The Needles Marine Conservation Zone (MCZ) Monitoring Report 2018

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Following designation, Natural England started a baseline monitoring programme across all marine protected areas.

This report was commissioned as part of an inshore benthic marine survey of The Needles MCZ.

Acknowledgements

We thank the Marine Protected Areas Group (MPAG) representatives for reviewing earlier drafts of this report.

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Executive Summary

This report is one of a series of Marine Protected Area (MPA) monitoring reports delivered to Department of Environment, Food and Rural Affairs (Defra) by the Marine Protected Areas Group (MPAG). The purpose of the report series is to provide the necessary information to allow Defra to fulfil its obligations in relation to MPA assessment and reporting, in relation to current policy instruments, including the Oslo-Paris (OSPAR) Convention, the Marine and Coastal Access Act (2009) and Community Directives (e.g. the Habitats and Birds Directives and the Marine Strategy Framework Directive). This monitoring report is informed by data acquired during a dedicated survey carried out at The Needles Marine Conservation Zone (MCZ) in 2018 and will form part of the ongoing time series data and evidence for this MPA.

The Needles MCZ is an inshore site that covers the stretch of the Solent adjacent to the north-west side of the Isle of Wight within the ‘Eastern English Channel’ Charting Progress 2 (CP2) sea area. A number of Features of Conservation Importance (FOCI), including both habitats and species, are designated for protection within The Needles MCZ. This report aims to provide characterisation of a number of broadscale habitats (BSHs) (‘A3.1 High energy infralittoral rock’, ‘A3.2 Moderate energy infralittoral rock’, ‘A4.2 Moderate energy circalittoral rock’, ‘A5.1 Subtidal coarse sediment’, ‘A5.2 Subtidal sand’, ‘A5.3 Subtidal mud’ and ‘A5.4 Subtidal mixed sediments’), habitat FOCI (‘Seagrass Beds’, ‘Sheltered Muddy Gravels’ and ‘Subtidal Chalk’) and provides information on the presence of one species FOCI (native oyster *Ostrea edulis*) designated within the MCZ.

The distribution of broadscale habitats recorded in 2018 was broadly similar to that recorded in 2014. For the seabed imagery data, low visibility led to poor image quality in 2018. Similarly poor visibility was also evident in the 2014 survey. It is difficult therefore to make robust comparisons of these data. A number of recommendations are made for future monitoring of The Needles MCZ.

1 Introduction

The Needles Marine Conservation Zone (MCZ) is part of a network of sites designed to meet conservation objectives under the Marine and Coastal Access Act (2009). These sites will also contribute to an ecologically coherent network of Marine Protected Areas (MPAs) across the North-east Atlantic, as agreed under the Oslo-Paris (OSPAR) Convention and other international commitments to which the UK is a signatory.

Under the Marine and Coastal Access Act (2009), Defra is required to provide a report to Parliament every six years that includes an assessment of the degree to which the conservation objectives set for MCZs are being achieved. In order to fulfil its obligations, Defra has directed the Statutory Nature Conservation Bodies (SNCBs) to carry out a programme of MPA monitoring. The SNCB responsible for nature conservation inshore in England (between 0 nm and 12 nm from the coast) is Natural England and the SNCB responsible for nature conservation offshore (between 12 nm and 200 nm from the coast) is the Joint Nature Conservation Committee (JNCC). Where possible, this monitoring will also inform assessment of the status of the wider UK marine environment; for example, assessment of whether Good Environmental Status (GES) has been achieved, as required under Article 11 of the Marine Strategy Framework Directive (MSFD) (OSPAR, 2012).

This monitoring report primarily explores data acquired from the first dedicated monitoring survey of The Needles MCZ, which will form the initial point in a monitoring time series against which feature condition can be assessed in the future. Comparisons are also made with data gathered as part of the 2014 verification survey (Arnold *et al.,* 2014). The specific aims of the report are discussed in more detail in Section 0.

1.1 Site overview

The Needles MCZ is an inshore site that covers the stretch of the Solent adjacent to the north-west side of the Isle of Wight within the ‘Eastern English Channel’ Charting Progress 2 (CP2) sea area (Figure 1). The Needles MCZ was recommended as an MCZ by the ‘Balanced Seas’ project. The site partially overlaps the South Wight Maritime Special Area of Conservation (SAC), is neighboured by the Solent Maritime SAC to the north and is adjacent to the terrestrial Isle of Wight Downs SAC (Figure 1). Following completion of the survey work detailed in this report, a new protected area: Solent and Dorset Coast Special Protection Area (SPA) was designated, due to the importance of the area for bird species which feed and forage in the area (Figure 1).

The MCZ covers an area of 11 km^2 and extends ca. 3 km from the shoreline, ranging from the intertidal to a water depth of ca. 50 metres below chart datum. The site was designated due to the presence of high quality reef features and a number of associated species of conservation interest[1].

The MCZ protects a number of rare and fragile habitats including chalk on the seabed, shallow water (infralittoral) rock and soft sediments which support communities of algae, sponges, sea squirts and delicate anemones (Table 1). It is a highly productive area biologically and an important spawning and nursery area with a range of fish species including common smelt, bass, sole, pout and mullet; lobsters and whelks are also known to occur here[2]. The site also protects seagrass *Zostera marina* beds which provide habitat that supports Stalked Jellyfish *Calvadosia campanulata*, Sea hares and marine molluscs. The site is also important for the native oyster *Ostrea edulis* and Peacock's Tail *Padina pavonica*[2].

Table 1. The Needles MCZ site overview © Natural England and Environment Agency 2022.

Charting Progress 2 Region[3]	Eastern English Channel
Spatial Area (km^2)	11
Water Depth Range (m)	0-50
Broadscale habitat (BSH) Features Present	**Designated**
A3.1 High energy infralittoral rock	✓
A3.2 Moderate energy infralittoral rock	✓
A4.2 Moderate energy circalittoral rock	✓
A5.1 Subtidal coarse sediment	✓
A5.2 Subtidal sand	✓
A5.3 Subtidal mud	✓
A5.4 Subtidal mixed sediments	✓
Habitat FOCI Present	
Seagrass Beds*	✓
Subtidal Chalk	✓
Sheltered Muddy Gravels†	✓
Species FOCI Present	
Native oyster (*Ostrea edulis*)	✓
Peacock's tail (*Padina pavonica*)†	✓
Stalked jellyfish (*Calvadosia campanulata*) †	✓

**Assessments of Seagrass Beds are detailed in a separate report (Green, 2019).*
†The monitoring survey was not specifically designed to target these FOCI.

[1] http://www.legislation.gov.uk/ukmo/2016/19/contents/created [accessed 24/04/20].

[2] Natural England Marine Site Detail [accessed 24/04/20].

[3] The Needles MCZ Conservation Objectives [accessed 24/04/20].

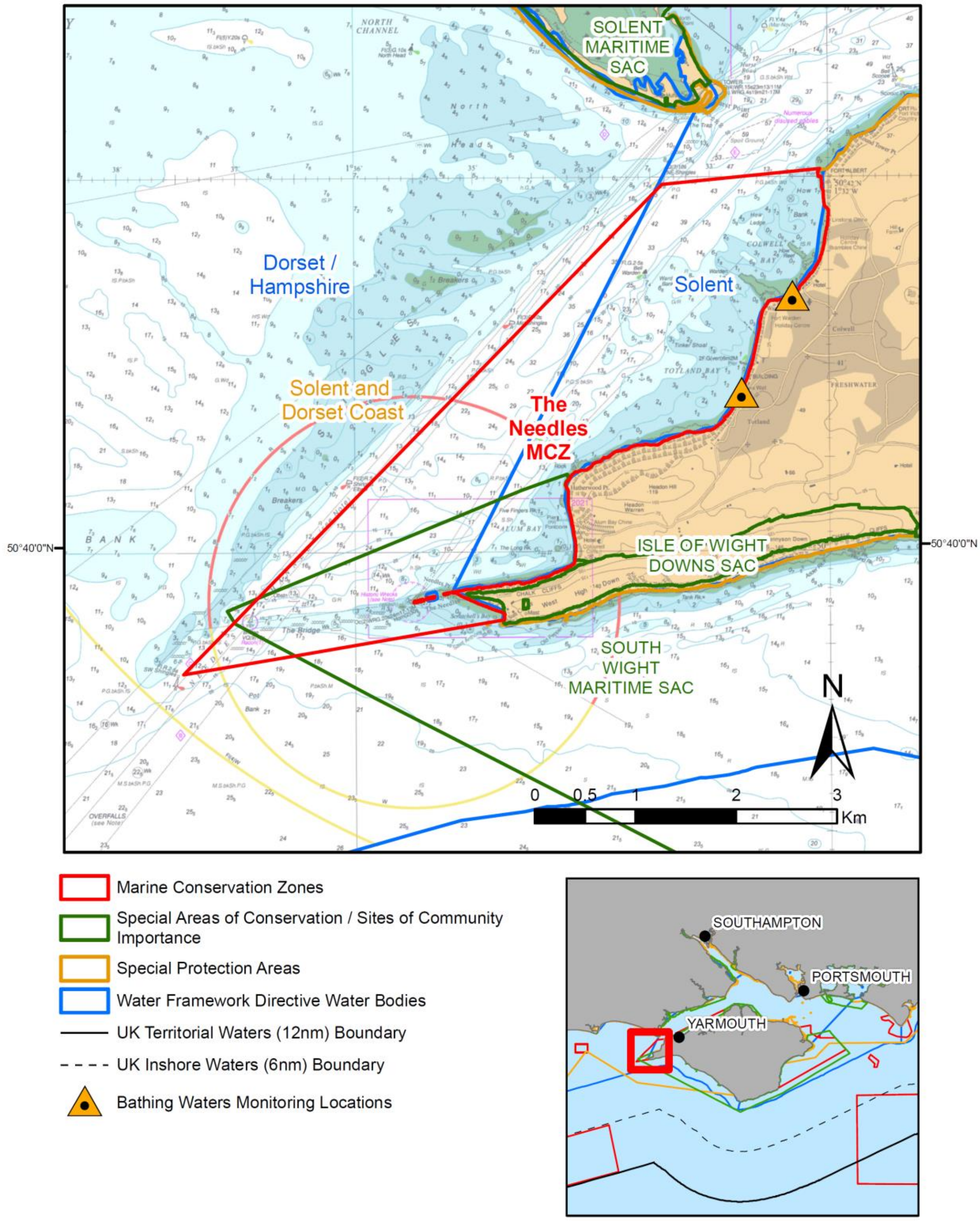


Figure 1. Location of The Needles MCZ in the context of Marine Protected Areas and management jurisdictions proximal to the site.

1.2 Existing data and habitat maps

The Needles MCZ 2018 survey (Garland *et al.,* 2019) built on the verification survey conducted by the Environment Agency in 2014 (Arnold *et al.,* 2014).

Acoustic surveys of the seabed within The Needles MCZ were carried out in 2010 and 2011 as part of the Southeast Regional Coastal Monitoring Programme (SERCMP) and in 2012 as part of the Maritime and Coastguard Agency's UK Civil Hydrography Programme (MCA CHP). These data were integrated with the groundtruthing data from the 2014 verification survey to produce an interpreted habitat map of The Needles MCZ (Mylroie *et al.,* 2015).

1.3 High-level conservation objectives

High-level site-specific conservation objectives serve as benchmarks against which to monitor and assess the efficacy of management measures in maintaining a designated feature in, or restoring it to, 'favourable condition'.

As detailed in The Needles MCZ designation order[1], the conservation objectives for the site are that the designated features:

a) So far as already in favourable condition, remain in such condition; and

b) So far as not already in favourable condition, be brought into such condition, and remain in such condition.

Definition of favourable condition

Favourable condition, with respect to a habitat feature, means that, subject to natural change:

a) Its extent and distribution is stable or increasing;

b) Its structures and functions, including its quality, and the composition of its characteristic biological communities, are such as to ensure that it remains in a condition which is healthy and not deteriorating; and

c) Its natural supporting processes are unimpeded.

The extent of a habitat feature refers to the total area in the site occupied by the qualifying feature and must also include consideration of its distribution. A reduction in feature extent has the potential to alter the physical and biological functioning of the sediment habitat types (Elliott *et al*., 1998). The distribution of a habitat feature influences the component communities present and can contribute to the condition and resilience of the feature (JNCC, 2004).

Structure encompasses the physical components of a habitat type and the key and influential species present. Physical structure refers to topography, sediment composition and distribution. Physical structure can have a significant influence on the hydrodynamic regime operating at varying spatial scales in the marine environment, as well as influencing the presence and distribution of associated biological communities (Elliott *et al*., 1998). The function of habitat features includes processes such as: sediment reworking (e.g. through bioturbation) and habitat modification, primary and secondary production and recruitment dynamics. Habitat features rely on a range of supporting processes (e.g. hydrodynamic regime, water quality and sediment quality) which act to support their functioning as well as their resilience (e.g. the ability to recover following impact).

For species features, favourable condition means that:

a) The quality and quantity of its habitat are such as to ensure that the population is maintained in numbers which enable it to thrive;

b) The composition of its population in terms of number, age and sex ratio are such as to ensure that the population is maintained in numbers which enable it to thrive; and

c) Its natural supporting processes are unimpeded.

Report aims and objectives

The primary aim of this monitoring report is to explore and describe the attributes of the designated features within The Needles MCZ. This report does not intent to assess the condition of designated features. Instead, the evidence presented within will enable subsequent monitoring efforts to determine the condition of the MCZ. The survey work was designed around the objectives as summarised in the Plan of Action (PoA) document (Miller, 2018) (Table 2). Namely, the objectives are to generate baseline data for the 'A5.4 Subtidal mixed sediments' BSH and 'A3.2 Moderate energy infralittoral rock' BSH. An additional aim was the characterisation of the 'A5.2 Subtidal sand', 'A5.3 Subtidal mud', 'A4.2 Moderate energy circalittoral rock' BSHs and the 'Subtidal Chalk' habitat FOCI and Native oyster (Ostrea edulis) species FOCI, A separate report (Green, 2019) describes the objective to ascertain the extent and density of the 'Seagrass Beds' habitat FOCI.

The results presented will be used to develop recommendations for future monitoring, including the operational testing of specific metrics which may indicate whether the condition of the feature has been maintained, is improving or is in decline.

The broad objectives of this monitoring report are provided below:

1) Provide a description of the **extent[4], distribution, structural** and **functional** attributes of the designated features within the site (see Table 3 for more detail), to enable subsequent condition monitoring and assessment;

2) Present any available evidence on the supporting processes of the designated features of the site;

3) Note observations of any habitat or species FOCI not covered by Designation Order as features of the site;

4) Present evidence relating to non-indigenous species (Descriptor 2) and marine litter (Descriptor 10), to satisfy requirements of the MSFD;

5) Record any anthropogenic activities or pressures encountered during the dedicated monitoring survey;

6) Provide practical recommendations for appropriate future monitoring approaches for the designated features (e.g., metric selection, survey design, data collection approaches) with a discussion of their requirements.

Table 2. Summary of objectives relating to The Needles MCZ as outlined in the Plan of Action (PoA) document (Miller, 2018) © Natural England and Environment Agency 2022.

PoA objective	Description
1	Baseline survey of the 'A5.4 Subtidal mixed sediments' and 'A3.2 Moderate Energy Infralittoral Rock' features of the MCZ
2	Extent and density survey of the 'Seagrass Beds' habitat FOCI
3	Characterisation survey of the 'A5.2 Subtidal sand', 'A5.3 Subtidal mud', 'A4.2 Moderate energy circalittoral rock' broadscale habitats, 'Subtidal Chalk' habitat FOCI and Native oyster (*Ostrea edulis*) species FOCI

A number of reporting sub-objectives will be addressed to provide evidence for Feature Attributes and supporting processes (as defined in Supplementary Advice on Conservation Objectives (SACOs) developed by Natural England for The Needles MCZ [5]). It was not possible to address all Feature Attributes in the monitoring survey design, given the comprehensive nature of the attribute lists for each feature (with sampling logistics and budget being the principal limiting factors). The Feature Attributes were therefore rationalised according to SNCB priorities, resulting in a smaller subset.

[4] Note that where current habitat maps are not available, extent will be described within the limits of available data.

[5] The Needles MCZ Supplementary Advice [accessed 24/04/20].

The list of reporting sub-objectives for selected Feature Attributes (and supporting processes) of the designated features is presented in Table 3, alongside the generated outputs for each. The corresponding PoA objective is also indicated. The locations and extents of the designated habitat FOCI Seagrass Beds was the target of PoA Objective 2 (Miller, 2018). This habitat is the focus of a separate report (Green, 2019).

Table 3. PoA and reporting sub-objectives addressed to achieve the objectives, for Feature Attributes of The Needles MCZ (© Natural England and Environment Agency 2022).

PoA objective(s)	Reporting Sub-objective	Feature Attribute*	Features†	Report Section(s)
1, 3	Discuss the physical structure of the rock habitats, as determined using imagery and acoustic data.	**Physical structure**	A3.1 High energy infralittoral rock A3.2 Moderate energy infralittoral rock A4.2 Moderate energy circalittoral rock	3.1, 3.4
1, 3	Discuss the composition and distribution of sediments across the MCZ, with reference to the BSH classes and habitat map.	**Sediment composition and distribution**	A5.1 Subtidal coarse sediment A5.2 Subtidal sand A5.3 Subtidal mud A5.4 Subtidal mixed sediments	3.2
1, 3	Conduct multivariate analysis of infaunal and epifaunal data to: - Identify patterns in biological assemblages. - Assign biotopes (where possible). - Describe variance in biological assemblage structure within and between BSH and habitat FOCI. - Identify key structural and influential species.	**Presence and spatial distribution of biological communities** **Presence and abundance of key structural and influential species** **Species composition of component communities**	A3.1 High energy infralittoral rock A3.2 Moderate energy infralittoral rock A4.2 Moderate energy circalittoral rock A5.1 Subtidal coarse sediment A5.2 Subtidal sand A5.3 Subtidal mud A5.4 Subtidal mixed sediments	3.3, 3.4, 3.5, 3.6, 3.7
NA	Map the location and abundance of non-indigenous species, as listed by the Great Britain Non-native Species Secretariat and under MSFD Descriptor 2 (Annex 6).	**Non-indigenous species (NIS)**	Entire MCZ	3.8

* As defined in Supplementary Advice on Conservation Objectives (SACO) for The Needles MCZ https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0040&SiteName=needles&SiteNameDisplay=The%20Needles%20MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=&HasCA=1 [accessed 24/04/20].

†The habitat FOCI Seagrass Beds fall under PoA Objective 2 and are detailed in a separate report (Green, 2019) and are summarised in Section 0 of this report.

2 Methods

2.1 Survey design

A number of surveys were conducted with the aim of providing sufficient information to deliver Objective 1 with incidental information being used to deliver Objectives 3, 4 and (in part) 5 (see Section 0). Grab sampling was conducted to assess soft-sediment habitats, targeting broadscale habitats ‘A5.4 Subtidal mixed sediments’, ‘A5.2 Subtidal sand’ and ‘A5.1 Subtidal coarse sediment’. The rocky substrate habitats ‘A3.2 Moderate energy infralittoral rock’, ‘A3.1 High energy infralittoral rock’ and ‘A4.2 Moderate energy circalittoral rock’ as well as the Subtidal Chalk FOCI were targeted using a subtidal camera survey. Sample locations are displayed in Figure 2.

The habitat FOCI Subtidal seagrass was surveyed as part of a separate survey of Seagrass Beds around the Isle of Wight and the Solent. Seagrass Beds in Colwell Bay and Totland Bay were surveyed using both drop camera and echosounder methods to estimate the extent of Seagrass Beds within The Needles MCZ and the canopy height of grasses within these beds. These surveys are described in a separate report (Green, 2019) and the findings summarised in Section 0 of this report.

Sedimentary habitats

The 2014 survey recorded ‘A5.1 Subtidal coarse sediment’, ‘A5.2 Subtidal sand’ and ‘A5.4 Subtidal mixed sediments’ throughout the site (Arnold *et al*., 2014, Mylroie *et al*., 2015).

For the ‘A5.1 Subtidal coarse sediment’ habitat, power analysis showed that detecting change in taxon richness would require an unfeasibly large number of samples. It was suggested that this was linked to the diversity of environments in which this habitat was found: including inshore bays and offshore ridges (Arnold *et al.*, 2014). Instead, 23 grab samples were targeted across these areas to characterise habitats thought to be coarse sediments, but not visited in 2014.

The ‘A5.2 Subtidal sand’ habitat was only recorded at a single grab station in 2014. As such, no indication of the variability in taxa between samples could be inferred as part of a power analysis. For 2018, three grab stations were placed in areas identified as sand in the 2014 interpreted broadscale habitat map.

The ‘A5.3 Subtidal mud’ habitat was recorded in five still images in the 2014 survey. Four grab stations were chosen to target likely location of this habitat in the 2018 survey.

For ‘A5.4 Subtidal mixed sediments’, infaunal data collected in 2014 were used for power analysis to determine an appropriate number of samples for the 2018 survey. Power analyses identified that 30 grab samples would be required to identify a 20% change in taxon richness at 80% power ($P < 0.05$). As such, 35 grab stations were selected to target the 'A5.4 Subtidal mixed sediments' habitat. Twelve stations where this habitat was identified in 2014 were resampled for the 2018 survey.

A total of 65 grab stations were therefore targeted for the 2018 survey. In addition, for stations targeting subtidal sediments, the presence of subtidal Seagrass Beds was checked before grabbing was conducted. This was to avoid the risk of harm to seagrass habitats which have historically been recorded in these areas.

Six stations were also selected for sediment contaminant analysis (heavy metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, tributyltin) (stations NDLS37, 49, 51, 54, 59 and 61). It was considered *a priori* that these stations were characterised by subtidal sand (station NDLS37) or subtidal mixed sediments (stations NDLS49, 51, 54, 59 and 61).

Rocky habitats

'A3.2 Moderate energy infralittoral rock' was the most commonly recorded rocky habitat in the 2014 verification survey (Arnold *et al.*, 2014). 'A4.2 Moderate energy circalittoral rock' was found at a small number of locations. 'A3.1 High energy infralittoral rock' was not mapped in the 2014 survey (Mylroie *et al*., 2015).

For the 2018 camera survey, camera stations were positioned over areas mapped as 'A3.2 Moderate energy infralittoral rock' and 'A4.2 Moderate energy circalittoral rock' in the verification survey (Arnold *et al.*, 2014, Mylroie *et al.*, 2015). The location of these stations was based on expert judgement and knowledge gained from previous inshore MCZ and shallow sublittoral rock surveys. The data from the 2014 survey did not cover a representative amount of the rock habitat to allow a meaningful power analysis to be undertaken. As such, 30 camera tow stations were planned over areas interpreted as 'moderate energy infralittoral rock' (Miller, 2018).

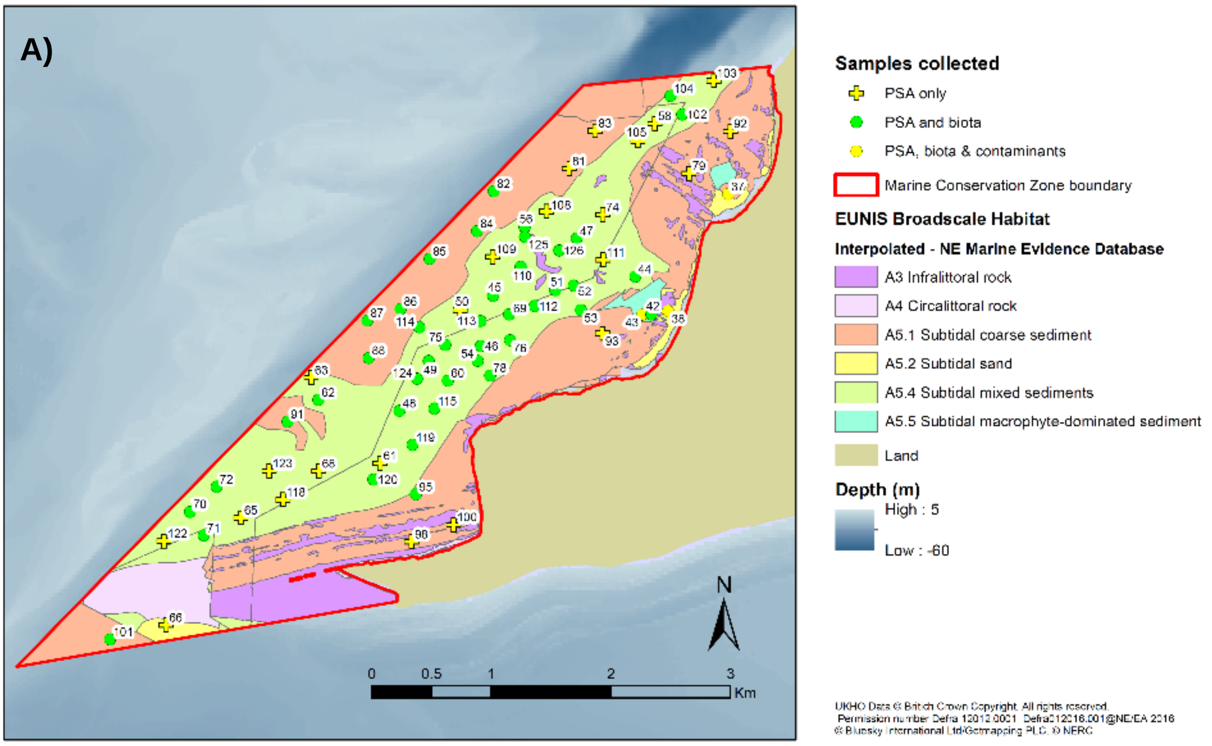
Due to the localised distribution and lack of mapping available for the non-designated habitat 'A4.1 High energy circalittoral rock', monitoring of this habitat was not specifically targeted during this survey.

