a maerl biotope; this was simply to reduce visual noise in the MDS plot and aid interpretation.

The analysis of the converted SACFOR scores showed that significant differences could be detected between the different sampling locations (ANOSIM R = 0.366, P<0.001) (Figure A4-1). Pairwise comparisons indicated significant differences (P<0.001) in the community data between all survey locations with the exception of Drumadoon and Iron Rock Ledges and between Holy Isle and each of Holy Isle North, Iron Rock Ledges and Pladda (P>0.300). Determination of the exact nature of any potential community differences between the different survey areas and any underlying causative factors were beyond the scope of the present study and were not addressed further. However, the analysis demonstrated that at a broad scale at least, converted SACFOR data could detect differences in community composition.

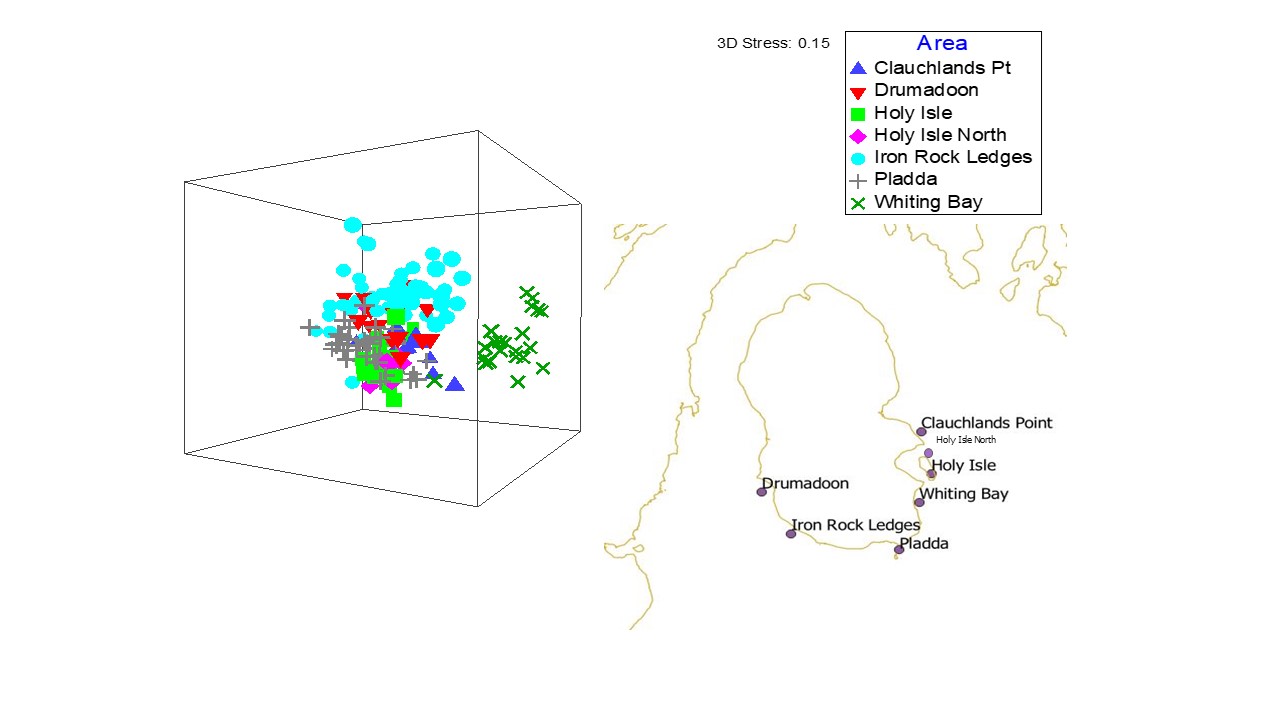


Figure A4-1: MDS plot of transect community composition converted SACFOR data collected from multiple survey locations around south Arran in 2014 (n = 182). (Contains OS data © Crown copyright and database right 2021).