The Subtidal Chalk habitat FOCI was recorded within a single image during the 2014 survey (Arnold *et al*., 2014). This station was revisited in 2018 (station NDLS05). Additional survey stations were added to areas not sampled in 2014, but where Subtidal Chalk has been previously observed by the Southern Inshore Fisheries and Conservation Agency (SIFCA) (stations NDLS 1-4, 11-15) (Miller, 2018).

A total of 30 camera stations were selected for the 2018 camera survey.

2.2 Data acquisition and processing

A dedicated monitoring survey was conducted between July and November 2018 at The Needles MCZ on board the Environment Agency coastal survey vessel *Solent Guardian*. (Garland *et al*., 2019). Drop camera deployments were conducted over two days on 3rd-4th July 2018. Mini-Hamon Grabs (0.1 m^2) were deployed to conduct sediment particle size analyses and benthic infauna between 5th and 12th July 2018. Vessel availability meant that sediment contaminant sampling was completed on one day, later in the sampling season (5th November 2018). Sampling locations are shown in Figure 2 and full survey details are provided by Garland *et al.* (2019).



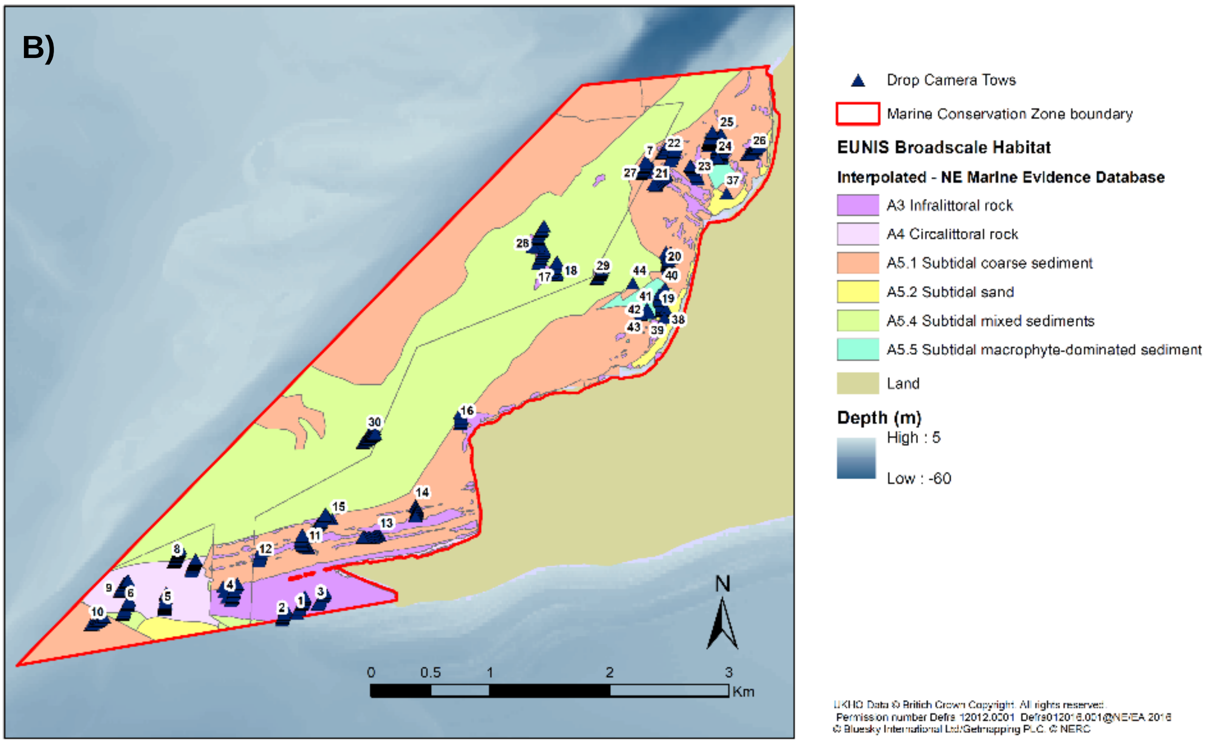


Figure 2. Location of ground truth samples collected at The Needles MCZ in 2018. A) Benthic grab sample locations; B) Drop camera survey locations.

Grab sampling

Seabed sediment samples for Particle Size Analysis (PSA) and benthic infauna analyses were collected using a 0.1 m^2 Hamon Grab (also known as a 'Mini' Hamon Grab). Samples were gathered at six stations for assessment of sediment contaminants. These samples were gathered using a 0.1 m^2 Day Grab.

A 500 ml sediment sub-sample was taken from each faunal grab sample and stored at -20°C prior to determining the particle size distribution. Sediment samples were processed by the Environment Agency's National Laboratory Service (NLS) following the recommended methodology of the North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme (Mason, 2011). The less than 1 mm sediment fraction was analysed using laser diffraction and the greater than 1 mm fraction was dried, sieved and weighed at 0.5 phi (ϕ) intervals. Sediment distribution data were merged and used to classify samples into sediment broadscale habitats.

The faunal fraction was sieved over a 1 mm mesh, photographed and then fixed in buffered 4% formaldehyde. Faunal samples were processed by the Institute of Estuarine and Coastal Studies (IECS) to extract all fauna present in each sample. Fauna were identified to the lowest taxonomic level possible, enumerated and weighed (blotted wet weight) to the nearest 0.0001 g following the recommendations of the NMBAQC scheme (Worsfold *et al*., 2010).

Surface scrapes were taken from the six sediment contaminant Day Grab samples, to a maximum depth of 1 cm. The surface layer of sediment provides a record of the most recent contaminant levels deposited. Samples were stored at -20°C and were processed by the Environment Agency's NLS to identify concentrations of heavy metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls and tributyltin.

Seabed imagery

Drop camera equipment was deployed following the Mapping European Seabed Habitats (MESH) 'Recommended Operating Guidelines (ROG) for underwater video and photographic imaging techniques' (Coggan *et al*., 2007). The Subsea Technology and Rentals SeaSpyder camera system was deployed from the stern of the survey vessel. Real time navigation data acquisition and manual position fixing when the gear contacted the seabed was captured via Trimble® HYDRO*pro*™ software. Video files and still images were transmitted via sea cable and saved directly to a computer hard drive. A video overlay was used to provide station metadata, time and GPS location.

Seabed images were captured every 10 to 15 m over a distance of >150 m. Additional images were taken opportunistically if heterogeneous areas of broadscale habitats, or specific features of interest were encountered. Video and still images were analysed following an established protocol developed and used by the Centre for the Environment, Fisheries and Aquaculture Science (Cefas) (Coggan and Howell, 2005; Hitchin *et al*., 2015; Turner *et al*., 2016) for epibiota community analysis, with the aim of identifying taxa to the lowest taxonomic level practicable and biotope assignment using the JNCC MNCR protocol (JNCC, 2015)

Further detail on ground truth sample collection is provided in the cruise report (Garland *et al*., 2019).

2.3 Data preparation and analysis

Sediment particle size distribution

Sediment particle size distribution data (0.5 phi (ϕ) classes) were grouped into the percentage contribution of gravel (particle diameter ≥2000 µm), sand (63–2000 µm) and mud (≤63 µm) derived from the classification proposed by Folk (1954). In addition, each sample was assigned to one of four sediment broadscale habitats using a modified version of the classification model produced during the (MESH project (Long, 2006).

Benthic data preparation

Prior to statistical analyses of faunal assemblages within The Needles MCZ, truncation and preparation of the data was undertaken for infauna (described in Annex 3. Infauna data truncation) and epifauna (described in Annex 4. Epifauna data truncation). Taxon names were standardised against the World Register of Marine Species[6] taxon lists to remove inconsistencies of having the same taxa being recorded under multiple synonyms. Data truncation minimises the influence of inconsistencies in the resolution of laboratory analyses. As such, this allows us to compare data sets with greater confidence.

Non-indigenous species (NIS)

The taxon lists generated from the infaunal samples and seabed imagery data were cross-referenced against lists of non-indigenous target species. These species have been selected for assessment of GES in GB waters under MSFD Descriptor 2, and identified as significant by the GB Non-native Species Secretariat. These taxa are listed in Annex 6. Non-indigenous species lists.

Data analyses

The DIVERSE routine in the PRIMER (Plymouth Routines in Multivariate Ecological Research) v6 software package (Clarke and Gorley, 2006) was used to calculate a range of univariate diversity indices on the untransformed truncated infaunal data. In addition, the Infaunal Quality Index[7] (IQI) Water Framework Directive (WFD) tool

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[6] http://www.marinespecies.org/ [accessed 24/04/20].

[7] Available from http://www.wfduk.org/resources%20/coastal-and-transitional-waters-benthic-invertebrate-fauna [accessed 22/01/2020].

(Phillips *et al*., 2014) was calculated to produce an Environmental Quality Ratio (EQR) which is a univariate proxy of the ecological status of a sample. Univariate index data were transferred to Minitab v18 (Minitab Inc., State College, PA) and differences in values between BSHs were assessed using Kruskal-Wallis tests. Non-parametric analyses were conducted as species data typically fail to meet the assumptions of parametric equivalents, such as ANOVA. For example, species data are typically non-normally distributed, based on taxon counts and are heteroscedastic (different groups of data having different degrees of variability) (e.g. Zuur *et al*., 2007, Warton *et al*., 2012). For the relatively small numbers of samples being analysed, non-parametric data are less sensitive to these issues. Where a significant difference between BSHs was apparent ($\alpha = 0.05$), Dunn's *post-hoc* test was used to identify which BSHs differed from each other[8] (following the guidance of Ruxton and Beauchamp, 2008). Diversity indices were compared between the 2018 and 2014 surveys using the Mann-Whitney Test routine in Minitab.

Bray Curtis similarity values were calculated between infaunal samples. These data were used to conduct analysis of similarity (ANOSIM) analyses and to produce non-metric multidimensional scaling (nMDS) plots to compare assemblage compositions between broadscale habitats. PRIMER's BIOENV procedure was run on the Bray Curtis similarity matrix, along with normalised data on the physical environment (sample depth and sediment mud, sand and gravel compositions). This routine explores which subset of physical parameters correlate maximally with the Bray Curtis similarity matrix (Clarke and Ainsworth, 1993).

Multivariate data were assigned to groups with similar assemblage structures using PRIMER's SIMPROF (similarity profile) routine. The resulting SIMPROF groups were assigned to biotopes following Parry (2015). Comparisons and explorations of SIMPROF groups was conducted using PRIMER's SIMPER (similarity percentages breakdown) routine.

[8] Using the Minitab macro file available at: https://support.minitab.com/en-us/minitab/18/macro-library/macro-files/nonparametrics-macros/krusmc/ [accessed 05/03/2020].

3 Results

3.1 Benthic and environmental overview

The Needles MCZ 2018 survey identified and successfully sampled all of the designated subtidal sediment and rock BSHs targeted by this work (Table 1). In addition, two non-designated BSHs were also identified as part of the imagery survey: 'A5.5 Subtidal macrophyte-dominated sediment' and 'A5.6 Subtidal biogenic reef' (Figure 18). The distribution of designated BSHs recorded in 2018 were in good agreement with the 2014 interpreted habitat map on which the survey design was based (Figure 3).

Low visibility made interpretation of the benthic imagery data difficult. As such, the interpretation and conclusions drawn from these data must be taken with caution (Coggan *et al.,* 2005; Hitchin *et al.*, 2015). Despite this however, four subtidal rock features were identified from the imagery data. In addition to recording rocky habitats, the imagery survey also indicated the presence of three of the four designated sedimentary BSHs ('A5.3 Subtidal mud' was not recorded in the digital imagery data). However, assigning of these images to sedimentary BSHs was based on visual cues only and no sediment data were gathered for groundtruthing. As such, the images assigned to sedimentary BSHs should be considered as indicative only.

Table 4 shows the number of grab and imagery samples collected in each BSH. The most commonly sampled rocky BSH recorded in the 2018 camera survey was 'A3.2 Moderate energy infralittoral rock'. The most commonly sampled sediment habitat in the grab survey was 'A5.4 Subtidal mixed sediments'. The distribution and taxon composition of the observed BSHs is explored further in the sections below.

3.2 Broadscale habitats (BSH) and Particle Size Analysis (PSA)

A total of 71 grab samples were successfully extracted from within The Needles MCZ for PSA in 2018. Of those, 49.3% (n = 35) were assigned to the 'A5.4 Subtidal mixed sediments' BSH). Most stations containing this BSH were distributed in the central portion of the MCZ (Figure 3). These stations were characterised by relatively high proportions of gravel, sand and mud sediments (Figure 4, Figure 5). The 'A5.1 Subtidal coarse sediment' BSH was also common, found at 36.6% (n = 26) of sampling locations. This BSH was recorded more commonly in the vicinity of the MCZ borders, particularly towards the offshore western extent of the MCZ. These samples were characterised by relatively high proportions of gravel-sized sediments. 'A5.2 Subtidal sand' was recorded in 11.3% (n = 8) of samples. These samples were all located in the east of the MCZ (Figure 3). Finally, the 'A5.3 Subtidal mud' BSH was recorded at two sampling stations (representing 2.8% of samples).

In addition to the rocky habitats targeted by the seabed imagery survey, the drop camera survey work also recorded sedimentary habitats. The location of these observations is provided in the biotope maps within each subsection in Section 3.3. It is not possible to elucidate infaunal ecology from such surface imagery data, however this information is potentially useful when describing the distribution of these habitats. The spatial distributions of these BSHs in 2018 were similar to those predicted in the interpreted distribution map, based on the 2014 survey work (Figure 3). As such, there is no indication that the distribution and extent of these BSHs has changed between 2014 and 2018.

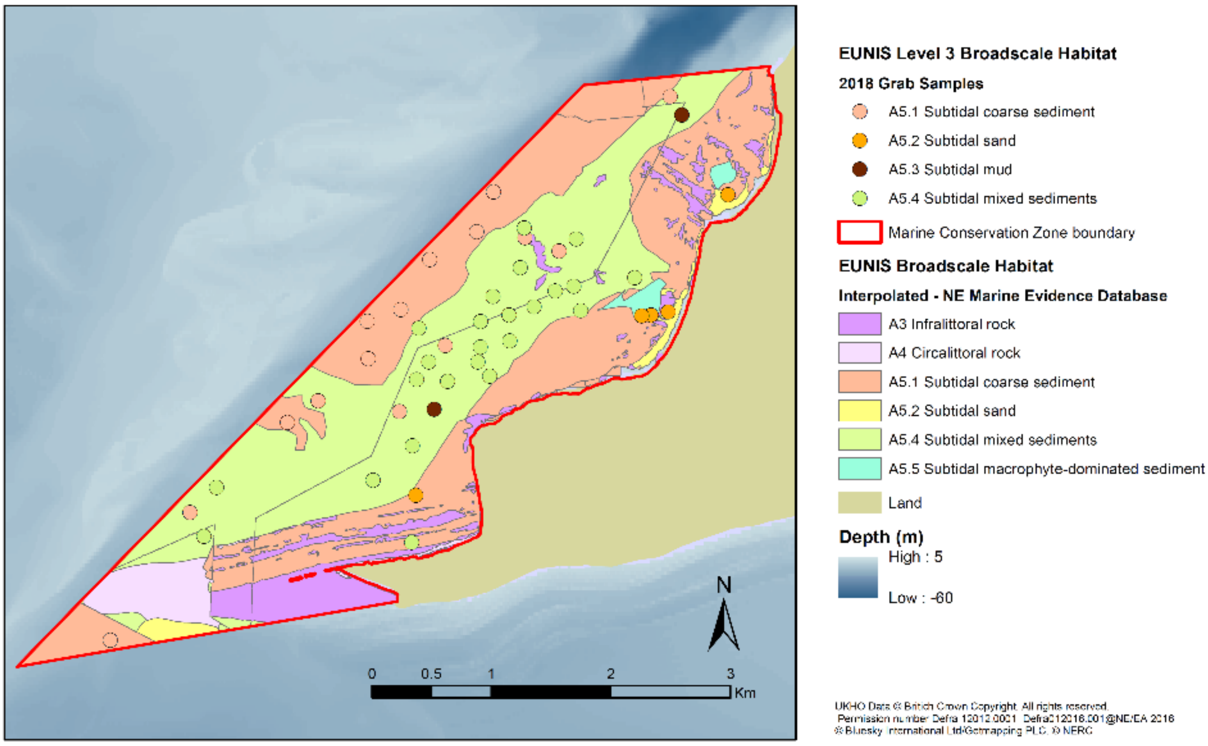


Figure 3. Distribution of BSHs inferred from The Needles MCZ 2018 data. Points represent BSHs recorded during the 2018 survey. Background polygons are the modelled BSHs taken from the Marine Evidence database and those interpreted from acoustic survey data (Mylroie *et al*., 2015).

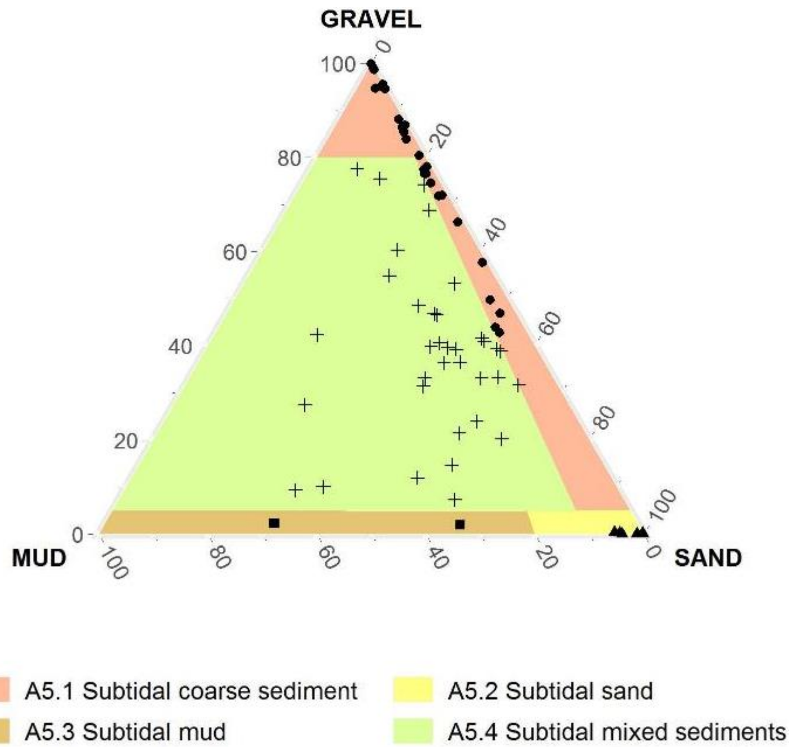


Figure 4. Classification of particle size distribution information for each sampling point gathered within The Needles MCZ in 2018 (© Natural England and Environment Agency 2022). Each sampling point was assigned to a BSH based on sediment granulometry: 'A5.1 Subtidal coarse sediment' (●), 'A5.2 Subtidal sand' (▲), 'A5.3 Subtidal mud' (■) and 'A5.4 Subtidal mixed sediments' (+). Sampling data are plotted onto a modified Folk triangle, dividing sediments using the simplified classifications for UKSeaMap (Long, 2006; Folk, 1954).

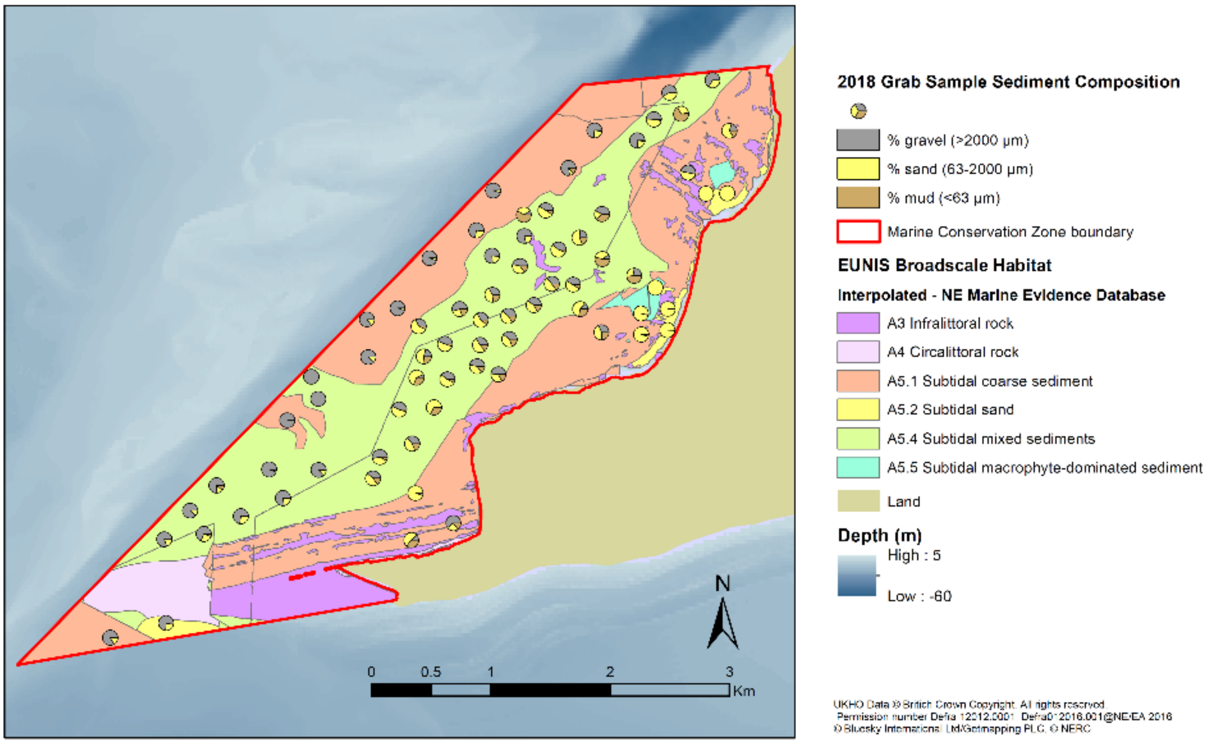


Figure 5. Percentage contributions of gravel, sand and silt in samples collected from The Needles MCZ in 2018.

Table 4. Number of samples collected in each BSH in 2018. Designated BSHs are indicated in bold (© Natural England and Environment Agency 2022).

Broadscale habitat	Grab - PSA and Infauna	Grab - PSA only	Video*	Stills*
A3.1 High energy infralittoral rock	0	0	4	29
A3.2 Moderate energy infralittoral rock	0	0	16	131
A4.1 High energy circalittoral rock	0	0	10	62
A4.2 Moderate energy circalittoral rock	0	0	1	12
A5.1 Subtidal coarse sediment	14	12	*12*	*109*
A5.2 Subtidal sand	5	3	*9*	*53*
A5.3 Subtidal mud	2	0	*0*	*0*
A5.4 Subtidal mixed sediments	25	11	*1*	*13*
A5.5 Subtidal macrophyte-dominated sediment	0	0	*12*	*66*
A5.6 Subtidal biogenic reef	0	0	*5*	*14*

*Sedimentary BSHs recorded in imagery data (indicated by *italicised* numbers) are indicative only

3.3 Infaunal community analysis

A total of 447 taxa were recorded in the benthic grab survey in 2018. The majority of taxa recorded in 2018 were typical of sedimentary environments in coastal UK waters. Some notable taxa were recorded in 2018, including the rarely recorded amphipod *Cheirocratus robustus*. In addition, a number of non-native fauna were also recorded (see Section 3.8).

There were no consistent overarching trends apparent in taxon richness, abundance or biomass within The Needles MCZ, beyond those tied to the underlying BSH (Summary of selected infaunal diversity indices gathered within The Needles MCZ in 2018: **a) taxon richness; b) total faunal abundance; c) total faunal biomass; d) IQI classifications. Point shapes in d) indicate BSH: 'A5.1 Subtidal coarse sediment' (▲), 'A5.2 Subtidal sand' (●); 'A5.3 Subtidal mud' (■); 'A5.4 Subtidal mixed sediments' (+).**

) (mean ± standard error correlation *r* values with eastings values 0.15 ± 0.04 and with northings values 0.09 ± 0.03). Diversity metrics were calculated for each BSH and mean values by BSH are shown in Table 5 and values plotted in Figure 6.

Kruskal-Wallis comparisons and Bonferroni-adjusted post-hoc pairwise Dunn's tests showed that taxon richness (H = 27.92, *P* <0.001, df = 3), faunal abundance (H = 27.24, *P* <0.001, df = 3) and total faunal biomass (H = 27.94, *P* <0.001, df = 3) values were all higher in the 'A5.4 Subtidal mixed sediments' BSH than those in both the 'A5.1 Subtidal coarse sediment' and 'A5.2 Subtidal sand' BSHs (post-hoc tests significant at *P* ≤0.003).