*Annex 6. SIMPER analysis – Pladda maerl 2014 vs 2018*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| One-Way Analysis | |  | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |
| Data worksheet | |  | |  | |  | |  | |  | |  | |
| Name: Pladda 14 &18 maerl habitats only | |  | |  | |  | |  | |  | |  | |
| Data type: Abundance | |  | |  | |  | |  | |  | |  | |
| Sample selection: All | |  | |  | |  | |  | |  | |  | |
| Variable selection: 1-4,6,10,11,16-20,31-64,66,70,71,73,74,76,77 | | | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |
| **Parameters** | |  | |  | |  | |  | |  | |  | |
| Resemblance: S17 Bray-Curtis similarity | |  | |  | |  | |  | |  | |  | |
| Cut off for low contributions: 90.00% | |  | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |
| **Factor Groups** | |  | |  | |  | |  | |  | |  | |
| Sample | | Survey date | |  | |  | |  | |  | |  | |
| PL01 | | 2014 | |  | |  | |  | |  | |  | |
| PL03 | | 2014 | |  | |  | |  | |  | |  | |
| PL05 | | 2014 | |  | |  | |  | |  | |  | |
| PL19 | | 2014 | |  | |  | |  | |  | |  | |
| PL34 | | 2014 | |  | |  | |  | |  | |  | |
| PL35 | | 2014 | |  | |  | |  | |  | |  | |
| PL37 | | 2014 | |  | |  | |  | |  | |  | |
| PL41 | | 2014 | |  | |  | |  | |  | |  | |
| PL46 | | 2014 | |  | |  | |  | |  | |  | |
| EP\_30 | | 2018 | |  | |  | |  | |  | |  | |
| EP\_29 | | 2018 | |  | |  | |  | |  | |  | |
| EP\_28 | | 2018 | |  | |  | |  | |  | |  | |
| EP\_27 | | 2018 | |  | |  | |  | |  | |  | |
| EP\_26 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_38 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_37 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_35 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_34 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_32 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_31 | | 2018 | |  | |  | |  | |  | |  | |
| WP\_33 | | 2018 | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |
| **Within group similarity contributions, 2014** |  | |  | |  | |  | |  | |  | |
| **Average similarity: 58.50** |  | |  | |  | |  | |  | |  | |
| **Species** | **Av.Abund** | | **Av.Sim** | | **Sim/SD** | | **Contrib%** | | **Cum.%** | |  | |
| Melobesioideae (dead) | 6.33 | | 10.58 | | 4.22 | | 18.08 | | 18.08 | |  | |
| *Saccharina latissima* | 5.89 | | 9.39 | | 5.46 | | 16.05 | | 34.13 | |  | |
| Melobesioideae (live) | 5.22 | | 7.8 | | 4.27 | | 13.33 | | 47.46 | |  | |
| *Desmarestia* | 4.22 | | 4.89 | | 1.15 | | 8.35 | | 55.81 | |  | |
| Corallinaceae | 3.44 | | 4.45 | | 1.7 | | 7.61 | | 63.42 | |  | |