IQI values were also lower in 'A5.2 Subtidal sand' than those in 'A5.3 Subtidal mud' and 'A5.4 Subtidal mixed sediments' (H = 13.83, *P* = 0.003, df = 3, post-hoc pairwise tests *P* ≤0.019). Mean IQI values in 'A5.2 Subtidal sand' were indicative of 'Moderate' ecological status. Those in 'A5.3 Subtidal mud' and 'A5.4 Subtidal mixed sediments' were indicative of an assemblage in 'Good' ecological status. It should be noted however that the total number of IQI values produced was lower than the total number of grab samples analysed (Table 5). This is because the IQI tool is designed to quantify benthic habitat condition in sedimentary environments. The IQI tool does not assess particularly gravelly habitats. As such, a number of particularly gravelly samples could not be compared (Summary of selected infaunal diversity indices gathered within The Needles MCZ in 2018: **a) taxon richness; b) total faunal abundance; c) total faunal biomass; d) IQI classifications. Point shapes in d) indicate BSH: 'A5.1 Subtidal coarse sediment' (▲), 'A5.2 Subtidal sand' (●); 'A5.3 Subtidal mud' (■); 'A5.4 Subtidal mixed sediments' (✚).**

) and consideration of this tool's output must be made with caution. Raw IQI values are presented in Annex 7.

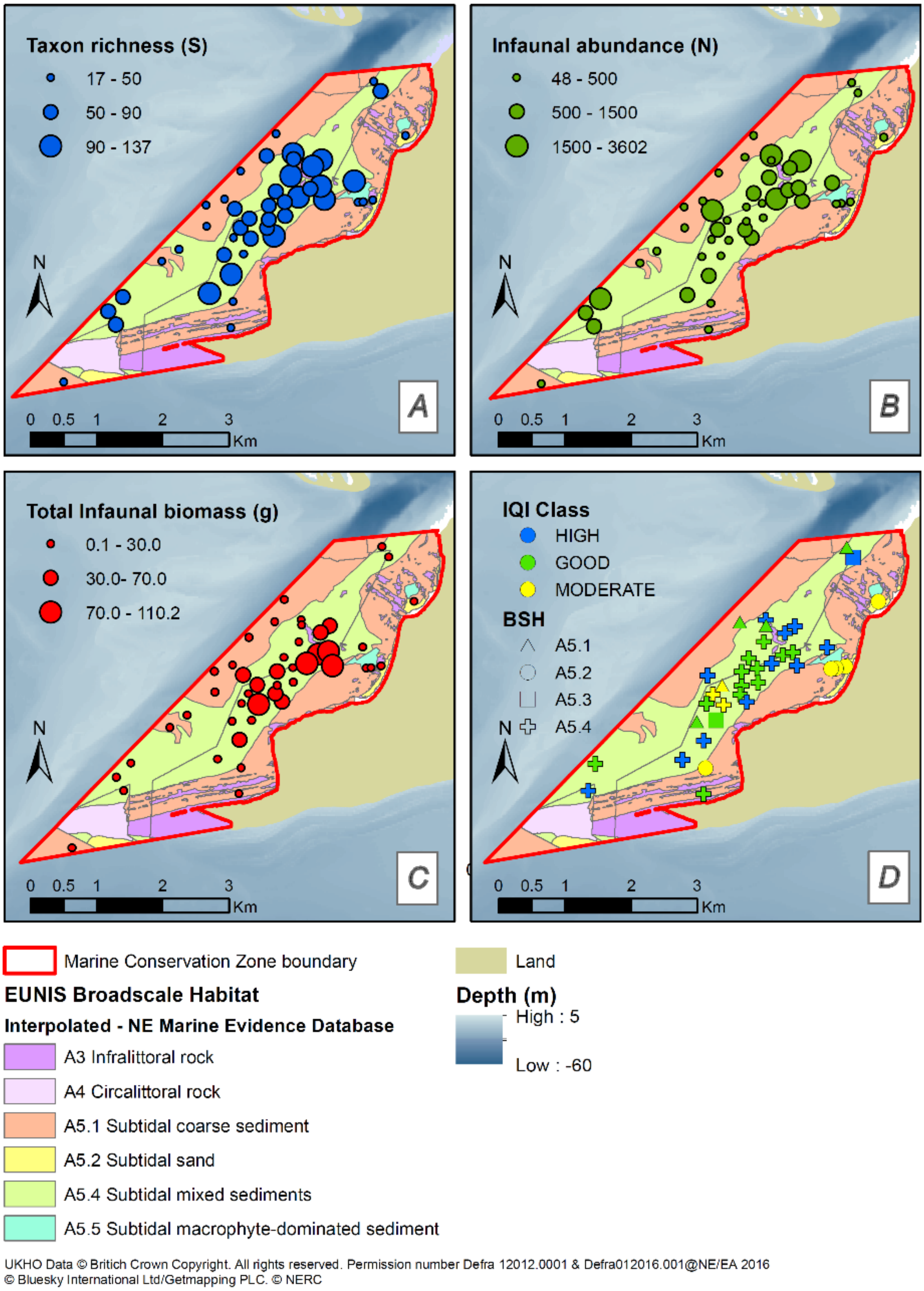
Multivariate comparison of infaunal assemblages between BSHs was carried out using PRIMER's ANOSIM routine on Bray Curtis similarities calculated from square root-transformed abundance data. ANOSIM indicated that assemblages differed significantly between the different BSHs (ANOSIM, R = 0.780, P = 0.001), suggesting a relationship between community composition and BSH type (Figure 7). PRIMER's BIOENV routine identified that the environmental parameter 'sand composition' had the maximum correlation with the species similarity matrix (ρ = 0.634, P = 0.001, 999 permutations).

Qualitative observations of epifaunal and epiphytic taxa in sedimentary habitats were also made as part of the imagery survey. However, no PSA data was gathered to confirm which BSH was present for each image. In addition, the imagery surveys did not specifically target these habitats, with observations recorded on an ad hoc basis during surveys of rocky habitats. This means that although this information does provide some insight into the taxa living at the sediment surface in these habitats, they should be considered indicative only and cannot be used to reliably quantify the abundances of epifaunal taxa present. A brief overview of taxa recorded in the imagery data within these (indicative) BSHs is included for each BSH.

Table 5. Mean (± standard error) univariate descriptors calculated from all grab samples and in each of the sedimentary BSHs sampled within The Needles MCZ in 2018 (© Natural England and Environment Agency 2022). Asterisks indicate metrics with significant differences between BSHs at *P* = 0.05(*) and *P* = 0.01(**). Superscripts reflect significant differences in Bonferroni-corrected between group comparisons, with different superscript values reflecting significant differences.

	Sample number	Total taxa	Taxon richness (S sample^{-1})**	Infaunal abundance (N sample^{-1})**	Biomass (g)**	Simpson's Evenness (1-λ')	Hill's N_1	Infaunal Quality Index[1]**
Overall	46	447	63.30 ± 4.65	652.63 ± 112.10	22.94 ± 4.54	0. 86 ± 0.01	16.79 ± 1.03	0.71 ± 0.01
A5.1 Subtidal coarse	14	198	44.1 ± 4.0[a]	240.07 ± 58.70[a]	4.11 ± 3.07[a]	0.87 ± 0.03	17.39 ± 2.10	0.69 ± 0.02
A5.2 Subtidal sand	5	61	22.2 ± 1.50[a]	71.6 ± 9.01[a]	1.156 ± 0.56[a]	0.89 ± 0.01	12.41 ± 1.03	0.59 ± 0.02[a]
A5.3 Subtidal mud	2	74	41.5 ± 11.50	169..0 ± 21.0	1.39 ± 0.66	0.87 ± 0.06	17.13 ± 6.65	0.75 ± 0.08[b]
A5.4 Subtidal mixed	25	377	84.0 ± 5.22[b]	1038.6 ± 168.9[b]	39.57 ± 6.55[b]	0.84 ± 0.02	17.31 ± 1.39	0.73 ± 0.02[b]

[1] number of IQI values for A5.1 = 5; A5.2 = 5; A5.3 = 2; A5.4 = 25



Summary of selected infaunal diversity indices gathered within The Needles MCZ in 2018: a) taxon richness; b) total faunal abundance; c) total faunal biomass; d) IQI classifications. Point shapes in d) indicate BSH: 'A5.1 Subtidal coarse sediment' (▲), 'A5.2 Subtidal sand' (●); 'A5.3 Subtidal mud' (■); 'A5.4 Subtidal mixed sediments' (✚).

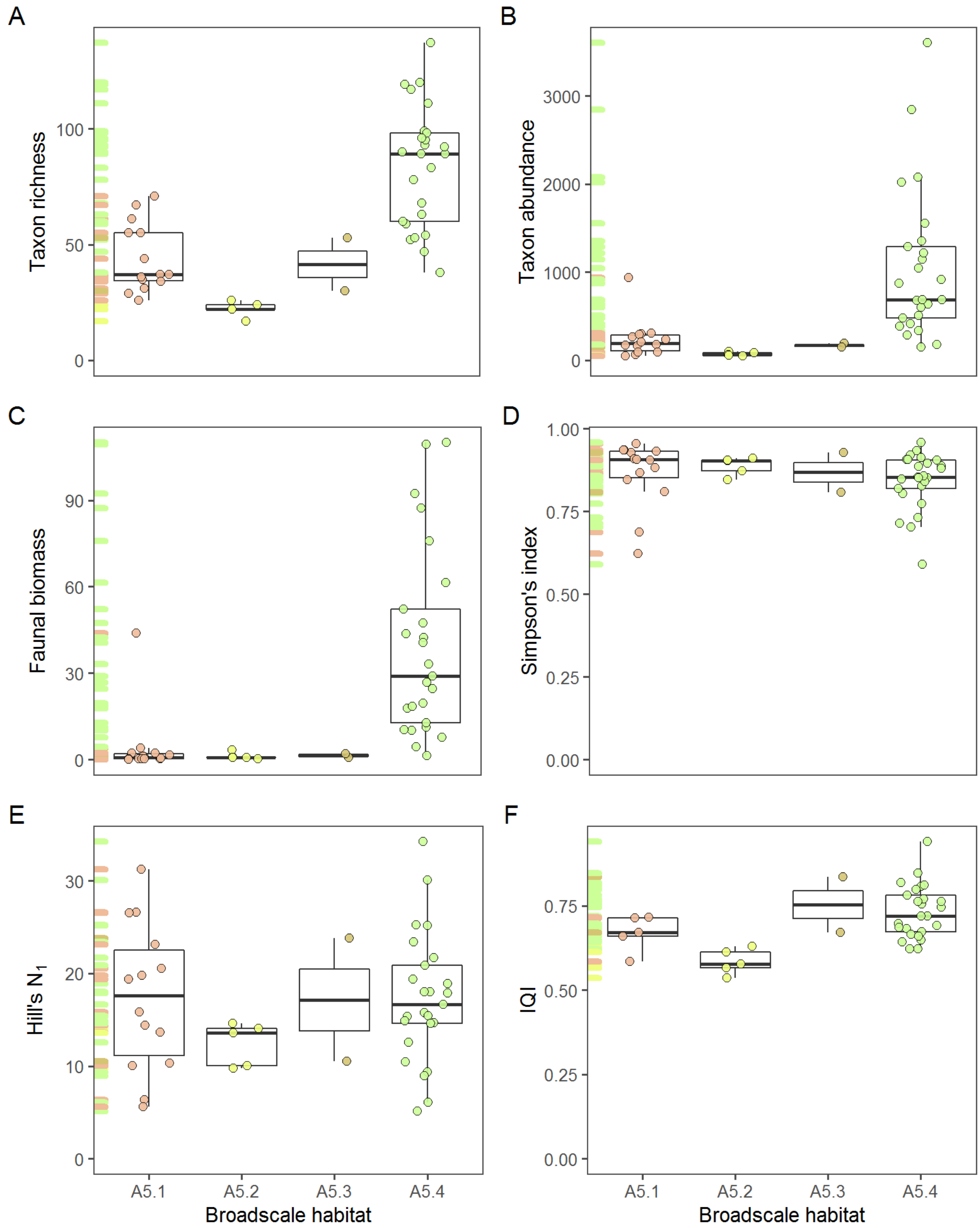


Figure 6. Distribution of diversity metrics within the four BSHs recorded in the 2018 sampling of The Needles MCZ(© Natural England and Environment Agency 2022). A) Taxon richness; B) Total faunal abundance; C) Total faunal biomass; D) Simpson's index; E) Hill's N_1; F) Infaunal quality index. All values are based on abundance data recorded in 0.1 m^2 Mini-Hamon Grabs.

Distribution of data across BSHs is summarised by the coloured marks along the y axis. BSH codes refer to Table 1.

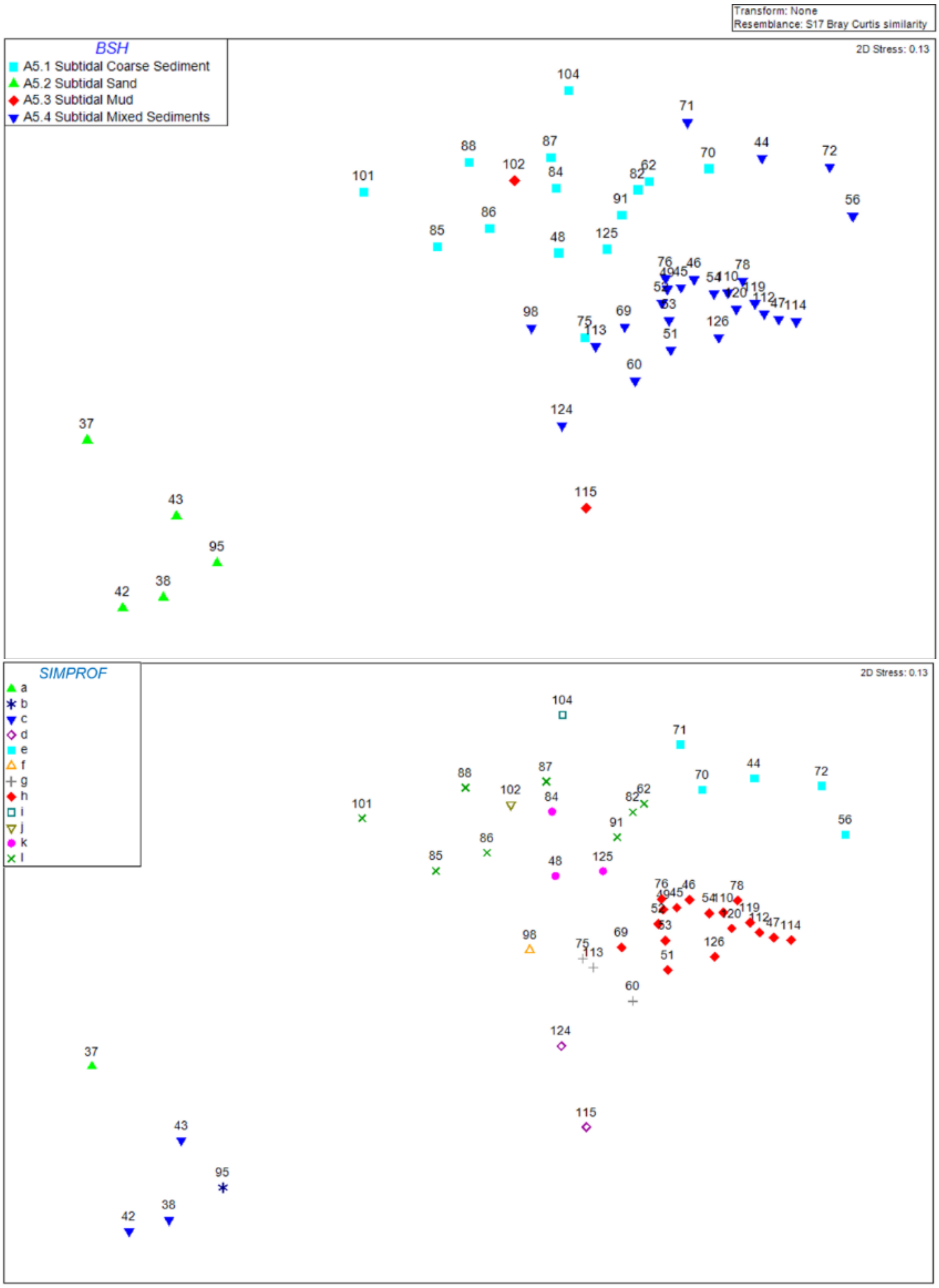


Figure 7. Non-metric multidimensional scaling (nMDS) plot of infaunal assemblages sampled in The Needles MCZ 2018 survey (© Natural England and Environment Agency 2022). Samples are grouped by assigned sediment broadscale habitats (top) and assemblage groups (bottom) as identified by SIMPROF analysis. Point labels indicate the station number.

SIMPROF grouping and associated biotopes

The SIMPROF routine was used to group samples by similarities in assemblage characteristics. The SIMPROF routine assigned samples across 12 groups (groups *a* to *l*) (Table 6). Representative images of the SIMPROF groups are provided in Figure 8, with their distributions indicated in Figure 9.

Nine of the 12 SIMPROF groups were found in only a single BSH. SIMPROF groups *i*, *k* and *l* were recorded only within the ‘A5.1 Subtidal coarse sediment’ BSH. Groups *a*, *b* and *c* were recorded only within the ‘A5.2 Subtidal sand’ BSH. Group *j* was recorded only within the ‘A5.3 Subtidal mud’ BSH. Groups *f* and *h* were recorded only within the ‘A5.4 Subtidal mixed sediments’ BSH. As such, the greatest apparent diversity of assemblage types was recorded in the ‘A5.1 Subtidal coarse sediment’ and ‘A5.4 Subtidal mixed sediments’ BSHs. Five biotopes were recorded within each of these BSHs. Three SIMPROF groups were recorded in ‘A5.2 Subtidal sand’ and two groups were recorded in the ‘A5.3 Subtidal mud’ BSH.

SIMPROF groups were assigned to biotopes following JNCC guidance (Parry, 2015). The 12 SIMPROF groups were representative of nine biotopes, with the majority of samples being assigned to more than one biotope (e.g. SIMPROF groups *a, b* and *c* were all assigned to a single biotope complex; Table 7). Samples assigned to multiple biotopes may reflect a habitat in transition between two or more similar biotopes or may reflect an area of seabed that is a complex mosaic of habitats. Where the term ‘biotope’ is used, this encompasses single biotope samples as well as those assigned to two or more biotopes. The difficulty in assigning samples to single biotopes may also be reflective of the often patchy distribution of taxa in the marine environment. For example, a number of samples were assigned to the biotope SS.SMX.IMx.VsenAsquAps (*Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment). However, one of the characteristic taxa for this biotope *A. latreilli* was not recorded in any of the samples gathered in The Needles MCZ.

Samples from the ‘A5.1 Subtidal coarse sediment’ BSH contained the greatest diversity of biotopes, with five biotopes observed (Table 7). Four biotopes were recorded in samples from the ‘A5.4 Subtidal mixed sediments’ BSH. The ‘A5.3 Subtidal mud’ and ‘A5.2 Subtidal sand’ BSHs were assigned to two and one biotopes, respectively.

The most commonly recorded biotope was assigned to 17 of the 46 samples (37%) SS.SMX.IMx.CreAsAn/ SS.SBR.PoR.SspiMx/ SS.SMX.IMx.VsenAsquAps (*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Sabellaria spinulosa* on stable circalittoral mixed sediment/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment). All examples of this biotope mosaic where recorded in the ‘A5.4 Subtidal mixed sediments’ BSH.

Table 6. Top three taxa characterising each assemblage as defined by the SIMPROF analysis(© Natural England and Environment Agency 2022). Data were assessed using SIMPER analysis on infaunal abundance data from The Needles MCZ 2018 survey. Five SIMPROF groupings (*a, b, f, i* and *j*) were composed of single samples and so are excluded.

Group '*c*' (A5.2, n = 3) Mean similarity = 61.1%		**Group '*d*' (A5.3, n = 1; A5.4, n = 1) Mean similarity = 46.4%**		**Group '*e*' (A5.1, n = 1; A5.4, n = 4) Mean similarity = 36.7%**		**Group '*g*' (A5.1, n = 1; A5.4, n = 2) Mean similarity = 46.0%**	
Taxon	**% contribution**	**Taxon**	**% contribution**	**Taxon**	**% contribution**	**Taxon**	**% contribution**
Spiophanes bombyx	29.63	*Ampelisca diadema*	30.67	*Balanus crenatus*	65.91	*Cirriformia tentaculata*	23.42
Galathowenia oculata	24.89	*Venerupis corrugata*	17.33	Ascidiacea	8.42	*Nucula nucleus*	11.04
Chaetozone christiei	14.22	*Cirriformia tentaculata*	10.67	*Pisidia longicornis*	7.11	*Crepidula fornicata*	10.31

Group '*h*' (A5.4, n = 17) Mean similarity = 48.1%		**Group '*k*' (A5.1, n = 3) Mean similarity = 49.9%**		**Group '*l*' (A5.1, n = 8) Mean similarity = 32.3%**	
Taxon	**% contribution**	**Taxon**	**% contribution**	**Taxon**	**% contribution**
Pisidia longicornis	29.96	*Spirobranchus lamarcki*	23.13	*Pisidia longicornis*	41.7
Sabellaria spinulosa	13.47	*Spirobranchus*	14.52	*Melita hergensis*	16.41
Nucula nucleus	12.85	*Syllis*	9.89	*Spirobranchus lamarcki*	5.54

Table 7. Biotopes (JNCC, 2015) assigned to the 12 sample groups assigned by PRIMER's SIMPROF routine (© Natural England and Environment Agency 2022). Where a SIMPROF group could not be allocated to a single biotope, more than one biotope was assigned.

SIMPROF group	Number of samples	Biotope code	Biotope name	BSHs represented	Notes
a	1	SS.SSA.CMuSa.AalbNuc/ SS.SSA.IMuSa.FfabMag	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment/ *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	A5.2	
b	1	SS.SSA.CMuSa.AalbNuc/ SS.SSA.IMuSa.FfabMag	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment/ *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	A5.2	
c	3	SS.SSA.CMuSa.AalbNuc/ SS.SSA.IMuSa.FfabMag	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment/ *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	A5.2	
d	2	SS.SMU.ISaMu.AmpPlon/ SS.SMX.IMx.VsenAsquAps	*Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud/ *Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.3; A5.4	
e	5	SS.SMX.CMx.FluHyd/ SS.SMX.IMx.VsenAsquAps	*Flustra foliacea* and *Hydrallmania falcata* on tideswept circalittoral mixed sediment/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.1; A5.4	
f	1	SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps	*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.4	Sample represents a faunally-depauperate representation of this biotope
g	3	SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps	*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.1; A5.4	

SIMPROF group	Number of samples	Biotope code	Biotope name	BSHs represented	Notes
h	17	SS.SMX.IMx.CreAsAn/ SS.SBR.PoR.SspiMx/ SS.SMX.IMx.VsenAsquAps	*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Sabellaria spinulosa* on stable circalittoral mixed sediment/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.4	
i	1	SS.SCS.CCS.PomB	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	A5.1	
j	1	SS.SMX.IMx.VsenAsquAps	*Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.3	
k	3	SS.SCS.CCS.Pkef/ SS.SMX.IMx.VsenAsquAps	*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	A5.1	
l	8	SS.SCS.CCS.PomB/ SS.SCS.CCS.Pkef	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/ *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand	A5.1	

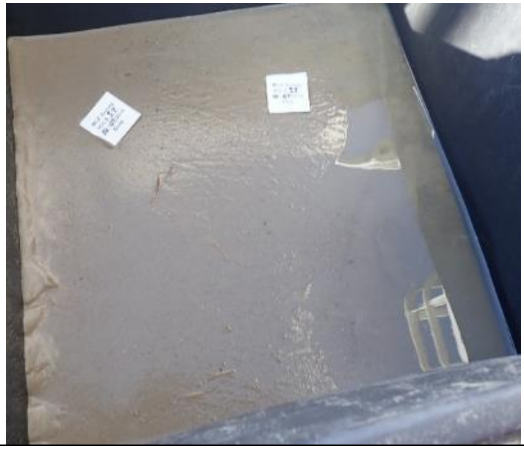
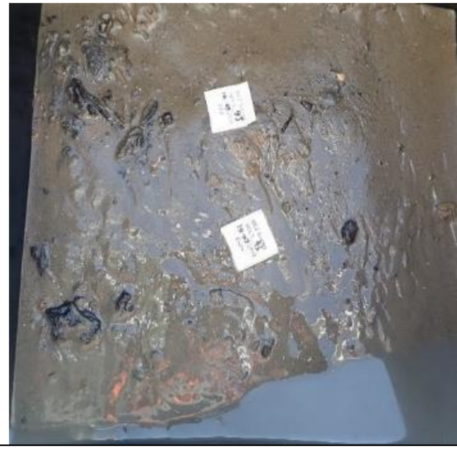
Group *a* - SS.SSA.CMuSa.AalbNuc/ SS.SSA.IMuSa.FfabMag	Group b - SS.SSA.CMuSa.AalbNuc/ SS.SSA.IMuSa.FfabMag	Group c - SS.SSA.CMuSa.AalbNuc/ SS.SSA.IMuSa.FfabMag
		
Group *d* - SS.SMU.ISaMu.AmpPlon/ SS.SMX.IMx.VsenAsquAps	**Group e - SS.SMX.CMx.FluHyd/ SS.SMX.IMx.VsenAsquAps**	**Group f - SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps**
		

Figure 8. Example images from The Needles 2018 MCZ 2018 infaunal grab survey. SIMPROF analysis identified 12 assemblage groups within the MCZ and these were assigned to biotopes (JNCC, 2015)(© Environment Agency and Natural England 2018). Biotope codes refer to Table 7. (Continued overleaf)

Group g - SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps	Group h - SS.SMX.IMx.CreAsAn/ SS.SBR.PoR.SspiMx/ SS.SMX.IMx.VsenAsquAps	Group i - SS.SCS.CCS.PomB
		
Group j - SS.SMX.IMx.VsenAsquAps	**Group k - SS.SCS.CCS.Pkef/ SS.SMX.IMx.VsenAsquAps**	**Group l - SS.SCS.CCS.PomB/ SS.SCS.CCS.Pkef**
		

Figure 9 (continued) (© Environment Agency and Natural England 2018)

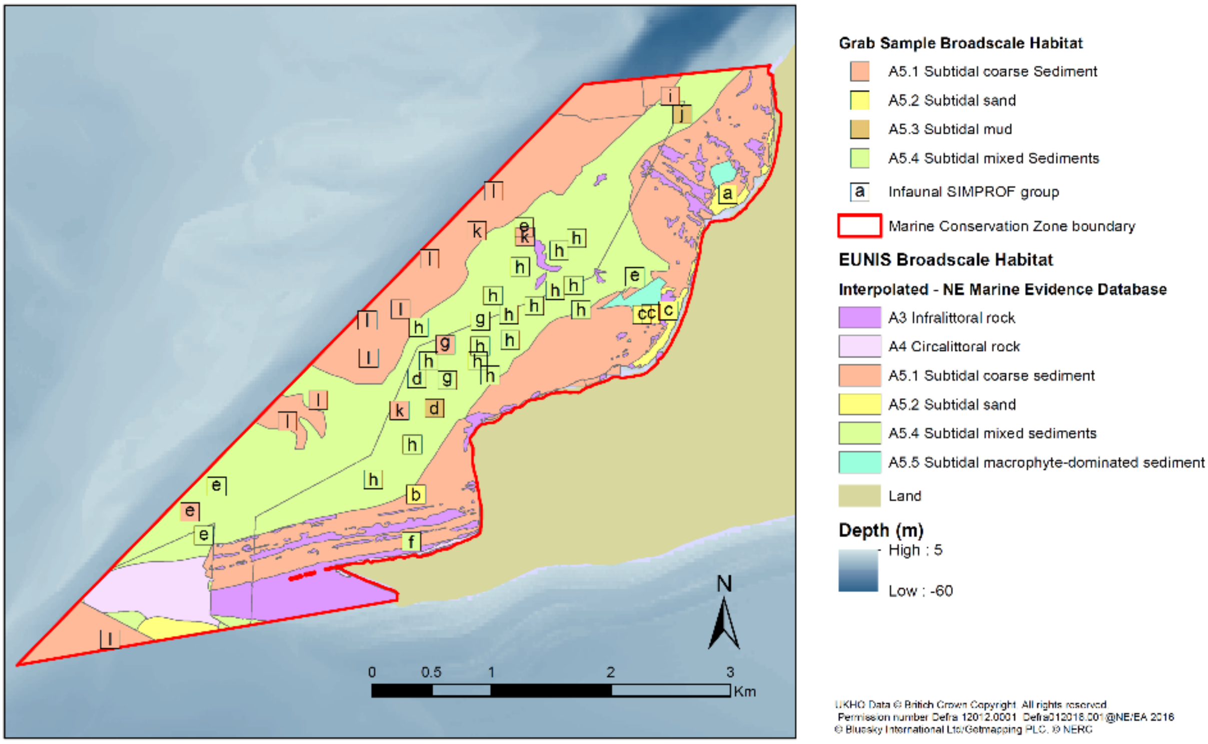


Figure 9. Distribution of infaunal assemblage groups identified using PRIMER's SIMPROF routine. Infaunal abundance data from The Needles MCZ 2018 survey were binary transformed prior to analysis. The SIMPROF routine identified 12 groups (*a* to *l*) within the four BSHs observed during the survey. SIMPROF group labels are displayed overlapping the BSH to which each sample was assigned.