| *Membranipora membranacea* | 3.33 | | 4.36 | | 1.8 | | 7.45 | | 70.87 | |  | |
| Ascidiidae | 2.56 | | 2.65 | | 1.1 | | 4.53 | | 75.4 | |  | |
| Rhodophyta - filamentous | 2.22 | | 2.13 | | 0.78 | | 3.64 | | 79.04 | |  | |
| Didemnidae | 2.11 | | 2.03 | | 0.83 | | 3.47 | | 82.5 | |  | |
| Serpulidae | 1.56 | | 1.99 | | 1.15 | | 3.41 | | 85.91 | |  | |
| *Dilsea carnosa* | 1.67 | | 1.47 | | 0.82 | | 2.51 | | 88.42 | |  | |
| *Scinaia* | 2.22 | | 1.4 | | 0.57 | | 2.4 | | 90.82 | |  | |
|  |  | |  | |  | |  | |  | |  | |
| **Within group similarity contributions, 2018** |  | |  | |  | |  | |  | |  | |
| **Average similarity: 70.54** |  | |  | |  | |  | |  | |  | |
| **Species** | **Av.Abund** | | **Av.Sim** | | **Sim/SD** | | **Contrib%** | | **Cum.%** | |  | |
| *Saccharina latissima* | 6.25 | | 11.11 | | 5.29 | | 15.75 | | 15.75 | |  | |
| *Desmarestia* | 5.25 | | 9.01 | | 4.66 | | 12.78 | | 28.53 | |  | |
| *Scinaia* | 4.08 | | 7.54 | | 6.2 | | 10.69 | | 39.21 | |  | |
| Melobesioideae (dead) | 5 | | 7.17 | | 1.8 | | 10.17 | | 49.39 | |  | |
| Rhodophyta - filamentous | 3.92 | | 6.45 | | 5.08 | | 9.14 | | 58.53 | |  | |
| Melobesioideae (live) | 3.75 | | 5.16 | | 1.94 | | 7.31 | | 65.84 | |  | |
| *Membranipora membranacea* | 3.08 | | 4.69 | | 2.1 | | 6.64 | | 72.48 | |  | |
| Serpulidae | 3.08 | | 4.51 | | 1.97 | | 6.39 | | 78.88 | |  | |
| Bivalve siphons | 2.17 | | 2.67 | | 1.44 | | 3.79 | | 82.67 | |  | |
| *Gibbula* | 1.75 | | 1.93 | | 1.06 | | 2.74 | | 85.41 | |  | |
| Spirorbidae | 2.58 | | 1.91 | | 0.66 | | 2.7 | | 88.11 | |  | |
| *Ulva* | 1.83 | | 1.56 | | 0.64 | | 2.21 | | 90.32 | |  | |
|  |  | |  | |  | |  | |  | |  | |
| **Between group dissimilarity contributions 2014 vs 2018** |  | |  | |  | |  | |  | |  | |
| **Average dissimilarity = 45.80** |  | |  | |  | |  | |  | |  | |
|  | **Group 2014** | | **Group 2018** | |  | |  | |  | |  | |
| **Species** | **Av.Abund** | | **Av.Abund** | | **Av.Diss** | | **Diss/SD** | | **Contrib%** | | **Cum.%** | |
| *Scinaia* | 2.22 | | 4.08 | | 2.24 | | 1.21 | | 4.88 | | 4.88 | |
| Spirorbidae | 0 | | 2.58 | | 2.2 | | 1.1 | | 4.8 | | 9.68 | |
| Corallinaceae | 3.44 | | 1.5 | | 2.11 | | 1.29 | | 4.61 | | 14.29 | |
| Ascidiidae | 2.56 | | 0.58 | | 2.03 | | 1.48 | | 4.43 | | 18.72 | |
| Melobesioideae (live) | 5.22 | | 3.75 | | 1.89 | | 1.29 | | 4.13 | | 22.84 | |
| Didemnidae | 2.11 | | 0 | | 1.83 | | 1.37 | | 4 | | 26.85 | |
| Bivalve siphons | 0.17 | | 2.17 | | 1.82 | | 1.76 | | 3.97 | | 30.81 | |
| Rhodophyta - filamentous | 2.22 | | 3.92 | | 1.74 | | 1.15 | | 3.8 | | 34.61 | |
| *Desmarestia* | 4.22 | | 5.25 | | 1.71 | | 0.76 | | 3.72 | | 38.33 | |
| Melobesioideae (dead) | 6.33 | | 5 | | 1.7 | | 0.96 | | 3.72 | | 42.05 | |
| Serpulidae | 1.56 | | 3.08 | | 1.66 | | 1.54 | | 3.62 | | 45.67 | |
| *Ulva* | 1.11 | | 1.83 | | 1.59 | | 1.17 | | 3.48 | | 49.15 | |
| *Gibbula* | 0.02 | | 1.75 | | 1.52 | | 1.59 | | 3.32 | | 52.46 | |
| Cerianthidae | 0.89 | | 1.83 | | 1.5 | | 1.33 | | 3.27 | | 55.73 | |
| *Dilsea carnosa* | 1.67 | | 0.42 | | 1.39 | | 1.28 | | 3.02 | | 58.76 | |
| Rhodophyta - foliose | 0.89 | | 1.33 | | 1.38 | | 1.13 | | 3 | | 61.76 | |
| *Scrupocellaria* | 0.22 | | 1.5 | | 1.25 | | 1.28 | | 2.74 | | 64.5 | |
| Laminariaceae | 1.33 | | 0 | | 1.21 | | 0.65 | | 2.65 | | 67.15 | |
| *Electra pilosa* | 0.89 | | 0.75 | | 1.17 | | 0.67 | | 2.55 | | 69.7 | |
| *Membranipora membranacea* | 3.33 | | 3.08 | | 1.14 | | 0.83 | | 2.5 | | 72.2 | |
| *Chaetopterus* | 0.56 | | 1.25 | | 1.14 | | 1.11 | | 2.5 | | 74.7 | |
| Rhodophyta - branched | 1.11 | | 0 | | 1.06 | | 1.07 | | 2.32 | | 77.02 | |
| Phaeophyceae (filamentous) | 0.89 | | 0 | | 0.93 | | 0.52 | | 2.02 | | 79.04 | |
| *Saccharina latissima* | 5.89 | | 6.25 | | 0.89 | | 1.12 | | 1.94 | | 80.98 | |
| Rhodophyta – *Heterosiphonia japonica* | 1 | | 0.01 | | 0.85 | | 0.69 | | 1.86 | | 82.84 | |
| *Obelia* | 0.89 | | 0.33 | | 0.84 | | 0.91 | | 1.83 | | 84.67 | |
| *Delesseria sanguinea* | 0.22 | | 0.67 | | 0.66 | | 0.75 | | 1.44 | | 86.11 | |
| *Kallymenia reniformis* | 0.56 | | 0.25 | | 0.6 | | 0.59 | | 1.3 | | 87.41 | |
| *Phyllophora* | 0.67 | | 0 | | 0.59 | | 0.69 | | 1.29 | | 88.71 | |
| *Plocamium* | 0.56 | | 0 | | 0.49 | | 0.52 | | 1.06 | | 89.77 | |
| *Neopentadactyla mixta* | 0 | | 0.49 | | 0.48 | | 0.79 | | 1.04 | | 90.81 | |

*Annex 7. SIMPER analysis – Holy Isle maerl 2014 vs 2018*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| One-Way Analysis |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Data worksheet |  |  |  |  |  |  |
| Name: 2018 & 2014 image analysis - STRONG SACFOR | | |  |  |  |  |
| Data type: Abundance |  |  |  |  |  |  |
| Sample selection: 1-5,7-19 |  |  |  |  |  |  |
| Variable selection: 1-3,5-8,11,13-17,19,20,22-27,31,39,42-83 | |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Parameters** |  |  |  |  |  |  |
| Resemblance: S17 Bray-Curtis similarity |  |  |  |  |  |  |
| Cut off for low contributions: 90.00% |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Factor Groups** |  |  |  |  |  |  |
| Sample | Survey date |  |  |  |  |  |
| HI02 | 09/01/2014 |  |  |  |  |  |
| HI03 | 09/01/2014 |  |  |  |  |  |