A5.1 Subtidal coarse sediment

Fourteen infaunal samples were assigned to the 'A5.1 Subtidal coarse sediment' BSH in 2018 (Table 4). This BSH was characterised by coarse sediments, with mean (± standard error) gravel content by weight of 80.14 ± 5.15%. Sands (18.50 ± 4.77%) and muds (1.34 ± 0.46%) were less common. Samples from this BSH were fairly diverse, having at least one occurrence for 198 of the total 447 taxa recorded across all sedimentary BSHs (44% of all taxa recorded in grab samples). Infaunal assemblages within this biotope were dominated by sabellid polychaete worms, amphipods, porcellanid crabs and bivalves belonging to family Nuculidae. Sabellid worms are considered to be important contributors to ecosystem functioning. This is principally linked to their contribution to habitat heterogeneity and their links to benthic-pelagic coupling (Pearce *et al.*, 2011). The suspension feeding *Nucula nucleus* is also potentially important in benthic-pelagic coupling and additionally is regarded as a highly fecund taxon, potentially able to quickly colonise and re-colonise habitats following disturbance (de Juan *et al.*, 2007).

Mean assemblage similarity (SIMPER) of samples within this BSH was 26.4%. The most abundant taxon was the porcelain crab *Pisidia longicornis* which accounted for 22% of faunal abundances. The second most abundant taxon within this BSH in 2018 was the acorn barnacle *Balanus crenatus* which accounted for 13% of faunal abundances. Both of these taxa are characteristic of coarse sediments and mixed, rocky and stony habitats and both are widespread in British seas.

SIMPROF assigned assemblages within this BSH to five distinct groups. SIMPROF group *l* was the most common and was assigned to eight samples along the western border of the MCZ (Figure 9). Group *k* was assigned to three samples and groups *e, g* and *i* were assigned to one sample each. Representative taxa of each SIMPROF group is provided in Table 6.

These SIMPROF groups were assigned to five biotopes (Figure , Figure 11). The most common biotope (n = 8) was SS.SCS.CCS.PomB/SS.SCS.CCS.Pkef (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand). Within this biotope, the rarely recorded amphipod *Cheirocratus robustus* was observed. The biotope mosaic SS.SCS.CCS.Pkef/ SS.SMX.IMx.VsenAsquAps (*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand/*Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment) was recorded at three stations. This represents a mixture of coarse and mixed sediment habitats. One station within this BSH was assigned to each of the three other biotopes recorded (Figure , Figure 11). Of note is the occurrence of the biotope mosaic SS.SMX.IMx.CreAsAn/ SS.SMX.Imx.VsenAsquAps. These two biotopes are described as being observed in mixed sediment habitats, rather than coarse sediments (JNCC, 2015). The sediment data for this sample place it on the border of the ‘A5.1 Subtidal coarse sediment’ and ‘A5.4 Subtidal mixed sediments’ BSHs. Given that the borderline between different biotopes is somewhat arbitrary, it is not uncommon for an assemblage to be recorded in a habitat that is typical of a related, but different habitat (discussed in Section 4.4).

Statistical comparisons were made to assess differences in univariate diversity metrics between the 2014 and 2018 surveys. Taxon abundance and taxon richness did not differ significantly between the two sampling events. Values of Simpson’s lambda and Hill’s N_1 were both higher in 2018. Values for both total faunal biomass and IQI were lower in 2018 (Table 8).

Fifty seven taxa were recorded within still images assigned to the ‘A5.1 Subtidal coarse sediment’. Commonly recorded epifauna were the terebellid worm *Lanice conchilega*, the scallop *Pecten maximus* and sea spiders (Class Pycnogonida), which were all present in over half of the ad hoc imagery assigned to this BSH. Bryozoans, Porifera and Cnidaria were recorded less commonly (present in 14-18% of images). Seagrass *Zostera marina* were recorded in 74% of images and unidentified foliose red algae were recorded in 43% of images.

Table 8. Summary of Mann-Whitney analyses comparing differences in diversity metrics between two sampling events within the 'A5.1 Subtidal coarse sediment' BSH in The Needles MCZ (© Natural England and Environment Agency 2022). Diversity metrics are based on infaunal abundances sampled in 0.1 m^2 Mini-Hamon Grabs in 2014 and 2018[1]. The *Difference* refers to the group median value from 2018 subtracted from that from 2014 (as such, positive values indicate that 2014 > 2018). Significant metrics (α = 0.05) are indicated in bold.

	Taxon abundance	**Taxon richness**	**Biomass**	**Simpson's λ**	**IQI**	**Hill's N1**
Difference	144	5.5	**2.9**	-0.14	0.12	-6.73
CI for difference	-36, 806	-11, 31	**0.01, 7.91**	0.21, -0.05	0.03, 0.19	-12.10, -1.91
W statistic	454	422.5	**470**	309	154	326
P	0.131	0.626	**0.043***	**0.002****	**0.003****	**0.009****

[1]n = 22 for 2014 and n = 14 for 2018, except for IQI: n = 13 for 2014, n = 5 for 2018

*p<0.05; **p<0.01

<table>
<tr><td colspan="2">A5.1 Subtidal coarse sediment</td></tr>
<tr><td>SS.SCS.CCS.PomB/ SS.SCS.CCS.Pkef (n = 8)

Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/ Protodorvillea kefersteini and other polychaetes in impoverished circalittoral mixed gravelly sand</td><td>SS.SCS.CCS.Pkef/ SS.SMX.IMx.VsenAsquAps (n = 3)

Protodorvillea kefersteini and other polychaetes in impoverished circalittoral mixed gravelly sand/ Venerupis senegalensis, Amphipholis squamata and Apseudes latreilli in infralittoral mixed sediment</td></tr>
<tr><td></td><td></td></tr>
<tr><td>SS.SCS.CCS.PomB (n = 1)

Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles</td><td>SS.SMX.CMx.FluHyd/ SS.SMX.IMx.VsenAsquAps (n = 1)

Flustra foliacea and Hydrallmania falcata on tideswept circalittoral mixed sediment/ Venerupis senegalensis, Amphipholis squamata and Apseudes latreilli in infralittoral mixed sediment</td></tr>
<tr><td></td><td></td></tr>
</table>

Figure 10. Example images of Mini-Hamon Grab samples associated with the 'A5.1 Subtidal coarse sediment' BSH collected in The Needles MCZ 2018 survey. (Continued overleaf) (© Environment Agency and Natural England 2018).

SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps (n = 1) ***Crepidula fornicata*** **with ascidians and anemones on infralittoral coarse mixed sediment/** ***Venerupis senegalensis*****,** ***Amphipholis squamata*** **and** ***Apseudes latreilli*** **in infralittoral mixed sediment**


Figure 11 (continued) (© Environment Agency and Natural England 2018).

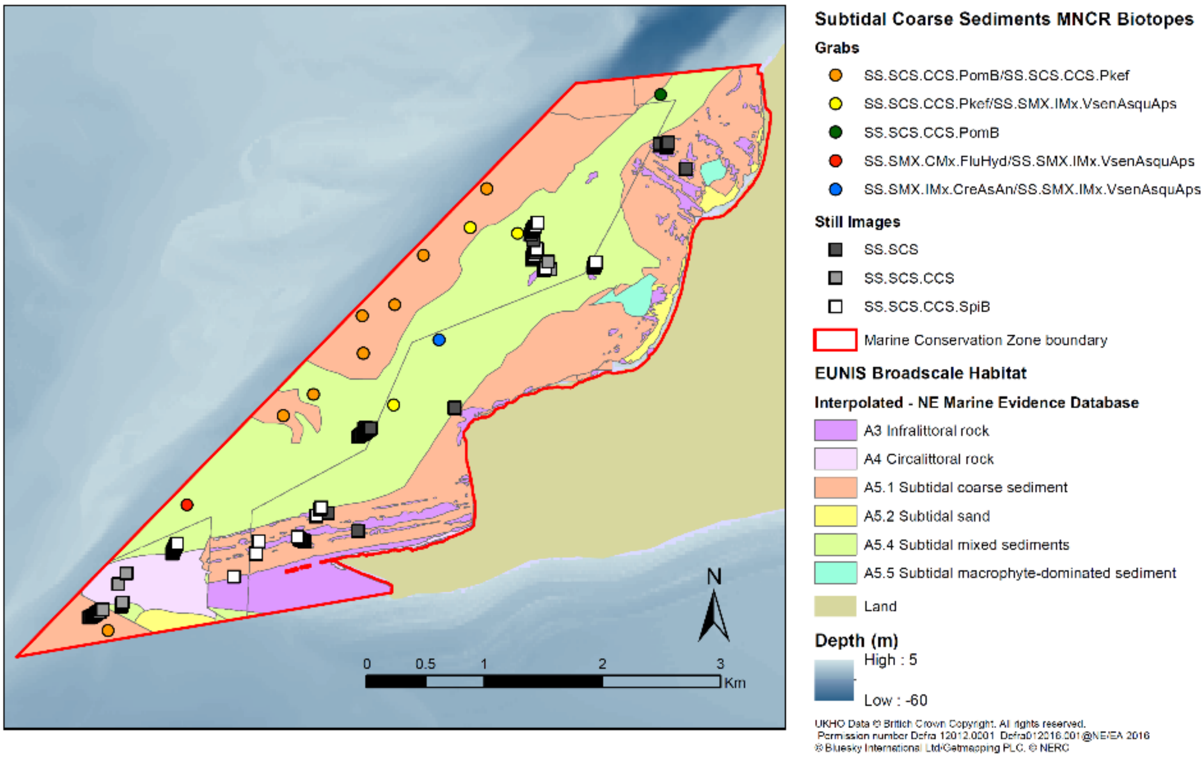


Figure 11. Distribution of biotopes (JNCC, 2015) recorded in the 'A5.1 Subtidal coarse sediment' BSH in the 2018 survey of The Needles MCZ. Grab samples are indicated by circles and drop camera imagery data are indicated by squares.

A5.2 Subtidal sand

Five infaunal samples were assigned to the ‘A5.2 Subtidal sand’ BSH in 2018 (Table 4). Mean (± standard error) sand content within this BSH was 97.6 ± 1.1%. Mud (2.2 ± 1.1%) and gravel (0.2 ± 0.1%) sediment were less common. Samples from this BSH were less diverse than other broadscale habitats recorded in this MCZ. A total of 61 taxa were recorded out of a total of 447 taxa recorded across all sedimentary BSHs (14% of all taxa recorded in grab samples).

Infaunal assemblages within this biotope were dominated by polychaetes belonging to Families Spionidae and Oweniidae. Amphipods belonging to Family Ampeliscidae and bivalve molluscs were also commonly recorded. These taxa are all common to shallow sandy habitats in the UK. Mean assemblage similarity (SIMPER) of samples within this BSH was 41.2%. The most abundant taxon was the polychaete *Galathowenia oculata* which accounted for 16.5% of individuals recorded in this BSH. The polychaete *Spiophanes bombyx* and the bivalve *Nucula nitidosa* were second and third most abundant, respectively (15.9% and 14.8% of individuals, respectively). These taxa are common to all British coasts and are commonly found in fine sandy habitats. These taxa can be considered as important contributors to ecosystem function. *G. oculata* and *S. bombyx* dwell in tubes constructed of sediment and are deposit and suspension feeders. As such, these taxa have influence on the cycling of materials and energy both within the benthos (through deposit feeding) and via benthic-pelagic coupling (through feeding on suspended matter). The construction of tubes contributes to habitat heterogeneity. As described in Section 0, the rapid dispersal of taxa such as *N. nitidosa* means that these taxa are able to rapidly colonise following disturbance and so are often associated with naturally changeable and anthropogenically-disturbed habitats (de Juan *et al.*, 2007). The sand mason worm *Lanice conchilega* was also recorded within this BSH. This taxon can be considered a potentially key contributor to ecosystem function, serving to stabilise mobile sediments, thus increasing habitat heterogeneity (JNCC, 2015).

The five samples gathered within this BSH were assigned to three SIMPROF groups (groups *a, b* and *c*). These samples were located in shallow (mean ± SE depth 4.96 ± 1.3 m) habitats in the east of the MCZ (Figure 9). All three SIMPROF groups were assigned to a single biotope: SS.SSA.CMuSa.AalbNuc/SS.SSA.IMuSa.FfabMag (*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment/*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand) (Figure 12, Figure 13). This biotope mosaic is indicative of a moderately exposed physical environment with weak to moderately strong tidal streams (JNCC, 2015).

Only a single sample from this BSH was recorded in 2014. As such statistical assessment of change between the two sampling events is not possible.

Sixteen taxa were recorded within still images assigned to the ‘A5.2 Subtidal sand’ BSH. Brittlestars (Genus *Ophiura*) were recorded in 41% of images assigned to this

BSH. Unidentified worm mounds were also commonly observed (25% of images). Seagrasses were recorded in 31% of images.

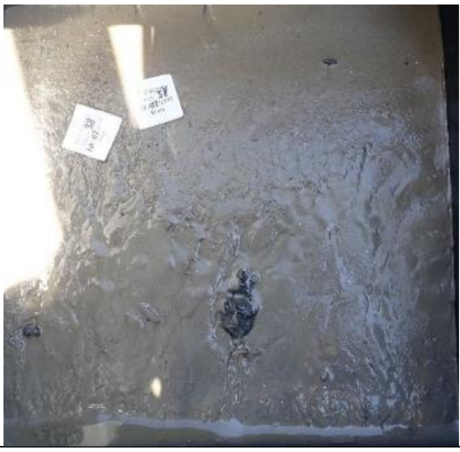
A5.2 Subtidal sand
SS.SSA.CMuSa.AalbNuc/SS.SSA.IMuSa.FfabMag (n = 5) ***Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment/ *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand**


Figure 12. Example image of Mini-Hamon Grab samples associated with the 'A5.1 Subtidal coarse sediment' BSH collected in The Needles MCZ 2018 survey (© Environment Agency and Natural England 2018).

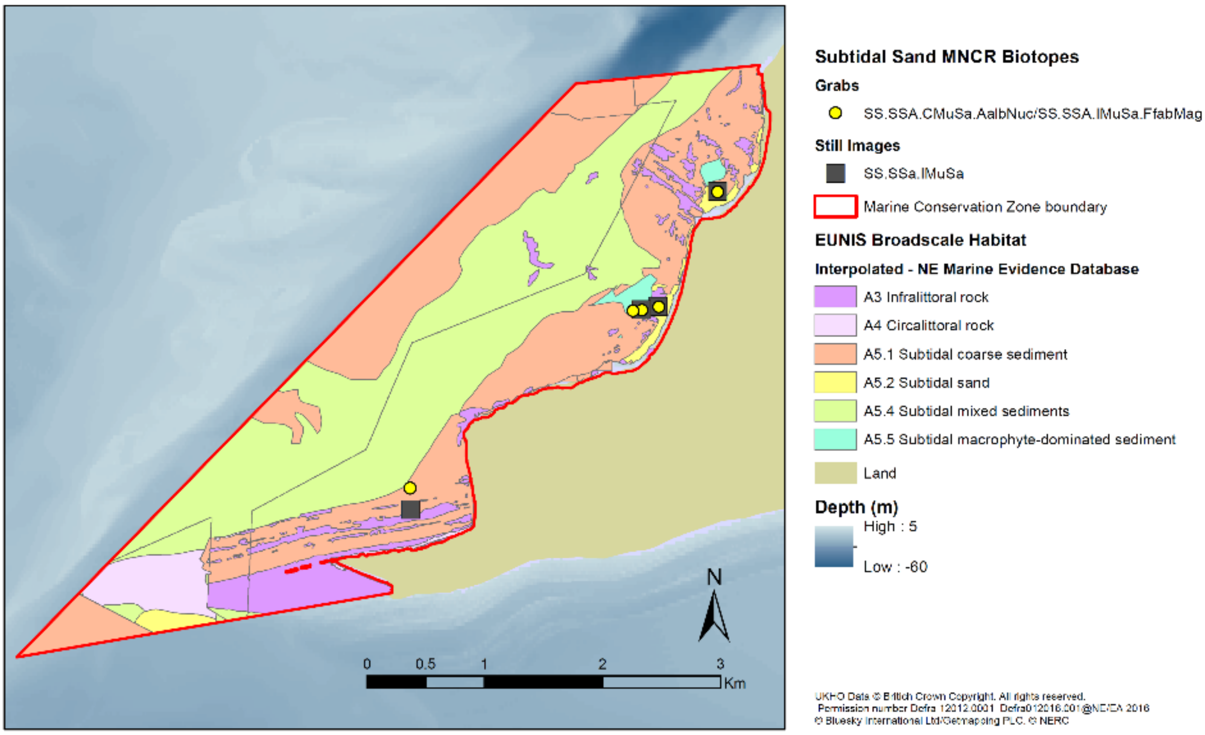


Figure 13. Distribution of biotopes recorded in the 'A5.2 Subtidal sand' BSH in the 2018 survey of The Needles MCZ. Grab samples are indicated by circles and drop camera imagery data are indicated by squares.

A5.3 Subtidal mud

Two infaunal samples were assigned to the 'A5.3 Subtidal mud' BSH in 2018 (Table 4). Mean (± standard error) sediment compositions within this BSH were dominated by muds (49.7 ± 17.0%) and sands (48.2 ± 17.1%), with relatively small proportions of gravel (2.1 ± 0.2%). Samples from this BSH contained at least one occurrence of 74 of the 447 taxa recorded across all sedimentary BSHs (17% of all taxa recorded in grab samples).

Infaunal assemblages within this biotope were dominated polychaete worms belonging to the Orders Phyllodocida, Sabellida and Terebellidae. Ampeliscid and corophiid amphipods were also common. Combined, these taxa represented 46% of the fauna recorded in this BSH in 2018. These taxa are all common in UK waters and are often associated with muddy habitats. Mean assemblage similarity (SIMPER) of the two samples within this BSH was 6.5%. The amphipod *Ampelisca diadema* was the most abundant taxon within this BSH, accounting for 18% of faunal abundances. This species is typically associated with sandy and muddy sediments and is recorded around the coast of Britain.

SIMPROF analysis assigned assemblages within this BSH to two groups (groups *d* and *j*). These groups were allocated to two biotopes: group *d* was assigned to the biotope mosaic SS.SMU.ISaMu.AmpPlon/SS.SMX.IMx.VsenAsquAps (*Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud/ *Venerupis senegalensis*, *Amphipholis squamata* and

Apseudes latreilli in infralittoral mixed sediment). Group *j* was assigned to SS.SMX.IMx.VsenAsquAps (*Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment). Although assigned to the 'A5.3 Subtidal mud' BSH, both samples were assigned to biotopes fully, or partially associated with 'A5.4 Subtidal mixed sediments'. Both samples were characterised by either muddy sands (station NDLS115, group *d*) or sandy muds (station NDLS102, group *j*). This highlights one of the issues of working with biotopes (discussed in Section 4.4). A similar apparent anomaly was also observed in the 'A5.2 Subtidal sand' BSH (Section 0). These biotopes are considered to be indicative of relatively sheltered to moderately exposed physical environments (JNCC, 2015). Example images are provided in Figure 14 and the location of biotopes is given in Figure 15.

This BSH was not recorded in 2014. As such, no statistical comparison of diversity metrics between years is possible for this BSH. In addition, no still images were assigned to this BSH.

A5.3 Subtidal mud	
SS.SMU.ISaMu.AmpPlon/ SS.SMX.IMx.VsenAsquAps (n = 1) ***Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment**	**SS.SMx.IMx.VsenAsquAps (n = 1)** ***Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment**
	

Figure 14. Example images of Mini-Hamon Grab samples associated with the 'A5.3 Subtidal mud' BSH collected in The Needles MCZ 2018 survey (© Natural England and Environment Agency 2022).

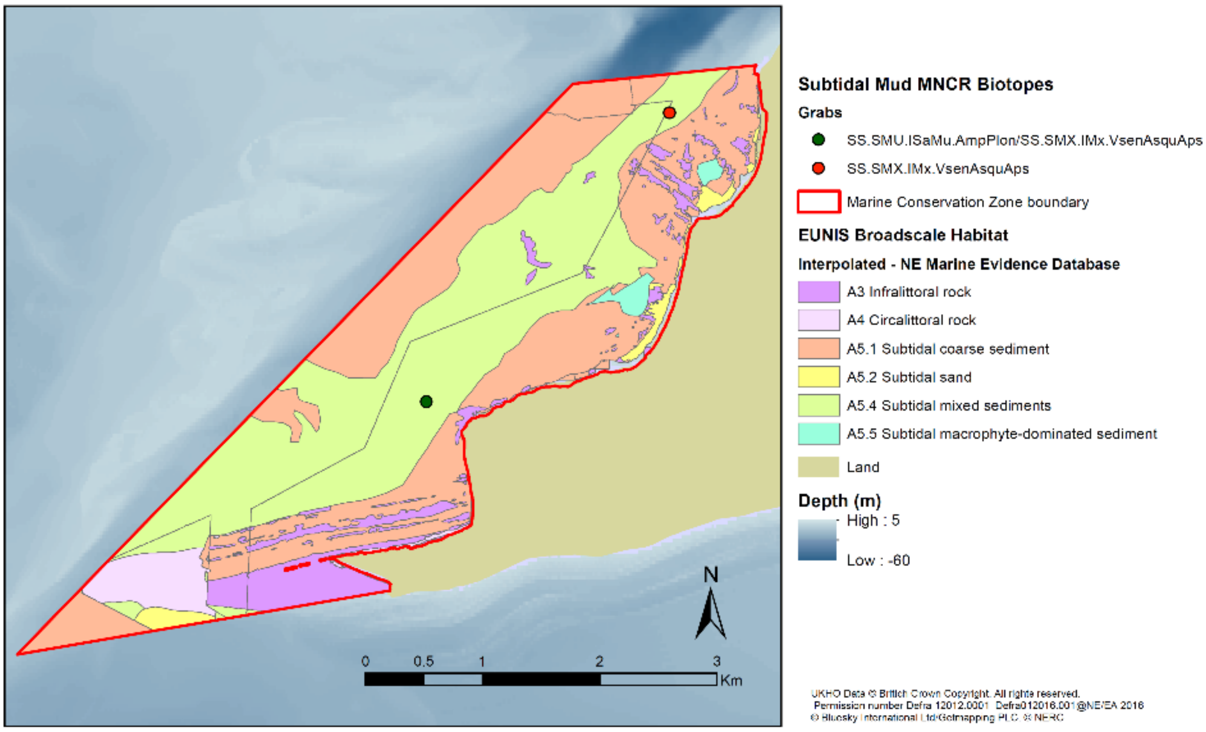


Figure 15. Distribution of biotopes (JNCC, 2015) recorded in the 'A5.3 Subtidal mud' BSH in the 2018 survey of The Needles MCZ.