| HI09 | 09/01/2014 |  |  |  |  |  |
| HI14 | 09/01/2014 |  |  |  |  |  |
| HI16 | 09/01/2014 |  |  |  |  |  |
| HI17 | 09/01/2014 |  |  |  |  |  |
| HI18 | 09/01/2014 |  |  |  |  |  |
| HI19\_15 | 09/01/2014 |  |  |  |  |  |
| HI21 | 09/01/2014 |  |  |  |  |  |
| HI22 | 09/01/2014 |  |  |  |  |  |
| HI56\_18 | 09/01/2018 |  |  |  |  |  |
| HI57\_18 | 09/01/2018 |  |  |  |  |  |
| HI60\_18 | 09/01/2018 |  |  |  |  |  |
| HI61\_18 | 09/01/2018 |  |  |  |  |  |
| HI63\_18 | 09/01/2018 |  |  |  |  |  |
| HI64\_18 | 09/01/2018 |  |  |  |  |  |
| HI65\_18 | 09/01/2018 |  |  |  |  |  |
| HI66\_18 | 09/01/2018 |  |  |  |  |  |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Within group similarity contributions, 2014** |  |  |  |  |  |  |
| **Average similarity: 65.87** |  |  |  |  |  |  |
| **Species** | **Av.Abund** | **Av.Sim** | **Sim/SD** | **Contrib%** | **Cum.%** |  |
| Melobesioideae (dead) | 7.3 | 11.04 | 6.95 | 16.77 | 16.77 |  |
| *Saccharina latissima* | 6.5 | 9.35 | 5.92 | 14.19 | 30.96 |  |
| *Scinaia* | 5.1 | 7.23 | 6.21 | 10.98 | 41.94 |  |
| Corallinaceae | 3.8 | 5.21 | 5.81 | 7.91 | 49.85 |  |
| Phaeophyceae (filamentous) | 3.2 | 4.38 | 5.79 | 6.64 | 56.5 |  |
| *Desmarestia* | 4.1 | 3.89 | 0.9 | 5.91 | 62.4 |  |
| *Membranipora membranacea* | 3.6 | 3.84 | 1.24 | 5.83 | 68.23 |  |
| Ascidiidae | 2.7 | 3.2 | 1.81 | 4.86 | 73.09 |  |
| Cerianthidae | 2.9 | 3.16 | 1.13 | 4.8 | 77.89 |  |
| *Ulva* | 2.9 | 3.1 | 1.21 | 4.71 | 82.61 |  |
| Melobesioideae (live) | 2.6 | 3.02 | 1.24 | 4.59 | 87.19 |  |
| Rhodophyta - Het jap | 2.6 | 1.92 | 0.69 | 2.91 | 90.11 |  |
|  |  |  |  |  |  |  |
| **Within group similarity contributions, 2018** |  |  |  |  |  |  |
| **Average similarity: 64.41** |  |  |  |  |  |  |
| **Species** | **Av.Abund** | **Av.Sim** | **Sim/SD** | **Contrib%** | **Cum.%** |  |
| *Toxisarcon* | 5.38 | 7.11 | 10.75 | 11.03 | 11.03 |  |
| Serpulidae | 5.25 | 7.02 | 10.34 | 10.89 | 21.93 |  |
| Melobesioideae (dead) | 5.75 | 6.71 | 2.7 | 10.42 | 32.35 |  |
| Ascidiidae | 4.75 | 6.32 | 6.75 | 9.82 | 42.17 |  |
| *Chaetopterus* | 3.75 | 4.89 | 8.15 | 7.6 | 49.77 |  |
| Cerianthidae | 4.25 | 4.55 | 1.68 | 7.07 | 56.83 |  |
| Corallinaceae | 3 | 4.18 | 12.5 | 6.49 | 63.32 |  |
| Rhodophyta - filamentous | 3.63 | 4.13 | 4.69 | 6.41 | 69.73 |  |
| Bivalve siphons | 3.38 | 3.91 | 1.66 | 6.07 | 75.79 |  |
| Melobesioideae (live) | 2.63 | 3.07 | 1.68 | 4.76 | 80.56 |  |
| Rhodophyta - foliose | 2 | 2.78 | 12.5 | 4.32 | 84.88 |  |
| Rhodophyta - crust | 1.88 | 1.41 | 0.73 | 2.19 | 87.07 |  |