A5.4 Subtidal mixed sediment

Twenty five infaunal samples were assigned to the 'A5.4 Subtidal mixed sediments' BSH (Table 4). Sands were the dominant sediments observed, with mean (± standard error) content of 45.2 ± 2.4%. Gravels (35.4 ± 3.2%) and mud (19.4 ± 2.6%) also made up a substantial proportion of sediments. Samples within this BSH were the most diverse assemblages recorded in 2018, containing at least one occurrence of 377 of the 447 taxa recorded across all sedimentary BSHs (84% of all taxa recorded in grab samples).

Assemblages in this BSH were characterised by polychaete worms, with a wide range of families represented. Tube-building sabellid polychaetes were very common, as were lumbrinerid, cirratulid and phyllodocid and polynoid polychaete taxa. In addition, a diverse array of amphipod taxa was recorded, including Corophiidae, Ischyroceridae, Unicolidae and Photidae.

Mean assemblage similarity (SIMPER) of samples within this BSH was 32.2%. The porcelain crab *Pisidia longicornis* was the most abundant taxon recorded in 2018, accounting for 16.4% of faunal abundances. The tube-building Ross Worm *Sabellaria spinulosa* was second most abundant, accounting 14.9% of faunal abundances. The acorn barnacle *Balanus crenatus* accounted for 12.1% of faunal abundance. All three taxa are typical of mixed sediments and all are widespread in British waters.

The majority of these samples were located in the central area of the MCZ and correlated well with the interpreted distribution of this habitat from previous work (Figure 9). PRIMER's SIMPROF routine assigned assemblages within this BSH into five distinct groups. SIMPROF group *h* was most common and was assigned to 17 of the 25 samples within this BSH. Four samples were assigned to group *e*, two samples were assigned to group *g* and one sample was assigned to each of groups *d* and *f*. Representative taxa of each SIMPROF group is provided in Table 6.

These five SIMPROF groups were assigned to four biotopes. Example images are provided in Figure 16 and the distribution of biotopes given in Figure 17. The most commonly assigned biotope within this BSH was the biotope mosaic SS.SMX.IMx.CreAsAn/SS.SBR.PoR.SspiMx/SS.SMX.IMx.VsenAsquAps (*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Sabellaria spinulosa* on stable circalittoral mixed sediment/ *Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment). This biotope was assigned to 17 samples and is indicative of a sheltered or moderately exposed physical environment with strong or moderately strong tidal streams (JNCC, 2015).

Four samples were assigned to the biotope mosaic SS.SMX.CMx.FluHyd/ SS.SMX.IMx.VsenAsquAps (*Flustra foliacea* and *Hydrallmania falcata* on tideswept circalittoral mixed sediment/*Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment) The combination of these two biotopes suggests a transition between a sheltered and a more exposed physical environment, with moderately strong tidal streams (JNCC, 2015).

Three samples were assigned to the biotope mosaic SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps (*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/*Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment). Again, these two biotopes suggest a transition between a sheltered and a more exposed physical environment (JNCC, 2015). Finally, one sample was assigned to the biotope mosaic SS.SMU.ISaMu.AmpPlon/ SS.SMX.IMx.VsenAsquAps (*Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud/*Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment).

Statistical comparisons were made to assess differences in univariate diversity metrics between the 2014 and 2018 surveys. Some caution is required when interpreting these analyses however, given that the 25 stations from this BSH recorded in 2018 were being compared against only the five samples recorded in 2014 (n = 3 for IQI values). Total faunal abundances and faunal biomasses were both significantly higher within the A5.4 BSH in 2018, compared with 2014. None of the other diversity metrics showed significant differences between survey years (Table 9).

Eleven taxa were recorded within still images assigned to the ‘A5.4 Subtidal mixed sediments’ BSH. Unidentified foliose red algae were the most commonly recorded epibiota, recorded in 89% of images assigned to this BSH. Unidentified animals were recorded in 67% of images and the sand mason worm *Lanice conchilega* was observed in 44% of images within this habitat.

Table 9. Summary of Mann-Whitney analyses comparing differences in diversity metrics between two sampling events within the 'A5.4 Subtidal mixed sediments' BSH in The Needles MCZ (© Natural England and Environment Agency 2022). Diversity metrics are based on infaunal abundances sampled in 0.1 m^2 Mini-Hamon Grabs in 2014 and 2018[1]. The *Difference* refers to the group median value from 2018 subtracted from that from 2014 (as such, positive values indicate that 2014 > 2018). Significant metrics (α = 0.05) are indicated in bold.

	Taxon abundance	**Taxon richness**	**Biomass**	**Simpson's λ**	**IQI**	**Hill's N1**
Difference	-517	-40	-20.62	6.9×10^{-3}	0.016	-4.6
CI for difference	-1196, -64	-79, 7	-51.97, -1.97	-0.07, 0.10	-0.12, 0.14	-11.34, 11.19
W statistic	37	45	37	81	48	66
P	**0.03***	0.075	**0.026***	0.867	0.766	0.540
[1]n = 5 for 2014 and n = 25 for 2018, except for IQI: n = 3 for 2014, n = 25 for 2018			*p<0.05; **p<0.01			

A5.4 Subtidal mixed sediments	
SS.SMX.IMx.CreAsAn/ SS.SBR.PoR.SspiMx/ SS.SMX.IMx.VsenAsquAps (n = 17) ***Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Sabellaria spinulosa* on stable circalittoral mixed sediment/ *Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment**	**SS.SMX.CMx.FluHyd/SS.SMX.IMx.VsenAsquAps (n = 4)** ***Flustra foliacea* and *Hydrallmania* falcata on tideswept circalittoral mixed sediment/ *Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment**
	
SS.SMX.IMx.CreAsAn/ SS.SMX.IMx.VsenAsquAps (n = 3) ***Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment/ *Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment**	**SS.SMU.ISaMu.AmpPlon/ SS.SMX.IMx.VsenAsquAps (n = 1)** ***Ampelisca spp., Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud/ *Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment**
	

Figure 16. Example images of Mini-Hamon Grab samples associated with the 'A5.4 Subtidal mixed sediments' BSH collected in The Needles MCZ 2018 survey (© Environment Agency and Natural England 2018).

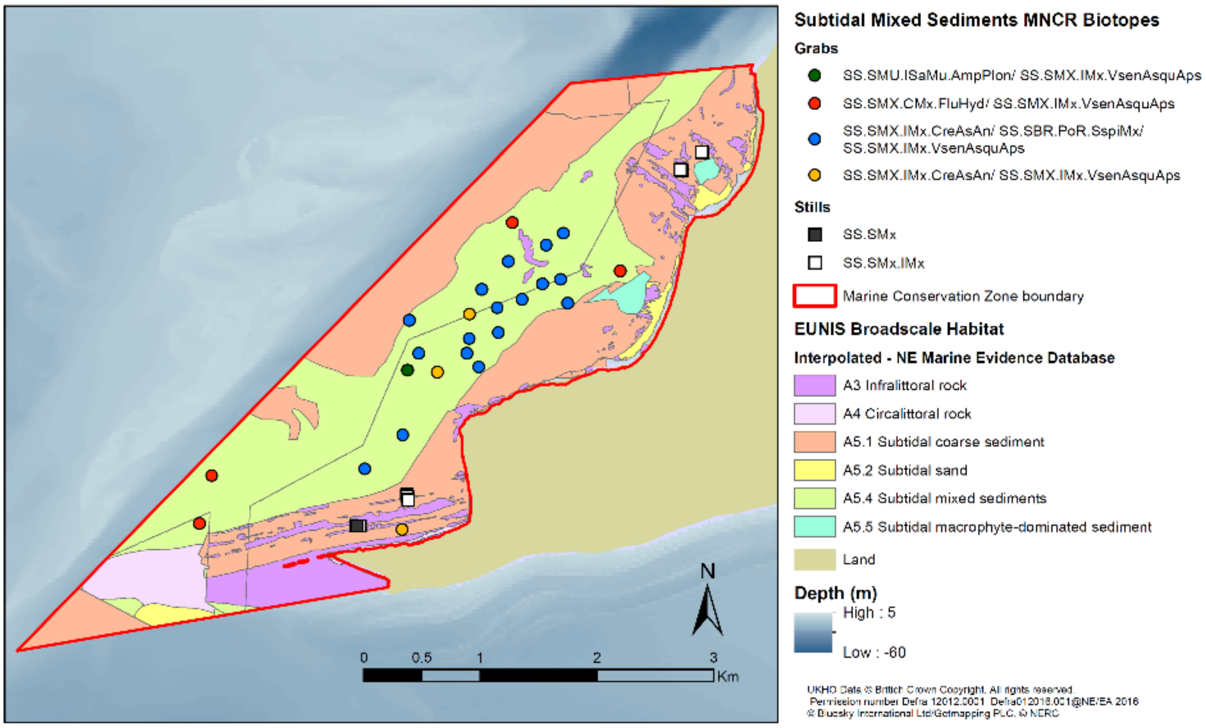


Figure 17. Distribution of biotopes (JNCC, 2015) recorded in the 'A5.4 Subtidal mixed sediments' BSH in the 2018 survey of The Needles MCZ. Grab samples are indicated by circles and drop camera imagery data are indicated by squares.

3.4 Subtidal Rock BSH: physical structure and biological communities

The drop camera survey area incorporated areas of infralittoral and circalittoral rock in both high and moderate energy environments. A total of 70 videos and 508 still images were analysed for The Needles MCZ. The subtidal rock survey area within The Needles MCZ was characterised by heavily silted bedrock and boulder reef with sediment infill (O'Dell, 2019). Video data from The Needles MCZ 2018 survey was considered to be of 'very poor' quality for 65 samples (defining each video tow as a sample), with the remaining five samples being categorised as 'poor' due to low visibility. During the video survey, the seabed was only visible when the camera gear landed on the substrate to capture still images in the majority of cases (O'Dell, 2019). As described in the NMBAQC guidance (Turner *et al*., 2016) little quantitative information can be derived from 'poor' quality (or worse) video imagery. As such, only the still imagery data is included in the following assessments. A breakdown of the issues encountered with video image quality is provided in Section 0.

Similar to the video data, 53% (n = 269) of the still images analysed were considered to be of 'poor' quality; 29% (n = 149) of images were of 'good' quality; 14% (n = 72) were of 'very poor' quality and 4% (n = 18) were marked as 'zero' quality, indicating that the seabed was not visible either due to suspended sediments or the image recording only the water column. Images from which no fauna or flora could be identified were excluded from the following analyses. This resulted in 461 images which were retained for investigation of broadscale habitats in The Needles MCZ. A breakdown of the issues encountered with still image quality is provided in Section 0

The poor quality of image data meant that many taxa could not be identified to species level and many individuals were only able to be identified to a high taxonomic, or descriptive/morphological level (e.g. 'unidentified faunal turf', 'Porifera (encrusting)'). None of the taxa recorded in 'very poor' still and video data were enumerated and were recorded as presence/absence only.

The poor image quality from the 2018 survey means that it is difficult to gain considerable insight into the ecology and the physical and biological structure of subtidal rock habitats in The Needles MCZ. It also meant that the taxonomic data required extensive truncation to avoid the potential duplication of taxa. As such, the interpretation of these data is necessarily high-level. To facilitate comparisons of imagery data and as recommended under NMBAQC guidance (Turner *et al.*, 2015), all data were transformed to presence-absence data before analysis. The NMBAQC guidance highlights that statistical comparisons of data from low quality images is problematic (Turner *et al.,* 2016). As such, statistical comparisons of taxon diversity between BSHs were made using taxon richness values only to exclude the influence of abundance. Interpretation of these analyses is necessarily high-level.

Different rocky BSHs showed statistically significant differences in the number of taxa recorded per sample image (Kruskal-Wallis, $H = 45.7$, $df = 3$, $P < 0.001$). Images captured within the undesignated ‘A4.1 High energy circalittoral rock’ BSH had significantly higher taxon richness values than those in ‘A3.1 High energy infralittoral rock’, ‘A3.2 Moderate energy infralittoral rock’ and ‘A4.2 Moderate energy circalittoral rock’.

Distribution of broadscale habitats were broadly similar between 2014 and 2018 and these correlated well with the interpreted BSH map (Figure 18). Initial comparisons of diversity between 2014 and 2018 suggest that assemblages were more diverse in 2018 than those surveyed previously (Figure 19). It was intended for comparisons to be made between assemblages surveyed in 2014 with those surveyed in 2018. However, as with the 2018 data, the quality of imagery data gathered in 2014 was also not ideal. Only 43% of images captured in 2014 were of ‘adequate’ quality, with the remaining 57% either ‘poor’ or ‘inadequate’. Given the coarse resolution and low quality of these data, there would be little confidence in any statistical comparisons between survey years and using these data to assess change would not be meaningful. In fact, the NMBAQC guidance recommends against analysing ≤ ‘poor’ quality imagery data (Turner *et al.,* 2016). As such, any management decisions, including the assignment of MCZ condition, must be taken with appropriate degree of caution.

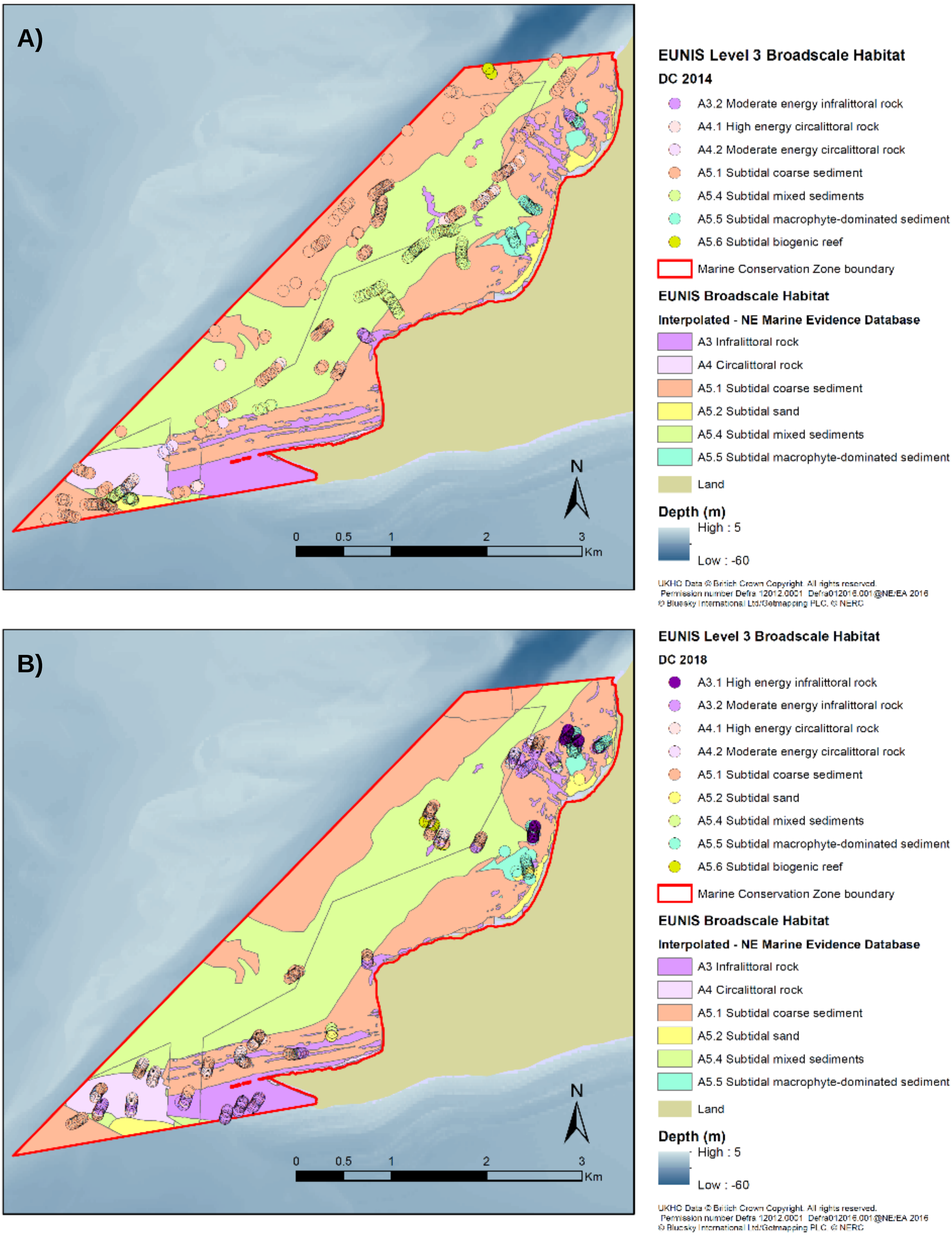


Figure 18. Distribution of BSH recorded in drop camera surveys in The Needles MCZ in A) 2014 and B) 2018. In both images, still image locations overlay the interpreted habitat map based on the 2014 data (Mylroie *et al*., 2015).

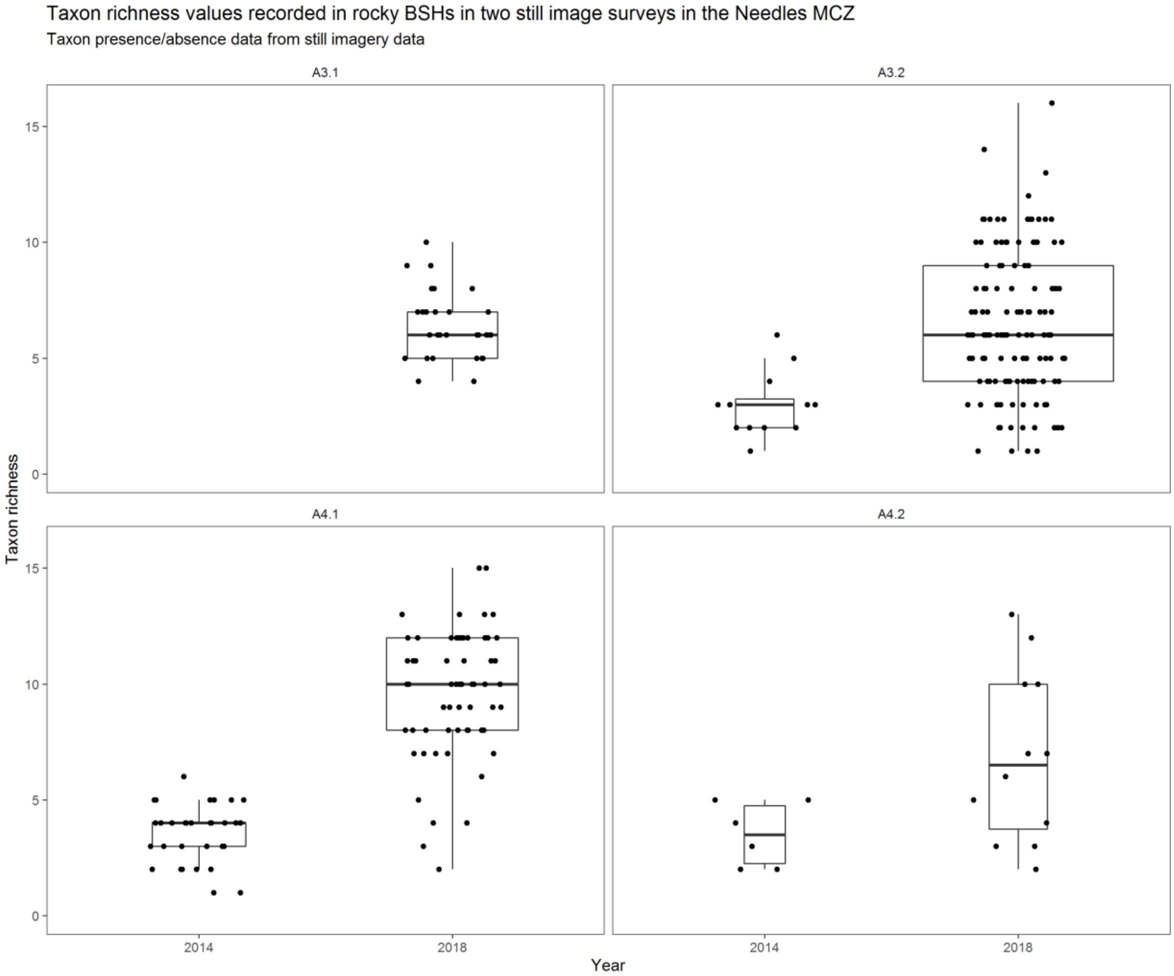


Figure 19. Taxon richness values in still images during for the 2014 and 2018 surveys of The Needles MCZ (© Natural England and Environment Agency 2022). Each plot facet displays data from one of the four rocky BSHs recorded in the survey work. Raw values are overlain as points. Some random noise has been added to the horizontal placement of the data points to allow visualisation of discrete data.

Image quality

As highlighted in Section 3.4, many of the still and video imagery data were difficult to interpret and were considered to be of less than good quality. This section summarises the comments relating to image quality recorded during the interpretation of the imagery data. For the still image quality data, comments for images recorded as less than 'adequate' (i.e. 'inadequate', 'poor', 'very poor' and 'zero' image quality) were extracted from the survey assessment results. For the video data, comments for all data were used as all tows were considered to be less than 'adequate' quality (i.e. 'inadequate', 'poor' and 'very poor'). For both sets of comments, comments on image quality were assigned to one or more broad categories:

- Blurred – relating to the focussing of images;
- Exposure and/or lighting – relating to over- or under-exposed images and image lighting;

- Positioning of camera or equipment – relating to distance of camera to seabed, direction of lens, apparent speed of tows (for video data);
- Visibility – general comments relating to visibility, including suspended particulate matter interfering with interpretation of images;
- Miscellaneous – comments relating either to other factors affecting image quality (e.g. large algal fronds obscuring the benthos), or comments difficult to directly assign to a category;
- General notes – notes that provide general comment, but do not necessarily provide insight to image quality issues.

Individual images could be assigned to more than one category as required. It should be noted that the comments within both the still and video image data sets are reported in an ad hoc manner and so interpretation of these comments is necessarily imprecise. However, this does provide some insight into the main issues within the imagery data.

The most commonly-reported issues across both the still and video images were those relating to visibility. Visibility issues were reported in 46% of lower quality still images and in 82% of lower quality video images (Table 10).

For video data, only one other issue was recorded and this alluded to the positioning of camera equipment and the speed of tows. This issue was recorded in 18% of video samples.

A broader range of issues was reported for still imagery data. Aside from general issues of visibility, which accounted for 46% of issues, comments potentially indicative of issues related to camera settings were also common. In particular were issues relating to lighting and positioning of camera equipment (Table 10).

Table 10. Summary of issues recorded as comments for less than 'adequate' images in still and video imagery data in 2018 (© Natural England and Environment Agency 2022). Values are expressed as the percentage of less than 'adequate' images for which each issue was assigned. Some images were assigned to more than one issue.

Issue	Still imagery %	Video imagery %
Blurred	12.96	0.00
Exposure & Lighting	17.85	0.00
Positioning	14.43	18.18
Visibility	46.21	81.82
Miscellaneous	5.13	0.00
General comments	3.42	0.00

A3.1 High energy infralittoral rock and A3.2 Moderate energy infralittoral rock

The 'A3.1 High energy infralittoral rock' BSH was recorded in 29 samples. This BSH was restricted to shallow waters (4.78 ± 1.0 m depth) in the north-east of the MCZ (Figure 21). Images from this BSH were assigned to four biotopes (Figure 21, Figure 22). The most common biotope was IR.HIR.Ksed (Sediment-affected or disturbed kelp and seaweed communities) (n = 15). This biotope was recorded in shallow waters (mean ± SD depth 5.14 ± 0.89 m) and is typically associated with bedrock and unstable rocky habitats, typically in the vicinity of coarse sediment habitats (JNCC, 2015). Red algae, brown algae and faunal turfs were commonly recorded within this biotope. Green algae were less commonly recorded. Conspicuous faunal taxa included arborescent Porifera, occurrences of scallops and sea spiders (Class Pycnogonida). A number (n = 13) of images could be assigned to a higher resolution derivative of this biotope: IR.HIR.KSed.DesFilR (Dense *Desmarestia* spp. with filamentous red seaweeds on exposed infralittoral cobbles, pebbles and bedrock). Occurrences of the scallop *P. maximus* were more frequent within this biotope as too were recordings of conspicuous ascidians ('Ascidian solitary') and green algae (Chlorophyta). This biotope is typically associated with rocky substrates in exposed conditions (JNCC, 2015).

The most commonly encountered rock habitats within The Needles MCZ 2018 seabed imagery survey was 'A3.2 Moderate energy infralittoral rock' (n = 131). Samples within this BSH were recorded within shallow waters (mean ± SD depth 8.11 ± 1.98 m). All samples recorded within this BSH were assigned to the IR.MIR.KR.XFoR biotope (Dense foliose red seaweeds on silty moderately exposed infralittoral rock) (Figure 20). This biotope is associated with bedrock, boulder and cobble habitats under moderately exposed conditions with moderately strong tidal streams (JNCC, 2015). Samples within this BSH were generally concentrated in two patches in the south and north-east of the MCZ (Figure 21). Images within this BSH were mostly of poor quality (62%), with fewer good (21%) and very poor (17%) quality images. This makes it difficult to describe the assemblages within this habitat in great detail and as such, quantitative analyses are not recommended for such images (Turner *et al.*, 2015). Within this habitat however, red algae (Rhodophyta) were frequently recorded as well as coverage of unidentified faunal turfs and sponges (Phylum Porifera). Individuals of the scallop *Pecten maximus* were also identified in a number of images.