| Bryozoa indet crusts | 1.5 | 0.97 | 0.51 | 1.51 | 88.58 |  |
| *Desmarestia* | 1.5 | 0.87 | 0.51 | 1.35 | 89.93 |  |
| *Saccharina latissima* | 1.63 | 0.87 | 0.51 | 1.35 | 91.27 |  |
|  |  |  |  |  |  |  |
| **Between group dissimilarity contributions 2014 vs 2018** |  |  |  |  |  |  |
| **Average dissimilarity = 59.14** |  |  |  |  |  |  |
|  | **Group 9/1/2014** | **Group 9/1/2018** |  |  |  |  |
| **Species** | **Av.Abund** | **Av.Abund** | **Av.Diss** | **Diss/SD** | **Contrib%** | **Cum.%** |
| *Toxisarcon* | 0 | 5.38 | 3.96 | 7.44 | 6.69 | 6.69 |
| *Saccharina latissima* | 6.5 | 1.63 | 3.58 | 2.46 | 6.05 | 12.74 |
| Serpulidae | 0.8 | 5.25 | 3.28 | 3.74 | 5.54 | 18.28 |
| *Scinaia* | 5.1 | 1.13 | 2.91 | 2.74 | 4.93 | 23.21 |
| *Desmarestia* | 4.1 | 1.5 | 2.54 | 1.68 | 4.3 | 27.51 |
| Bivalve siphons | 0 | 3.38 | 2.5 | 2.48 | 4.22 | 31.73 |
| *Membranipora membranacea* | 3.6 | 1.13 | 2.15 | 1.54 | 3.63 | 35.36 |
| Phaeophyceae (filamentous) | 3.2 | 0.63 | 1.92 | 1.9 | 3.24 | 38.6 |
| **Species** | **Av.Abund** | **Av.Abund** | **Av.Diss** | **Diss/SD** | **Contrib%** | **Cum.%** |
| Rhodophyta - *Het jap* | 2.6 | 0 | 1.83 | 1.18 | 3.09 | 41.7 |
| *Ulva* | 2.9 | 1 | 1.68 | 1.72 | 2.85 | 44.54 |
| Rhodophyta - filamentous | 2 | 3.63 | 1.64 | 1.49 | 2.77 | 47.31 |
| *Chaetopterus* | 1.6 | 3.75 | 1.6 | 1.34 | 2.71 | 50.02 |
| Ascidiidae | 2.7 | 4.75 | 1.55 | 1.64 | 2.62 | 52.64 |
| Cerianthidae | 2.9 | 4.25 | 1.52 | 1.17 | 2.58 | 55.21 |
| Rhodophyta - crust | 0 | 1.88 | 1.34 | 1.27 | 2.27 | 57.48 |
| Rhodophyta - foliose | 0.6 | 2 | 1.33 | 3.76 | 2.26 | 59.74 |
| Hydrozoa (turf) | 2.1 | 1 | 1.27 | 1.13 | 2.15 | 61.89 |
| *Obelia* | 1.7 | 0 | 1.21 | 1.16 | 2.04 | 63.93 |
| Melobesioideae (dead) | 7.3 | 5.75 | 1.16 | 0.9 | 1.96 | 65.9 |
| Bryozoa indet crusts | 0 | 1.5 | 1.15 | 0.98 | 1.95 | 67.85 |
| *Porania (Porania) pulvillus* | 0.7 | 1.13 | 0.97 | 0.92 | 1.65 | 69.49 |
| *Ophiocomina nigra* | 0 | 1.25 | 0.87 | 0.57 | 1.46 | 70.96 |
| *Pecten maximus* | 0.53 | 0.88 | 0.79 | 0.75 | 1.33 | 72.29 |
| Balanoidea | 0.3 | 0.75 | 0.76 | 0.48 | 1.29 | 73.58 |
| Melobesioideae (live) | 2.6 | 2.63 | 0.75 | 0.75 | 1.27 | 74.85 |
| Phaeophyceae (filmat?) | 0 | 1 | 0.74 | 0.98 | 1.24 | 76.09 |
| *Nemertesia antennina* | 0.2 | 0.88 | 0.73 | 0.62 | 1.23 | 77.32 |
| *Alcyonidium diaphanum* | 0.3 | 0.75 | 0.68 | 0.73 | 1.16 | 78.48 |
| *Neopentadactyla mixta* | 0 | 0.88 | 0.63 | 0.74 | 1.06 | 79.53 |
| Bryozoa (turf) | 0.2 | 0.75 | 0.58 | 0.8 | 0.99 | 80.52 |
| Corallinaceae | 3.8 | 3 | 0.57 | 1.07 | 0.97 | 81.49 |
| *Ciona intestinalis* | 0.3 | 0.63 | 0.57 | 0.49 | 0.96 | 82.45 |
| *Lanice conchilega* | 0 | 0.75 | 0.57 | 0.57 | 0.96 | 83.41 |
| *Myxicola* | 0 | 0.75 | 0.55 | 0.57 | 0.93 | 84.33 |
| Hydrozoa (fine) | 0 | 0.75 | 0.54 | 0.76 | 0.92 | 85.26 |
| Phaeophyceae (filamentous mat) | 0 | 0.75 | 0.53 | 0.76 | 0.9 | 86.16 |
| *Palmaria palmata* | 0.7 | 0 | 0.52 | 0.62 | 0.88 | 87.03 |
| *Dictyota* | 0.3 | 0.5 | 0.51 | 0.65 | 0.86 | 87.89 |
| *Fucus* | 0.6 | 0 | 0.41 | 0.49 | 0.7 | 88.59 |
| *Chorda filum* | 0.56 | 0 | 0.4 | 0.54 | 0.67 | 89.26 |
| *Abietinaria abietina* | 0 | 0.5 | 0.37 | 0.57 | 0.63 | 89.89 |
| *Gibbula* | 0 | 0.5 | 0.35 | 0.37 | 0.6 | 90.49 |

*Annex 8. BEST analysis, physical data, BIOENV – Holy Isle maerl 2014 vs 2018*

|  |  |  |
| --- | --- | --- |
| **Biota and/or Environment matching** | |  |
|  |  |  |
| **Resemblance worksheet** |  |  |
| Name: Resem7 | |  |
| Data type: Similarity |  |  |
| Selection: All |  |  |
|  |  |  |
| **Data worksheet** |  |  |
| Name: Physical data – depth and substrate | |  |
| Data type: Environmental |  |  |
| Sample selection: All |  |  |
| Variable selection: All |  |  |
|  |  |  |
| **Parameters** |  |  |
| Correlation method: Spearman rank | |  |
| Method: BIOENV |  |  |
| Maximum number of variables: 7 | |  |
| Within levels of factor: Survey date | |  |
| Analyse between: Samples |  |  |
| Resemblance measure: D1 Euclidean distance | |  |
|  |  |  |
| VARIABLES |  |  |
| Sub\_Boulders | Sub\_Boulders | Trial |
| Sub\_Boulders\_ | Sub\_Boulders\_small | Trial |
| Sub\_C | Sub\_Cobbles | Trial |
| Sub\_P | Sub\_Pebbles | Trial |
| Sub\_Sh | Sub\_Shells\_empty | Trial |
| Sub\_Gravel\_st | Sub\_Gravel\_stone | Trial |
| Sub\_Gravel\_sh | Sub\_Gravel\_shell | Trial |
| Sub\_Gravel\_d | Sub\_Gravel\_dead\_maerl | Trial |
| Sub\_Gravel\_l | Sub\_Gravel\_live\_maerl | Trial |
| Sub\_Sand | Sub\_Sand | Trial |
| Sub\_Sand\_ | Sub\_Sand\_fine | Trial |
| Av | Av depth BCD | Trial |
|  |  |  |
| **Best result for each number of variables** | |  |
| No.Vars Corr. Selections |  |  |
| 1 0.653 Sub\_Sand |  |  |
| 2 0.832 Sub\_Sand,Sub\_Sand\_ | |  |
| 3 0.723 Sub\_Boulders\_,Sub\_Sand,Sub\_Sand\_ | |  |
| 4 0.574 Sub\_Boulders,Sub\_Sand,Sub\_Sand\_,Av | |  |
| 5 0.585 Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand,Sub\_Sand\_,Av | |  |
| 6 0.600 Sub\_Boulders,Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand,Sub\_Sand\_,Av | |  |
| 7 0.601 Sub\_Boulders,Sub\_C,Sub\_P,Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand\_,Av | |  |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| **Global Test** |  |  |