Two more biotopes were recorded within this BSH, with one image assigned to each. IR.HIR.KSed.ProtAhn (*Polyides rotunda*, *Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock). This biotope is associated with coverage of red and brown seaweeds on sediment-covered rock in exposed physical environments (JNCC, 2015). This biotope tends to have few conspicuous faunal taxa. Likewise, the biotope IR.HIR.KFaR.FoR.Dic (Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock) is also found in exposed habitats, though is typically associated with a less mobile substrate than IR.HIR.KSed.ProtAhn (JNCC, 2015).

With both the A3.1 and A3.2 BSHs, the drop camera imagery data suggested the presence of the habitat FOCI 'Subtidal Chalk'. These are discussed in Section 3.6.

IR.MIR.KR.XFoR biotope (Dense foliose red seaweeds on silty moderately exposed infralittoral rock)


Figure 20. Example image of the biotope (JNCC, 2015) assigned to all still images within the 'A3.2 Moderate energy infralittoral rock' BSH in 2018 within The Needles MCZ (© Environment Agency and Natural England 2018).

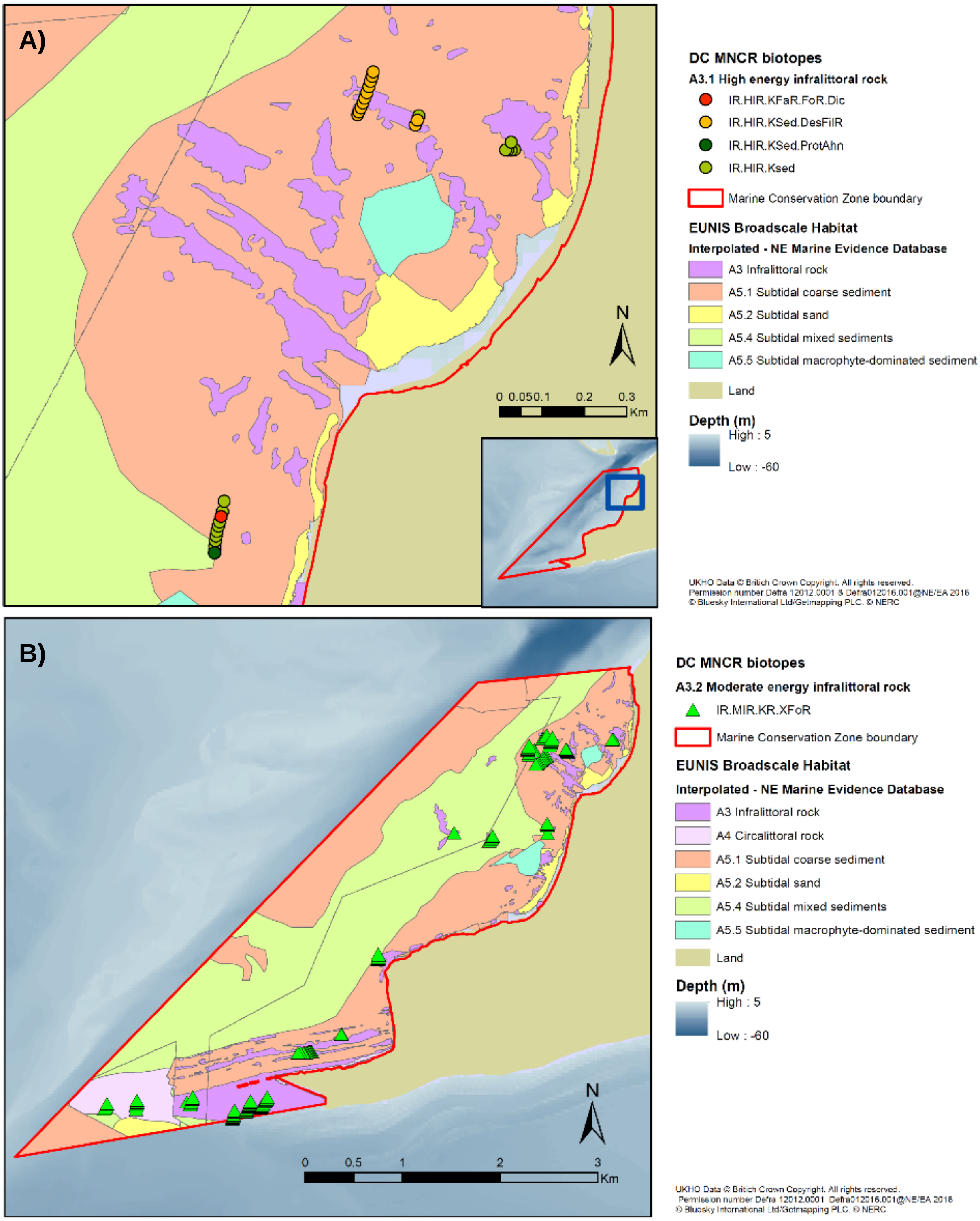


Figure 21. Distribution of biotopes (JNCC, 2015) recorded in infralittoral rock BSH during the 2018 drop camera survey of The Needles MCZ.A) 'A3.1 High energy infralittoral rock' (zoomed in to the north-east of the MCZ) and B) 'A3.2 Moderate energy infralittoral rock'.

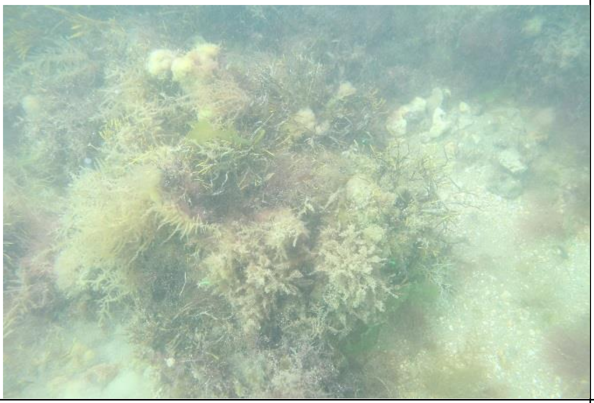
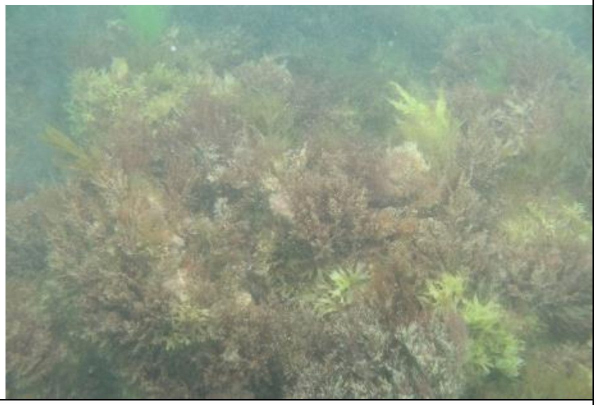
IR.HIR.Ksed (Sediment-affected or disturbed kelp and seaweed communities)	IR.HIR.KSed.DesFilR Dense *Desmarestia* spp. with filamentous red seaweeds on exposed infralittoral cobbles, pebbles and bedrock
	
IR.HIR.KSed.ProtAhn (*Polyides rotunda*, *Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock)	**IR.HIR.KFaR.FoR.Dic (Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock)**
	

Figure 22. Example images of the four biotopes (JNCC, 2015) recorded within the 'A3.1 High energy infralittoral rock' BSH acquired in the 2018 drop camera survey of The Needles MCZ (© Environment Agency and Natural England 2018).

A4.2 Moderate energy circalittoral rock'

'A4.2 Moderate energy circalittoral rock' was recorded in 12 still images. The majority of records of this BSH were in the north of the MCZ (Figure 23), with a mean ± SD depth of 11.30 ± 5.88 m. The majority of images within this BSH (n = 11) were assigned to the CR.MCR.SfR (soft rock communities) biotope (Figure 24). This biotope was recorded in areas where Subtidal Chalk was apparent and there were indications of piddock (Family Pholadidae) burrows in the substrate. This biotope characterised the 'Subtidal Chalk' habitat FOCI (see Section 3.6). In addition, small patches of seagrass were recorded intermittently in a number of images within this biotope. However as these patches typically consisted of individual or a small number of plants, these patches were too small to define a seagrass bed and so did not characterise the designated habitat FOCI 'Seagrass Beds'. Unidentified faunal turfs, and erect bryozoans (family Flustridae), various sponge growth forms (Phylum Porifera) and red algae were also recorded in a number of images within this biotope. One image was classified as the CR.MCR.CSab.Sspi (*Sabellaria spinulosa* encrusted circalittoral rock) biotope. This biotope characterised the non-designated habitat FOCI Ross Worm (*Sabellaria spinulosa*) reefs (Section 3.6).

Both of the biotopes recorded within the A4.2 BSH are associated with moderately exposed environments (JNCC, 2015).

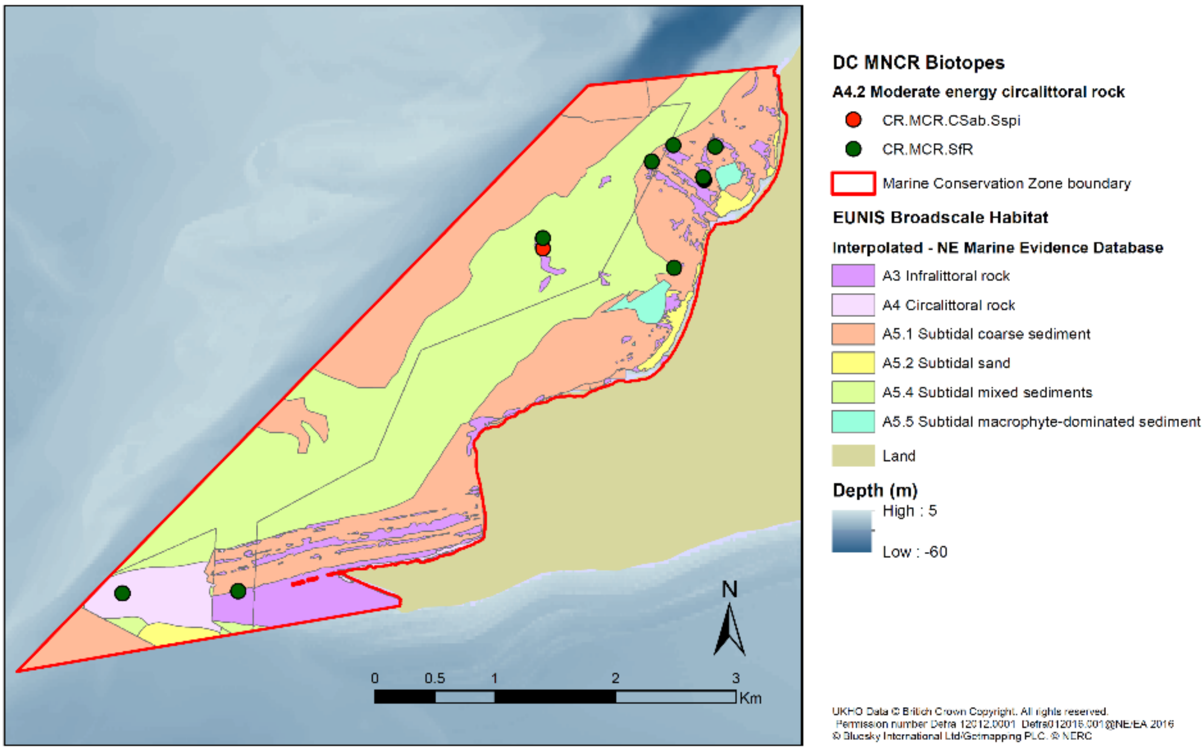


Figure 23. Distribution of biotopes (JNCC, 2015) recorded in the 'A4.2 Moderate energy circalittoral rock' BSH during the 2018 drop camera survey of The Needles MCZ.

CR.MCR.CSab.Sspi (*Sabellaria spinulosa* encrusted circalittoral rock)	**CR.MCR.SfR (Soft rock communities)**
	

Figure 24. Example images of the two biotopes (JNCC, 2015) recorded within the 'A4.2 Moderate energy circalittoral rock' BSH acquired in the 2018 drop camera survey of The Needles MCZ (© Environment Agency and Natural England 2018).

3.5 Non-targeted habitats

In addition to the seven designated broadscale habitat features that were recorded in the infaunal and imagery survey (Table 1), a number of images were also allocated to non-designated broadscale habitats that were not specifically targeted by the survey design.

A number of images (n = 66) were captured of the ‘A5.5 Subtidal macrophyte-dominated sediment’ BSH. This habitat was located in shallow near-shore waters in the east of the MCZ (Figure 25). The deeper-lying examples of this BSH were characterised by the algae dominated SS.SMp.KSwSS Kelp and seaweed communities on sublittoral sediment biotope (Figure 26). Near-shore examples were characterised by the presence of seagrass meadows (*Zostera marina*) (Figure 29). These stations were assigned to the biotope SS.SMp.SSgr.Zmar *Zostera marina* beds on lower shore or infralittoral clean or muddy sand[9]. Although not designated as a specific broadscale habitat within The Needles MCZ, seagrasses are a designated habitat FOCI (‘Seagrass Beds’, see Section 3.6).

In addition to macrophyte and algae dominated sediments, ‘A5.6 Subtidal biogenic reefs’ BSH was also recorded (Figure 32) defined by the presence of the reef-forming species the Ross Worm, *Sabellaria spinulosa*. Predominantly, this was located in the central area in the north of the MCZ (Figure 25). Whilst *S. spinulosa* reefs are habitat FOCI, The Needles MCZ is not designated for this BSH. The 14 images which recorded this BSH were divided according to the underlying substrate with reefs atop mixed sediments (64%) more common than those on rock habitats (36%).

The second most commonly recorded rock habitat in The Needles MCZ 2018 seabed imagery survey was the undesignated ‘A4.1 High energy circalittoral rock’ (n = 62) BSH. Most images (56%) in this BSH were of poor or very poor quality. The remaining images (44%) were of good quality. This BSH was most commonly recorded in the south of the MCZ, with smaller numbers in the north (Figure 25). Mean ± SD depth of this BSH was 15.0 ± 3.1 m. Within this BSH, the majority of images (n = 57) were assigned to the CR.HCR.XFa (Mixed faunal turf communities) biotope (Figure 26). Unidentified faunal turfs were commonly recorded within this biotope in addition to large, encrusting and arborescent sponges. The remaining images were assigned to derivatives of this biotope. Three images were assigned to a mosaic between CR.HCR.XFa and CR.HCR.XFa.SpNemAdia (Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata), due to the relatively high occurrence of sponge taxa (Phylum Porifera). Two images were assigned to CR.HCR.XFa.FluCoAs (*Flustra foliacea* and colonial ascidians on tideswept moderately wave-exposed circalittoral rock). This habitat was characterised by solitary anemones and conspicuous bryozoans of the family Flustridae.

[9] Note that the biotope name refers to *Zostera marina/angustifolia*, however *Z. angustifolia* is considered an unaccepted synonym of *Z. marina*.

The survey imagery from the A4.1 BSH contained examples of the non-designated habitat FOCI Ross Worm (*Sabellaria spinulosa*) Reefs. These are discussed further in Section 3.6.

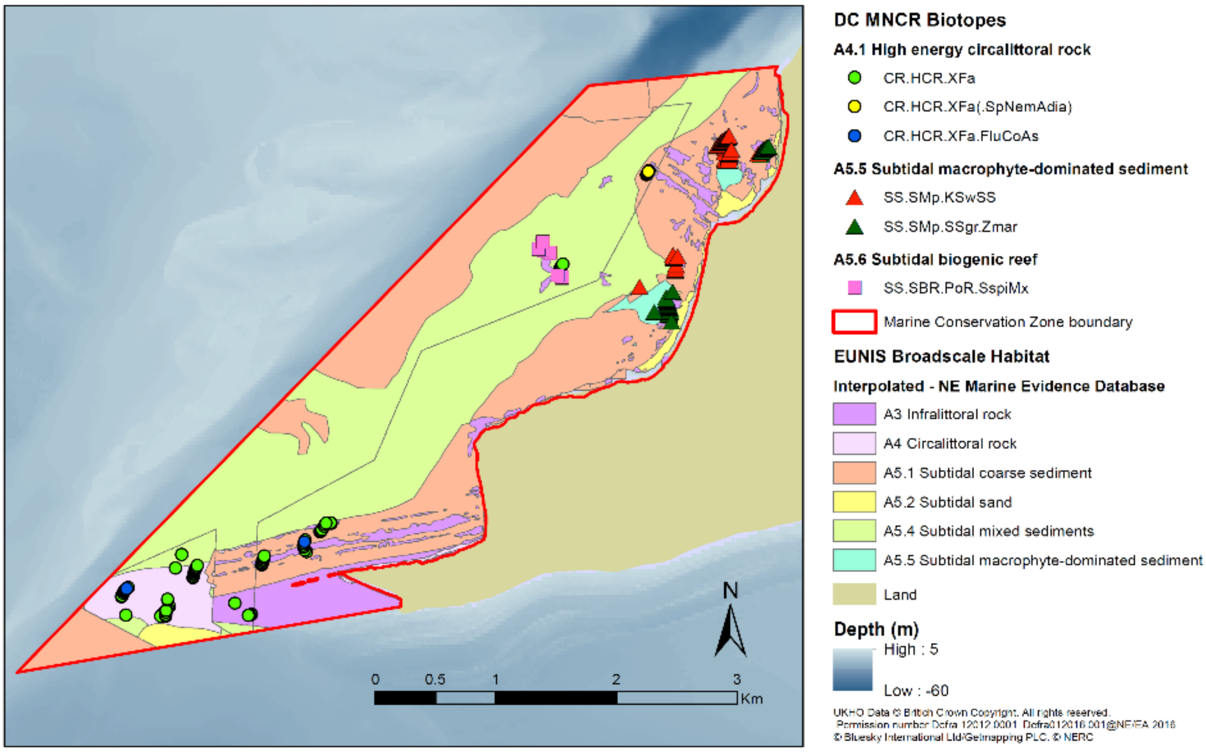


Figure 25. Distribution of biotopes (JNCC, 2015) observed within undesignated BSHs during the 2018 drop camera survey of The Needles MCZ data. Background polygons are the modelled BSHs taken from the Marine Evidence database and those interpreted from acoustic survey data (Mylroie *et al*., 2015).

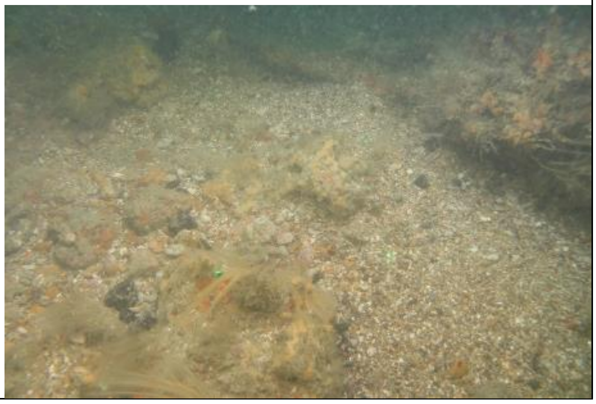
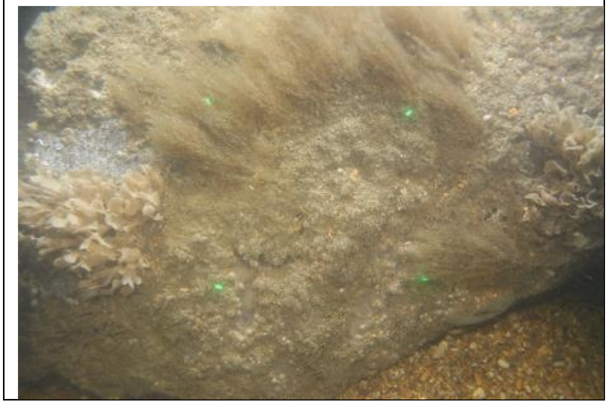
CR.HCR.XFa (Mixed faunal turf communities)	**CR.HCR.XFa(.SpNemAdia) (Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata)**
	
CR.HCR.XFa.FluCoA (*Flustra foliacea* and colonial ascidians on tideswept moderately wave-exposed circalittoral rock)	
	

Figure 26. Example images of the three biotopes (JNCC, 2015) recorded within the 'A4.1 High energy circalittoral rock' BSH acquired in the 2018 drop camera survey of The Needles MCZ (© Environment Agency and Natural England 2018).

3.6 Habitat Features of Conservation Importance (FOCI)

One aim of the survey conducted in 2018 was to record the presence and distribution of Habitat Features of Conservation Importance. Although seabed imagery data were compromised by low visibility conditions, habitats indicative of habitat FOCI were identified at a number of stations (Figure 27).

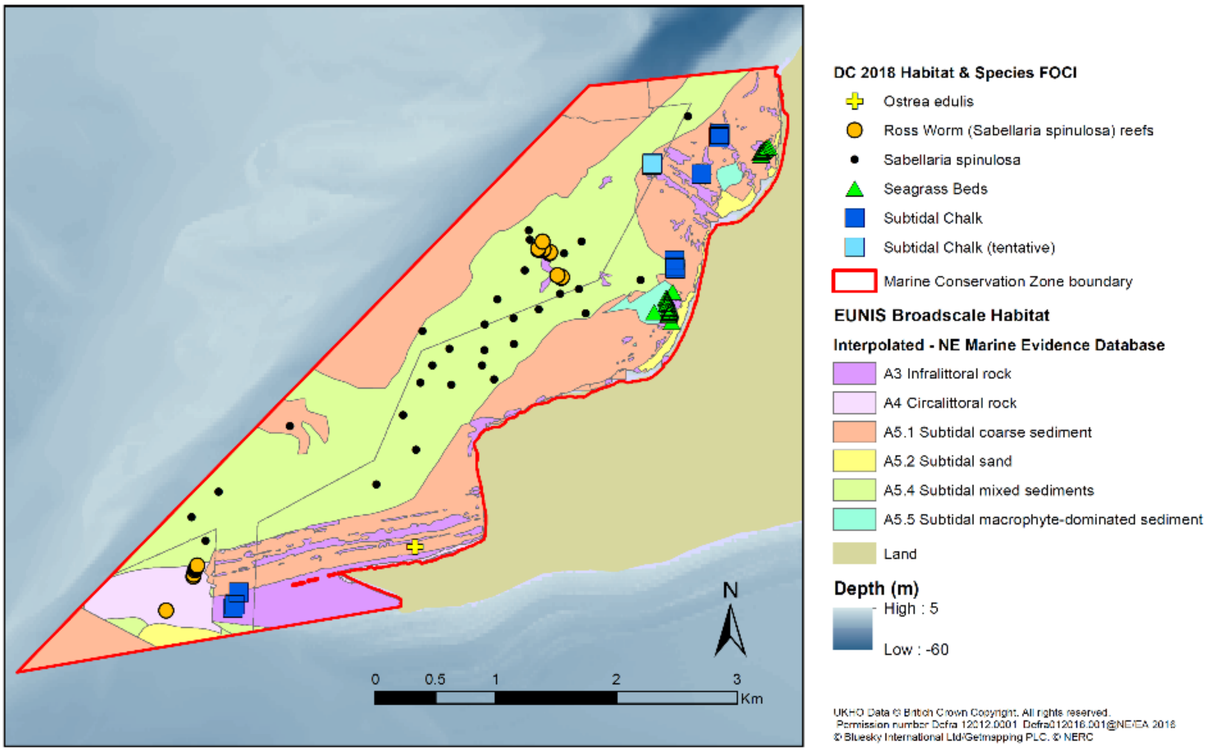


Figure 27. Distribution of designated and undesignated habitat and species FOCI recorded from drop camera data in The Needles MCZ in 2018.

Subtidal Chalk (designated habitat FOCI)

Habitat indicative of the Subtidal Chalk habitat FOCI was recorded at 15 stations (Figure 27, Figure 28). Due to poor image quality, two of these records were marked as tentative only. The survey narrative (O'Dell, 2019) indicated that chalk habitats typically acted as substrates over which silt and sediment-influenced communities were observed. Where exposed chalk bedrock and associated piddock boreholes were recorded in the imagery survey, the CR.MCR.SfR (soft rock communities) biotope was recorded.

Figure 28. Still image of the Subtidal Chalk habitat FOCI recorded in The Needles MCZ in 2018 (© Environment Agency and Natural England 2018).

Seagrass Beds (designated habitat FOCI)

Although not specifically targeted by the 2018 surveys described here, the designated habitat FOCI Seagrass Beds was recorded at 27 sampling locations in the drop camera survey (Figure 27, Figure 29). Seagrass meadows were located in near-shore stations in shallow waters (mean ± SD 4.5 ± 0.50 m depth) in the east of the MCZ (Figure 27). Where image quality allowed quantification of seagrass (*Zostera marina*) density, coverage was variable, ranging between <1% and 100% cover. Due to the poor quality of the survey images, overall bed size and density could not be estimated (O’Dell, 2019).

These Seagrass Beds were located around Totland Bay and Colwell Bay which were surveyed as part of a dedicated drop camera and echosounder seagrass survey (Green, 2019). The interpolated seagrass extents were 5.283 ha and 9.386 ha in Colwell Bay and Totland Bay, respectively (Figure 30). Mean canopy heights were 0.8 m in Totland Bay and 0.4 m in Colwell Bay (Figure 31).