| Sample statistic (Average Rho): 0.832 | |  |
| Significance level of sample statistic: 1% | |  |
| Number of permutations: 99 (Random sample) | |  |
| Number of permuted statistics greater than or equal to Average Rho: 0 | |  |
|  |  |  |
| **Results showing the physical variables correlating with the community data – best correlation shown first** |  |  |
| No.Vars Corr. Selections |  |  |
| 2 0.832 Sub\_Sand,Sub\_Sand\_ | |  |
| 3 0.723 Sub\_Boulders\_,Sub\_Sand,Sub\_Sand\_ | |  |
| 1 0.653 Sub\_Sand |  |  |
| 1 0.618 Sub\_Sand\_ |  |  |
| 2 0.603 Sub\_Boulders\_,Sub\_Sand\_ | |  |
| 7 0.601 Sub\_Boulders,Sub\_C,Sub\_P,Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand\_,Av | |  |
| 6 0.600 Sub\_Boulders,Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand,Sub\_Sand\_,Av | |  |
| 7 0.598 Sub\_Boulders,Sub\_C,Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand,Sub\_Sand\_,Av | |  |
| 2 0.598 Sub\_Boulders\_,Sub\_Sand | |  |
| 6 0.596 Sub\_Boulders,Sub\_C,Sub\_Sh,Sub\_Gravel\_sh,Sub\_Sand\_,Av | |  |

Annex . BEST analysis, community data, BVSTEP – Holy Island maerl 2014 vs 2018

|  |  |  |
| --- | --- | --- |
| **Biota and/or Environment matching** |  |  |
|  |  |  |
| **Resemblance worksheet** |  |  |
| Name: Resem7 - no mobile taxa, except molluscs |  |  |
| Data type: Similarity |  |  |
| Selection: All |  |  |
|  |  |  |
| **Data worksheet** |  |  |
| Name: 2018 & 2014 image analysis - STRONG SACFOR |  |  |
| Data type: Abundance |  |  |
| Sample selection: 1-5,7-19 |  |  |
| Variable selection: 1-3,5-8,11,13-17,19,20,22-27,31,39,42-83 |  |  |
|  |  |  |
| |  |  |  |  | | --- | --- | --- | --- | | **Results of iterations looking at restricted taxa combinations best aligning with the complete community data set, in order of best correlation.** | | | | |  | | |  | | Multiple | No. of variables | Correlation coefficient | Selected taxa | | 1 | 17 | 0.939 | Al,Cer,Por,Cl,Gi,To,Cho,Bryozoa i,Co,De,Fu,Melobesioideae (d,Melobesioideae (l,Sacch,Bryozoa (,Rhodophyta - fi,Scr | | 1 | 20 | 0.936 | An,Cer,Ophiu,Gi,To,Am,Co,Laminariaceae,Mem,Sacch,Ab,Ca,Cr,Hydrozoa (f,Ob, Phaeophyceae (filamentous ,Rhodophyta - b,Rhodophyta - fi,Rhodophyta - H,Sert | | 1 | 18 | 0.935 | Ci,Por,Gi,Cho,Neo,Ba,De,Fu,Laminariaceae,Melobesioideae (l,Sacch,Cr,Dic,Hydrozoa (f,Hydrozoa (t,Pol,Rhodophyta - fi,Scr | | 1 | 16 | 0.920 | Om,Pea,Por,Te,To,Cho,Co,De,Melobesioideae (l,Sacch,Cel,Dic,Hydrozoa (t,Pol,Rhodophyta - fi,Scr | | 1 | 10 | 0.912 | Om,Te,To,Neo,Am,Ba,Rhodophyta - c,Bryozoa (,Cel,Scr | |  |  |
|  |  |  |