Figure 29. Still image of the subtidal 'Seagrass Beds' habitat FOCI recorded in The Needles MCZ in 2018 (© Environment Agency and Natural England 2018).

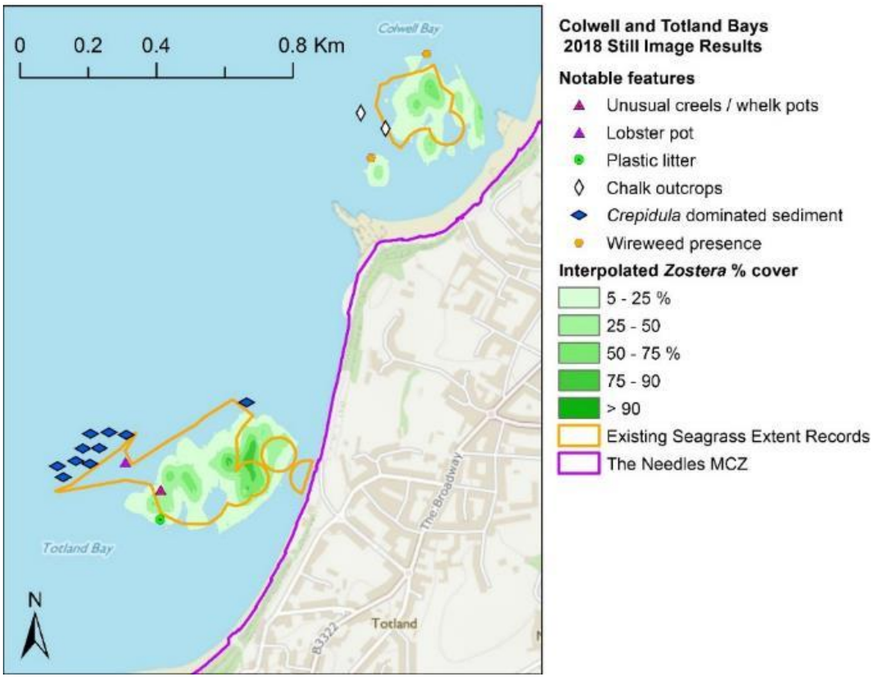


Figure 30. Seabed vegetation for Colwell Bay (top) and Totland Bay from visual assessment of drop camera stills from the 2018 seagrass survey. Image taken from Green, 2019.

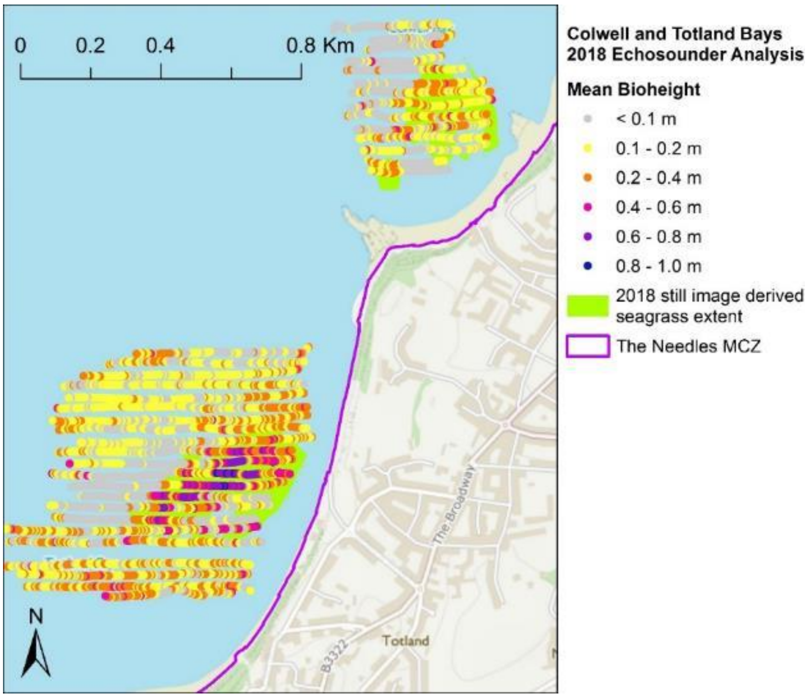


Figure 31. Seagrass canopy height (mean bioheight per 20 pings) measured using a BioSonics echosounder for the Colwell Bay (northern bed) and Totland Bay (southern bed) Seagrass Beds within The Needles MCZ. Image taken from Green (2019).

Sheltered Muddy Gravels (designated habitat FOCI)

The habitat FOCI Sheltered Muddy Gravels is a designated habitat feature of The Needles MCZ (Table 1). However, this habitat was not specifically targeted as part of the 2018 survey work. There is potential however that this habitat FOCI was observed in stations assigned to the ‘A5.4 Subtidal mixed sediment’ BSH (Section 0). Although the survey did not aim to identify this FOCI, the sediment properties of this BSH are qualitatively similar to what would be predicted within this habitat FOCI. That is, stations within the ‘A5.4 Subtidal mixed sediment’ BSH were associated with a mixture of gravel and mud sediments. Likewise the biotope SS.SMx.IMx.CreAsAn (*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment) is associated with this habitat FOCI (JNCC, 2014). A transition between SS.SMx.IMx.CreAsAn and two other biotopes (the SS.SBR.PoR.SspiMx and SS.SMX.IMx.VsenAsquAps biotopes) was recorded in grab samples in the central area of the MCZ (Figure 17).

Ross Worm (*Sabellaria spinulosa*) Reefs (undesignated habitat FOCI)

The undesignated habitat FOCI Ross Worm (*Sabellaria spinulosa*) Reefs was also recorded during the digital imagery survey (Figure 32). In addition, 31 Mini-Hamon Grab samples recorded the presence of *S. spinulosa*. Mean ± SD densities of *S. spinulosa* in grab samples were 85 ± 192 individuals per 0.1 m^2 grab with the maximum density being 987 individuals, recorded at station NDLS114 within an area characterised by the ‘A5.4 Subtidal mixed sediments’ BSH. As highlighted in Section 0, 17 samples were assigned to a biotope mosaic containing the biotope

SS.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment. There was insufficient information gathered on parameters such as the morphology, topography, extent and associated biodiversity of this habitat to define it as a Habitats Directive Annex I reef feature (Gubbay, 2007).

Figure 32. Still image of the Ross Worm (*Sabellaria spinulosa*) Reefs undesignated habitat FOCI recorded in The Needles MCZ in 2018 (© Environment Agency and Natural England 2018).

3.7 Species FOCI

The Needles 2018 MCZ survey was not designed to specifically identify the presence or distribution of any of the species FOCI designated within the MCZ. Observations of such species gathered by this sampling work would be expected to be low and absence of such taxa in the data should not be interpreted as a confirmed absence of these species FOCI from the site. However, the aim was to highlight any occurrences of the oyster *Ostrea edulis* recorded during the grab sampling. One individual of the species FOCI oyster *O. edulis* was recorded within a grab sample in 2018. This individual was recorded in the 'A5.4 Subtidal mixed sediments' BSH in the south-east of the MCZ (Figure 27). The single record of this designated species FOCI should not be used to infer the condition of *O. edulis* populations in The Needles MCZ. That the taxon was recorded at all is an indication that there is a population of this species in the vicinity of the MCZ.

Neither the Stalked Jellyfish *Calvadosia campanulata*, nor the Peacock's Tail *Padina pavonica* were recorded in the imagery or grab data. This should not be interpreted as an absence of these species FOCI from the site.

3.8 Non-indigenous species (NIS)

All taxa identified in The Needles MCZ 2018 survey were cross-referenced with the list of NIS compiled by Eno *et al.* (1997), the 49 non-indigenous target species identified for assessment of GES in UK waters under MSFD Descriptor 2 (Stebbing *et al.,* 2014; Annex 5) and the UK Technical Advisory Group impact list (WFD UK TAG, 2015). Multiple NIS taxa were recorded in The Needles MCZ in 2018, with occurrences recorded in most BSHs (Table 11). No NIS were recorded in the designated 'A4.2 Moderate energy circalittoral rock' or the undesignated BSH 'A5.6 Subtidal biogenic reef' BSHs. These are described below and their distributions plotted in Figure 33.

The barnacle *Austrominius modestus* is native to Oceania and has been recorded in UK waters since the 1940s (Global Invasive Species Database, 2020). This taxon was recorded in nine grab samples across three BSHs in 2018, with abundances ranging from 1 to 165 individuals per grab. Mean ± SD abundance within those grabs was 37.3 ± 59.3 individuals 0.1 m^2 grab. No observations of this taxon were made in the digital imagery data. This species was recorded in three grab samples in 2014, with a mean abundance of 7.7 ± 4.2 individuals per 0.1 m^2 grab.

The Asian tunicate *Styela clava* was recorded within four BSHs at 13 stations in 2018. One individual was recorded in the grab sampling data and 12 individuals were recorded across 12 still images. Observations were spatially distributed throughout the MCZ (Figure 33) and all observations were recorded as individual sightings, rather than multiple individuals at high densities. This species was not recorded in 2014.

The most widely distributed NIS recorded in 2018 was the slipper limpet *Crepidula fornicata*. This taxon has been established in UK waters since its introduction from North America in the late 1800s (Eno *et al.*, 1997). One sighting of this taxon was recorded during the still imagery survey. In addition, this taxon was also recorded in 28 grab samples (Figure 33). The highest density was within the 'A5.4 Subtidal mixed sediments' habitat at station NDLS051 where 111 individuals were recorded. Mean ± SD abundance of this species was 23.3 ± 29.7 individuals per 0.1 m^2 grab. This species was recorded in 13 grab samples in 2014, with mean abundances of 40.2 ± 67.5 individuals per 0.1 m^2 grab. *C. fornicata* was also recorded in 63 still images in 2014, with a mean percentage cover of 1.2 ± 7.5%.

The amphipod *Monocorophium sextonae* was recorded in 21 grab samples. The majority of sightings were in the 'A5.4 Subtidal mixed sediments' BSH (Table 11). This tube-building taxon is native to New Zealand and was introduced to the UK in the 1930s. Abundances ranged from 1 to 73 individuals, with a mean ± SD abundance of 13.2 ± 16.8 individuals per 0.1 m^2 grab. One individual of this species was recorded in a 2014 grab sample.

One individual each of the spionid polychaete *Pseudopolydora paucibranchiata,* indigenous to Japan and the Manila clam *Ruditapes philippinarum*, indigenous to Asia, was recorded in 2018. These were recorded in the 'A5.2 Subtidal sand' and 'A5.4 Subtidal mixed sediments' BSHs, respectively. Neither taxon was recorded in 2014.

The brown alga *Sargassum muticum* is native to the north-west Pacific and has been recorded in UK waters since the 1970s. This species was recorded at low densities (<1% to 3% cover) in 23 images and within five BSHs during the drop camera survey. This species was not recorded in 2014.

There was evidence of a further NIS in 18 still images captured in 2018 in the north-east of the MCZ and principally recorded in the 'A3.1 High energy infralittoral rock' BSH (Table 11, Figure 33). Within these data, a record was made of an unidentified red alga, which bore resemblance to *Bonnemaisonia hamifera*, ranging from <1% to 17% cover (mean ± SD 3.9 ± 4.8%). This taxon is native to the Pacific Ocean and was first recorded in the UK in 1890. Given the limitations of the imagery data, this identification is uncertain and it is difficult to confirm the identification of *B. hamifera* and there is the potential that more NIS were present during the imagery survey, but were not recorded due to poor visibility (O'Dell, 2019).

Table 11. Sightings of non-indigenous species recorded in (BSHs) in 2018 in The Needles MCZ. Designated BSHs are in bold.

Taxon	**A3.1**	**A3.2**	A4.1	**A5.1**	**A5.2**	**A5.3**	**A5.4**	A5.5
Austrominius modestus	-	-	-	4	-	1	4	-
Crepidula fornicata	-	-	-	7	1*	-	21	-
Monocorophium sextonae	-	-	-	2	-	-	19	-
Pseudopolydora paucibranchiata	-	-	-	-	1	-	-	-
Ruditapes philippinarum	-	-	-	-	-	-	1	-
Sargassum muticum	9	3	1	1	-	-	-	9
Styela clava	-	6	4	2	-	-	1	-
U red algae cf. *Bonnemaisonia hamifera*	13	1	-	-	-	-	-	4

*shell material only. Uncertain if empty

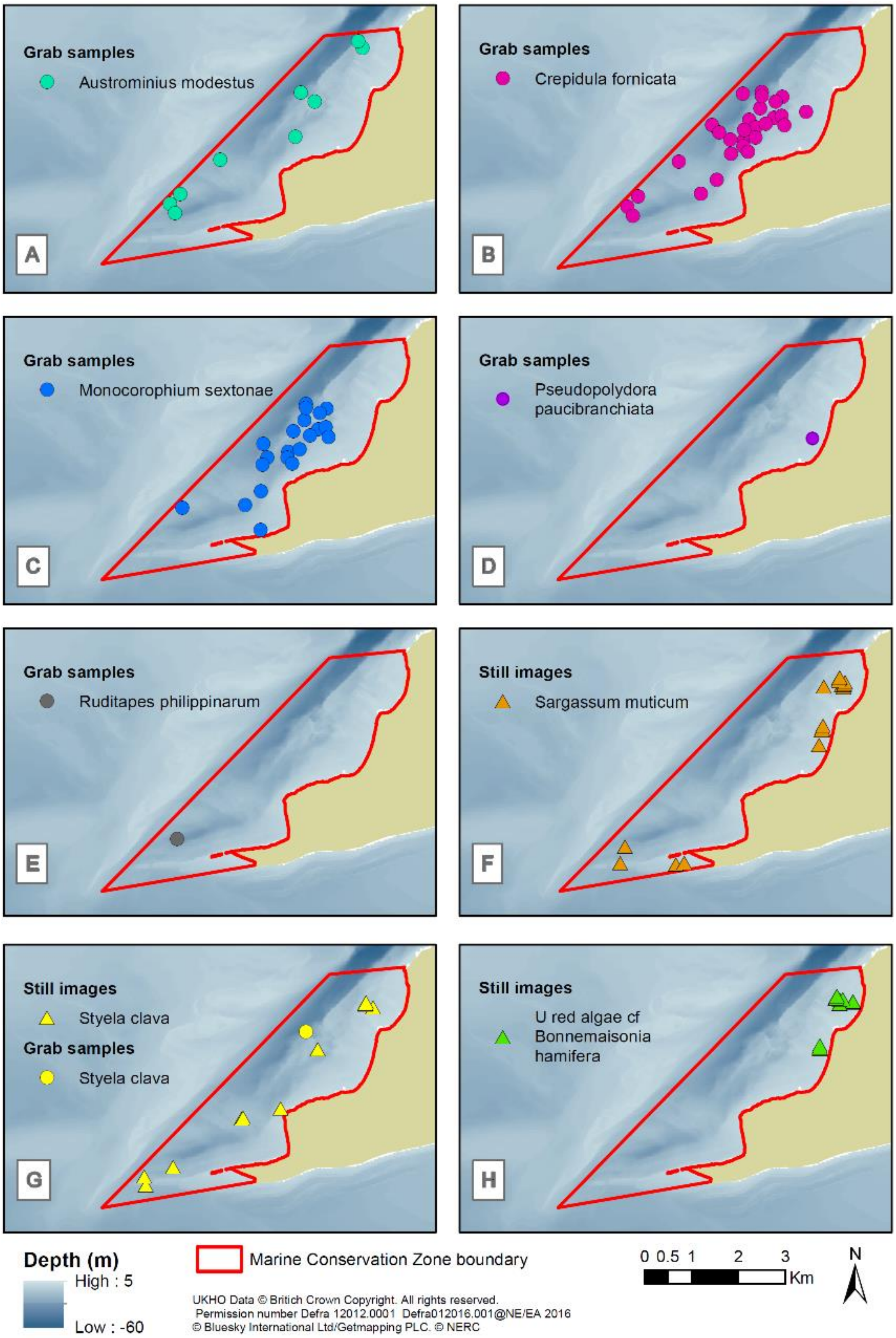


Figure 33. Distribution of non-indigenous species recorded in the Hamon Grab and drop camera survey in The Needles MCZ in 2018. Eight NIS were recorded in 2018 A) *Austrominius modestus*, B) *Crepidula fornicata*, C) *Monocorophium sextonae*, D) *Pseudopolydora paucibranchiata*, E) *Ruditapes philippinarum*, F) *Sargassum muticum*, G) *Styela clava* and H) U red algae cf. *Bonnemaisonia hamifera.*

3.9 Contaminants

Surface sediment samples were successfully taken at three grab stations to provide a record of heavy metal and organic content concentrations within The Needles MCZ. Sampling could not be completed at three of the six intended contaminant sample locations. The unsuccessful stations either could not be sampled, or samples had to be discarded due to unsuitable, or insufficient sediment, strong currents, or the presence of fishing gear at the sampling site (Garland *et al*., 2019). The three successfully sampled sediment contaminant stations were all located in the north and north-east of the MCZ.

Concentrations of most heavy metal concentrations were broadly similar between stations (Figure 34). Concentrations of aluminium, iron, lithium and manganese were all highest in the near-shore station NDLS43 in the vicinity of Totland. None of the measured heavy metal concentrations exceeded OSPAR's background assessment concentrations (BACs) or effects range low (ERL) concentrations.

Similar to heavy metals, all measured organic contaminants were recorded at concentrations below OSPAR's BAC and environmental assessment criteria (EAC) threshold concentrations (Figure 35). The measured concentrations were similar between stations.

No replicate sampling was undertaken for sediment contaminant data at the sampling stations. As such, it was not possible to identify statistically significant differences between stations. Likewise, lack of replication the extent to which we can infer the variability in the concentration data. This limits our confidence of stations being below BAC, ERL and EAC concentrations.

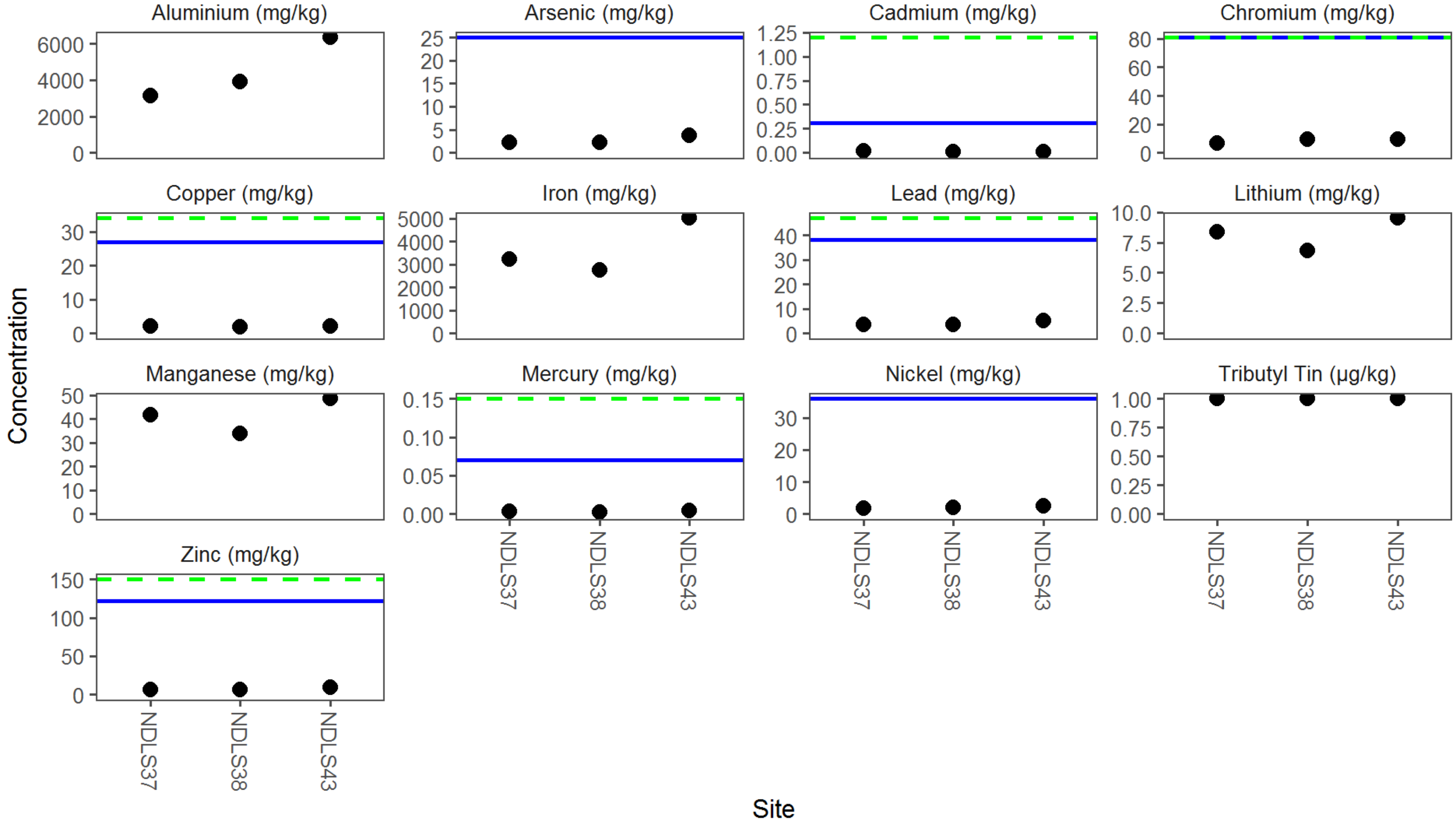


Figure 34. Results of heavy metal contaminant analyses of sediment samples collected during The Needles MCZ 2018 survey (© Natural England and Environment Agency 2022). The blue solid reference lines indicate the OSPAR background assessment concentrations (BAC) thresholds and the green dashed reference lines indicate the OSPAR effects range low (ERL) thresholds.

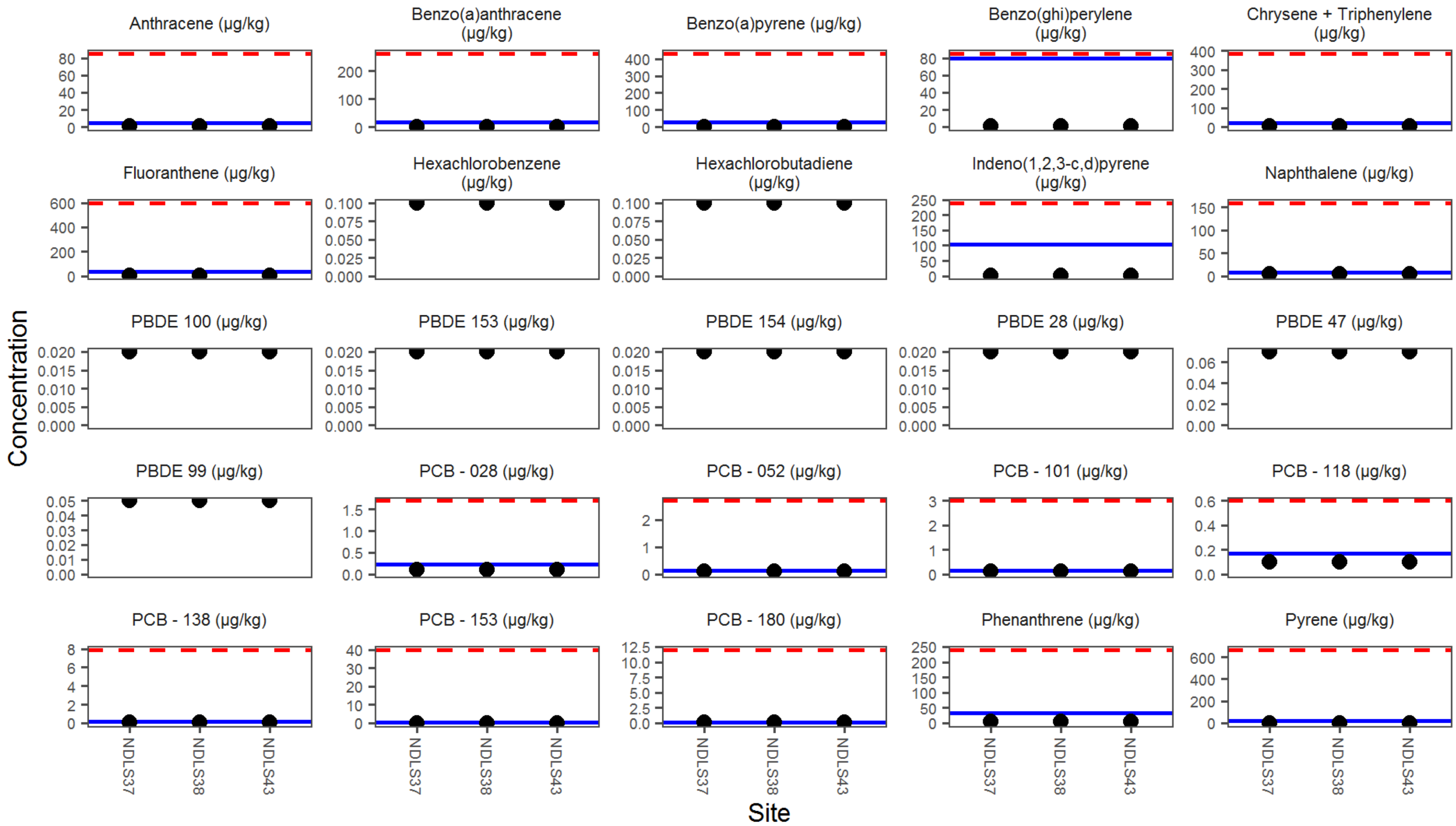


Figure 35. Results of organic contaminant analyses of sediment samples collected during The Needles MCZ 2018 survey. The blue solid reference lines indicate the OSPAR background assessment concentration (BAC) thresholds and the red dashed reference lines indicate the OSPAR environmental assessment criteria (EAC) thresholds.

3.10 Marine litter

Litter fragments larger than 1 mm that were observed in Mini-Hamon Grab samples were recorded. Fragments were present within 37 of the 46 (80%) infaunal grab samples in 2018 (Figure 36). The largest number of fragments of litter was recorded at station NDLS072, where ten pieces were recorded. The majority of fragments were plastics of various types, with the MSFD litter category 'Plastic A14 – Other' the most common (Table 12). The highest counts of litter were associated with 'A5.4 Subtidal mixed sediments' BSH (Figure 36). No observations were recorded of litter fragments in the video or still imagery data.

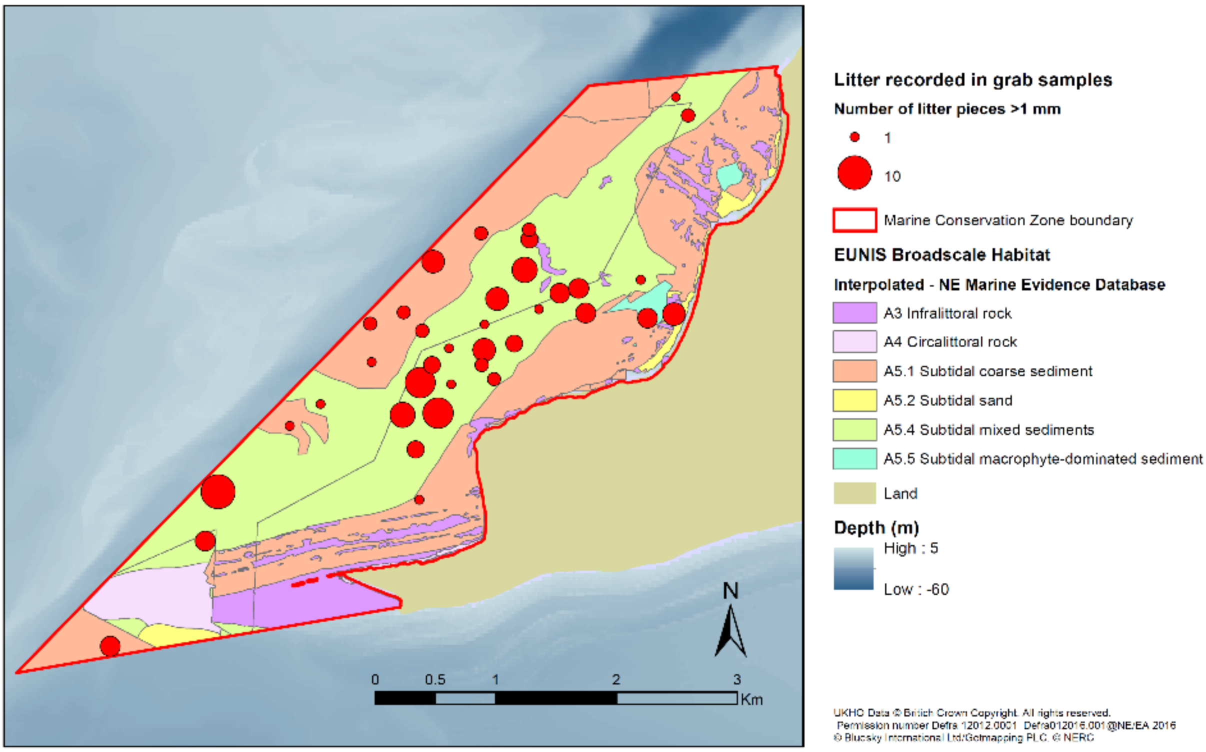


Figure 36. Marine litter fragments recorded in 0.1 m² Mini-Hamon Grab samples gathered in The Needles MCZ in 2018.

Table 12. Marine litter fragments recorded in 0.1 m² Mini-Hamon Grab samples in The Needles MCZ in 2018 (© Natural England and Environment Agency 2022). Litter categories are based on MSFD guidance (MSFD GES Technical Subgroup on Marine Litter, 2013).

Litter category	Number of litter fragments	Number of samples
Glass	8	3
Metal	7	4
Plastic - A2 Sheet	8	5
Plastic - A5 Monofilament	2	2
Plastic - A7 Synthetic rope	12	9
Plastic - A14 Other	83	33

4 Discussion

4.1 Benthic and environmental overview

The data gathered in 2018 and supported by those gathered in 2014 show that The Needles MCZ is characterised by a mixture of sedimentary habitats, with areas of infra- and circalittoral sediment-influenced rocky habitats. The majority of sedimentary habitats in the MCZ are coarse sandy and mixed sediments. Two areas of muddy habitat were also recorded.

The benthic environment observed in 2018 was characteristic of a moderate to high energy environment. These habitats are discussed in the sections below.

4.2 Subtidal sediment BSH

The data and analysis results provided contributes to Objective 1 in describing the extent, distribution, structural and functional attributes of the subtidal sediment BSHs within The Needles MCZ. The benthic infaunal data gathered in the 2018 Mini-Hamon Grab survey were broadly similar to those gathered in 2014 and have been used to produce the interpreted habitat map (Figure 3, Mylroie *et al.*, 2015). All four designated sedimentary BSHs were recorded in 2018 (Table 3). These habitats are discussed in the sections below.

Extent and distribution

Four subtidal sediment habitats are designated as BSH features within The Needles MCZ: ‘A5.1 Subtidal coarse sediment’, ‘A5.2 Subtidal sand’, ‘A5.3 Subtidal mud’ and ‘A5.4 Subtidal mixed sediments’. The PSA data showed that all four designated BSHs were present in 2018.

The most widely-recorded sedimenty BSH in 2018 was ‘A5.4 Subtidal mixed sediments’. As the name of the BSH would suggest, these stations were characterised by a mixture of sand, gravel and muddy sediments. ‘A5.1 Subtidal coarse sediment’ was also commonly recorded. These sediments had relatively high proportions of gravels, in addition to sands and small proportions of muddy sediments.

‘A5.2 Subtidal sand’ and ‘A5.3 Subtidal mud’ designated BSHs were recorded but were relatively uncommon in the 2018 grab samples. Future surveys should aim to target more sampling in these habitats to allow a more robust assessment of the condition of these BSHs.

Biological communities

Infaunal taxa recorded in 2018 were generally typical of those found in UK waters. Across all broadscale habitats polychaete worms were the most abundant fauna, with bivalve and gastropod molluscs as well as amphipods and tunicates also commonly recorded. Infaunal assemblages differed between sedimentary BSHs. Assemblages within the ‘A5.4 Subtidal mixed sediments’ BSH contained more taxa, with higher total faunal abundances and higher faunal biomass compared with the ‘A5.1 Subtidal coarse sediment’ and the ‘A5.2 Subtidal mixed sediments’ habitats. No statistically significant differences were recorded with the ‘A5.3 Subtidal mud’ habitat, given that only two samples were recorded for this BSH.

IQI values were significantly lower in the ‘A5.2 Subtidal sand’ BSH compared with the ‘A5.3 Subtidal mud’ and ‘A5.4 Subtidal mixed sediments’ habitats. Sandy habitats reflected ‘Moderate’ WFD status, compared with predominantly ‘High’ or ‘Good’ status elsewhere. It is difficult to unambiguously identify the driver(s) behind this observation. The ‘A5.2 Subtidal sand’ BSH stations were in a poorer ecological state than those in the ‘A5.4 Subtidal mixed sediments’ and ‘A5.3 Subtidal mud’ BSHs and thus showed lower IQI values. It is more likely however that the ‘moderate’ values in the sandy BSHs are a result of their near-shore location (Summary of selected infaunal diversity indices gathered within The Needles MCZ in 2018: **a) taxon richness; b) total faunal abundance; c) total faunal biomass; d) IQI classifications. Point shapes in d) indicate BSH: ‘A5.1 Subtidal coarse sediment’ (▲), ‘A5.2 Subtidal sand’ (●); ‘A5.3 Subtidal mud’ (■); ‘A5.4 Subtidal mixed sediments’ (+).**

). The reference conditions used by the IQI tool do control for the habitats present at a given sampling station. However, the IQI tool does not incorporate the depth from which a sample was gathered (Phillips *et al*., 2014). Intertidal and near-shore infaunal assemblages tend to be less species rich than those at depth (e.g. Knott *et al.*, 1983; Piacenza *et al.*, 2015). It is likely therefore that the relatively low IQI values for the 'A5.2 Subtidal sand' samples is, at least in part, linked to them being gathered from relatively shallow, near-shore areas.

The laboratory analyses of infaunal taxa identified the amphipod *Cheirocratus robustus* which is rarely recorded in UK habitats (Myers *et al.,* 2017). This taxon was recorded in the 'A5.1 Subtidal coarse sediment' BSH. However, no infaunal taxa were recorded in 2018 that are afforded any specific protected status.

Key structural and influential species

There is currently no publically available guidance on the identification of key and influential taxa in marine conservation zones. However, the roles that species play in ecosystem functioning and in the delivery of ecosystem goods and services is a long-established area of research (e.g. Naeem, 1998; Hooper *et al*., 2005). There is therefore an existing research base which can contribute towards the identification of potentially important taxa in The Needles MCZ.

Structural taxa

- In the infaunal data, *Sabellaria spinulosa* was recorded at multiple stations and was particularly abundant in the 'A5.1 Subtidal coarse sediment' and 'A5.4 Subtidal mixed sediments' BSH. As a reef-forming species, this taxon is potentially a functionally-important contributor to the habitat morphology and consequentially the ecology of The Needles MCZ and hence considered a key structural species. To evaluate the current extent of reef formation by *S. spinulosa* in The Needles MCZ (and to determine if the reefs present fulfil the Habitats Directive Annex I reef habitat requirements), additional information is required, including topographic distinctness, biodiversity within the habitat, longevity of reefs, diversity of reef forms (Gubbay, 2007). This information could not be determined from the 2018 survey data.

Influential taxa

- As well as being a potentially important structural taxon within sedimentary habitats, *S. spinulosa* and functionally similar taxa are also potentially important contributors to ecosystem function. When found at high densities, *S. spinulosa* are considered important for the cycling of materials and energy within the benthos (through the assimilation of materials when tube-building and when feeding directly from the substrate) and the exchange of materials between the pelagic and benthic environment (through suspension feeding). High density assemblages of tube-building polychaetes can filter and effectively regulate overlying water quality (Pearce *et al*., 2011). *S. spinulosa was* not recorded in

‘A5.2 Subtidal sand’, however the tube-building polychaete *Galathowenia oculata* was abundant in this BSH. There is potential that *G. oculata* could also be an influential taxon in sandier habitats.

- Bivalves belonging to family Nuculidae were recorded in all designated sedimentary BSHs. As active filter feeders, these taxa could be influential with respect to nutrient, material and energy cycling, particularly when present at high densities (de Juan *et al*., 2007).
- Other taxa, such as the blue mussel *Mytilus edulis* and the sand mason *Lanice conchilega* were recorded at low densities. When present at high densities, these taxa can act as key influencers of ecosystem functioning, either through efficient filtering of overlying waters (*M. edulis*, Troost *et al.*, 2000), or enhancing the stability of benthic sediments, generating habitat heterogeneity and allowing a diverse array of biotopes to develop (JNCC, 2015).

4.3 Subtidal rock broadscale habitats

The data and analysis results provided contributes to Objective 1 in describing the extent, distribution, structural and functional attributes of the subtidal rock BSHs within The Needles MCZ. The 2018 drop camera survey captured a total of 508 still images and 70 videos within The Needles MCZ. Low visibility conditions meant that the majority of video data captured in the 2018 survey was of very poor quality. Furthermore, the majority of still images captured in 2018 were of poor or very poor quality. As highlighted in the NMBAQC guidance (Turner *et al.*, 2016) precise, quantitative comparisons of such data is inappropriate, given the coarse level of taxon identification. As such, discussion of information derived from the imagery data is necessarily high-level and based on qualitative observations only.

The low video and still image quality reported in 2018 was similar to that observed in 2014 (Arnold *et al.*, 2014). It is possible that the previously poor image visibility and the presence of habitats associated with silt-influenced rocky habitats (O’Dell, 2019) mean that poor visibility is a characteristic of the site. It is also possible that image quality might be improved in future surveys by reconsidering the settings of camera and accessory equipment. Consideration of these issues should feed into the design of future survey work at this site.

Gathering and attempting to extract ecologically-informative information from poor quality image data requires substantial time and financial resources that may not be cost effective in contrast to sites where issues related to image quality are less prevalent. As such, it is important that thorough consideration is made on how best to gather useful information on rocky habitats in future. This might include the use of alternate equipment or camera equipment settings, in addition to the current standard practice of assessments of image quality in the field. This allows survey teams to identify and possibly take alternative action when image quality is considered too poor to be useful. An alternative approach for consideration is the use of diver surveys in such environments. Although diver surveys are resource-intensive and might introduce a number of health and safety issues, trained diver surveys can often gather high resolution ecological information that is difficult when using imagery data alone. Diver teams are also potentially able to survey in locations inaccessible by larger survey vessels. There is potential to combine such surveys. Drop camera surveys could be used to produce large-scale and relatively rapid assessments of the extent of rocky habitats. Diver surveys could aim to gather high quality insights into the ecological condition of habitats within these BSHs. A combination of diver and drop camera surveys is used to monitor the neighbouring South Wight SAC.

Extent and distribution

The most commonly recorded rocky BSH in 2018 was the designated BSH ‘A3.2 Moderate energy infralittoral rock’, which was predominantly located in shallow waters in the south and north-east of the MCZ (Figure 21). This is slightly different to the 2014 survey, which observed a greater frequency of ‘A4.1 High energy circalittoral rock’. However, this does not indicate a change in the extent or distribution of BSHs between 2014 and 2018. Instead, this is likely a consequence of a shift in survey focus from more deep and offshore stations in 2014, to a higher proportion of shallow, near-shore stations in 2018 (Figure 18). Plotting the distribution of BSHs recorded in 2014 and 2018 over the interpreted habitat map created by Mylroie *et al.* (2015) shows that the 2018 data are in good agreement with both the 2014 data and the interpreted map (Figure 18). As such, there is no indication that the extents or distribution of rocky habitats has changed where the two surveys overlap, but further evidence is needed to draw conclusions for the areas of the 2014 survey that were not resurveyed in 2018.

Biological communities

As highlighted above, the high proportion of poor quality images gathered in the 2018 survey means that the biological data gathered could only be acquired at a coarse taxonomic resolution and therefore interpreted tentatively. This makes it difficult to identify all but the most general patterns in the data. Furthermore, this means that meaningful insight into the ecology of The Needles MCZ is not possible. As such, analyses of the ecology of rocky shore BSHs are restricted to high-level observations.

Across all BSHs, unidentified red algae and faunal turfs were the most commonly recorded biological groups. Brown algae and various sponge growth forms were also recorded in a number of images. Such assemblages are common to moderately exposed habitats around the UK (JNCC, 2015) and provide useful evidence in evaluating the condition of the habitat.

4.4 Biotopes

Some samples (typically infaunal grab samples) were assigned to two (or more) biotopes. This highlights a difficulty in the use of biotopes to describe ecosystems. Temperate marine habitats and the species that dwell within them may be highly variable as a result of both natural and anthropogenic drivers. The presence, the number and the spatial distribution of taxa and environmental parameters are highly dynamic over both large and small spatial and temporal scales (e.g. Ysebaert and Herman, 2002; Frid *et al*., 2009). Such changes may be (at least to an extent) predictable, with certain taxa more abundant in particular habitats or at a particular time of the year. However, there is also considerable noise or stochasticity in such data, resulting from the often patchy distribution of taxa within the environment and measurement error, such as the scale from which samples are gathered.

This variability makes classifying habitats into pre-defined biotopes difficult. Even when replicate sampling within a given habitat, there is potential to miss taxa which are characteristic of a given biotope. This may be due to chance (i.e. the taxon was present, but not observed in the samples) or due to the taxon not actually being present at the time of sampling (e.g. some local conditions, or the time of year preclude the presence of the taxon). There is no ready way of identifying why a taxon is not recorded in a sampling event after the fact. As such, it is common for sample data to be an imperfect match to pre-defined biotopes and the taxa present often match multiple biotopes. Although they are useful for grouping large data sets into similar assemblages and habitat 'types', biotopes are not necessarily the most robust method of detecting ecological change. More consideration is therefore required to identify the best approaches to detect change in protected environments.

4.5 Undesignated BSH

A number of habitats were recorded in 2018 which are not designated as features of The Needles MCZ. This includes the 'A4.1 High energy circalittoral rock' BSH which was recorded extensively in the south of the MCZ (Figure 25). This habitat was not predicted in the existing interpreted habitat map. The considerable number of observations of 'A4.1 High energy circalittoral rock' in the 2018 survey suggests that this BSH potentially represents an important feature of The Needles MCZ. Future work should aim to characterise the extent of this habitat to potentially allow assessment of the condition of this currently undesignated habitat.

The 'A5.5 Subtidal macrophyte-dominated sediment' BSH was also recorded. A number of these stations were associated with subtidal macroalgae growing on sediment habitats. Other stations contained seagrasses. Although not highlighted specifically as a designated BSH, seagrass meadows are a designated habitat FOCI within The Needles MCZ (Section 4.6).

Similarly, the 'A5.6 Subtidal biogenic reef' BSH was recorded at a number of stations in the north-central area of the MCZ (Figure 25). This habitat was characterised by Ross Worm (*Sabellaria*) Reefs. Details of the ecological significance of this taxon is provided in Section 0. Unlike seagrass meadows, these reefs are neither a designated broadscale habitat nor a designated habitat FOCI within The Needles MCZ. The extent and distribution of this habitat could not be determined from the 2018 survey, so future work should aim to address this.

4.6 Habitat FOCI

The survey information acquired contributes to Objective 3 in recording habitat FOCI that are absent from The Needles MCZ Designation Order. The Needles MCZ has a number of designated habitat FOCI associated with it (Table 1). A number of these were targeted by the 2018 survey. Given the low visibility present within The Needles MCZ, image quality was very poor in many cases. As such, although the information gathered in the 2018 drop camera survey is useful to indicate the presence of habitat FOCI within the MCZ at a considerable number of stations, it cannot confidently be used to quantify the full extent of these features.

Subtidal Chalk habitats were recorded in relatively near-shore stations in the north and south of the MCZ (Figure 27). This habitat was associated with the presence of piddock boreholes in the drop camera samples. This habitat FOCI was assigned to the CR.MCR.SfR (Soft rock communities) biotope. Unidentified red algae, brown algae and ascidian and unidentified faunal turf assemblages were common to this FOCI. The observed chalk habitats were often recorded in association with sediment-influenced assemblages, where sediments had settled on a chalk substrate.

Although not specifically targeted in this survey, incidental occurrences of Seagrass Beds were also recorded in 2018 as part of the drop camera survey work. These were recorded in shallow near-shore waters in the north-east of the MCZ. As highlighted in the drop camera survey report (O'Dell, 2019), quantification of the extent of this habitat was not possible due to issues with image quality. Where image quality allowed it to be recorded, coverage of *Zostera marina* within these images was as high as 100%. Specific surveys were conducted in Totland Bay and Colwell Bay targeting seagrasses. These data are discussed in a separate report (Green, 2019).

The Sheltered Muddy Gravels FOCI was not targeted nor observed within this survey, but the potential presence of this FOCI was indicated by the presence of a *Crepidula* biotope known to be associated with this habitat. This information may be useful in the design of a future survey to identify the presence and extent of this FOCI.

4.7 Species FOCI

The survey information acquired contributes to Objective 3 in recording species FOCI that are absent from The Needles MCZ Designation Order. There are three designated species FOCI for The Needles MCZ (Table 1). Two of the three species were not targeted as part of the 2018 survey: Peacock's tail (*Padina pavonica*) and Stalked jellyfish (*Calvadosia campanulata*). Neither were recorded during the 2018 survey work. Both taxa are found in shallow waters, often growing on macroalgae and seagrasses (*C. campanulata*) or in association with clay and silty sediments (*P. pavonica*). Given the low visibility within the camera data, it is unlikely that the 2018 survey would have recorded these taxa even if they were present at the time of sampling.

The native oyster (*Ostrea edulis)* was not specifically targeted, but records were made of its presence where observed. A single individual of *O. edulis* was recorded in 2018. This single sighting is insufficient to confirm the presence of a healthy or self-sustaining population of this species in The Needles MCZ. Given that *O. edulis* are often recorded in dense aggregations on shell and hard-substrata, the 2018 survey design and Mini-Hamon Grab sampling method were not necessarily the best approach to sample this taxon. As such, the observation of only a single oyster in 2018 is not indicative of a poor condition of this taxon in The Needles MCZ.

4.8 Non-indigenous species

The survey information acquired contributes to Objective 4 in providing evidence of the presence of NIS within The Needles MCZ and associated MSFD Descriptor 2 assessment. A number of NIS were recorded in the 2018 survey, in both still images and grab data. NIS were distributed throughout the MCZ (Figure 33) and were recorded in most of the BSHs observed. These taxa are all commonly recorded in UK benthic surveys. A vector by which NIS commonly enter new environments is through attachment to travelling vessels. Given the location of The Needles MCZ in the vicinity of some of the UK's busiest shipping routes around the Solent and northern English Channel and close vicinity to multiple large ports, including Southampton and Portsmouth, there is a substantial likelihood of such taxa being present. As such, given that these taxa are well-established in UK waters, it is considered unlikely that these observations reflect a novel introduction of these NIS into The Needles MCZ.

4.9 Marine litter

The survey information acquired contributes to Objective 4 in providing evidence of the presence of marine litter within The Needles MCZ and associated MSFD Descriptor 10 assessment. Marine litter >1 mm was recorded in 80% of benthic grab samples. This is likely due to a combination of the high population centres along the south coast of England and the busy shipping environment of the Solent and English Channel.

4.10 Anthropogenic activities and pressures

The survey information acquired contributes to Objective 5 in providing evidence of certain anthropogenic pressures within The Needles MCZ. No exceedances of OSPAR BAC or ERL thresholds of heavy metal or organic contaminants were recorded in 2018. Given the high human population in the area and the extensive use of this part of the English Channel for shipping, it is recommended that monitoring of these contaminants continues in future years to ensure that contaminants remain below advised thresholds to prevent any associated ecological impacts within The Needles MCZ.

5 Recommendations for future monitoring

The below recommendations for future monitoring contribute to the fulfilment of Objective 6 of the current report:

- Consistency and clarity in the gathering and analysis of imagery data is required to achieve the repeatable, statistically robust and ecologically meaningful data required to draw reliable conclusions and inform effective management actions. The majority of imagery data gathered in 2018 was of poor (or worse) quality, severely limiting the degree to which these data could be analysed and interpreted. Prior to the commencement of future surveys of rocky habitats, thorough consideration of the most appropriate technical (e.g. appropriate equipment and equipment settings) and methodological (e.g. survey teams reviewing image quality in the field as it is gathered) approaches is required. This should include consideration of the use of diver surveys, possibly in combination with drop camera surveys, to gather high quality, ecologically-informative data on these valuable habitats. In addition to providing data which could be statistically analysed and interpreted with greater confidence, the analyses would also be more likely to record any habitats and species of conservation importance as well as the presence, distribution and abundances of non-indigenous species.
- The information gathered as part of the 2018 survey of The Needles MCZ could be incorporated into an updated habitat map.
- Species composition, biodiversity measures and biotopes can provide only limited information on the functioning of assemblages. The identification of key species and/or suites of biological and ecological traits could provide valuable insights into ecological functioning and hence an improved understanding of the condition of designated BSHs.
- Specific targeting of Ross Worm (*Sabellaria spinulosa*) Reefs, with surveys designed to target the Annex I reef criteria defined by Gubbay *et al*. (2007).
- Specific targeting of the Sheltered Muddy Gravels habitat FOCI to provide information on the extent of this habitat.
- Improved information on the condition of ‘A5.2 Subtidal sand’ and ‘A5.3 Subtidal mud’ BSHs would be gained from specifically targeting these habitats in future surveys. This would allow a more robust assessment of the condition of these habitats within The Needles MCZ.
- Consider adapting survey design and methodologies for quantification of rare and sparsely distributed taxa. This is essential if the aim is to confidently assess changes over time in these taxa.
- Consider a dedicated sonar camera survey to establish the extent and condition of subtidal Seagrass Beds.

- Research into structurally important taxa in rocky habitats within The Needles MCZ. For example, does coverage of branching and massive sponges represent a structurally important feature within rocky habitats? Similar consideration of the importance of erect bryozoans (e.g. Family Flustridae), red and brown algae and seagrasses.

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Annex 1. Abbreviations

BSH	Broadscale Habitats
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CHP	Civil Hydrography Programme
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EUNIS	European Nature Information System
FOCI	Feature of Conservation Interest
GES	Good Environmental Status
IECS	Institute of Estuarine and Coastal Studies
IFCA	Inshore Fisheries and Conservation Authority
IQI	Infaunal Quality Index
JNCC	Joint Nature Conservation Committee
NMBAQC	North East Atlantic Marine Biological Analytical Quality Control Scheme
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MESH	Mapping European Seabed Habitats
MPA	Marine Protected Area
MPAG	Marine Protected Areas Group
MSFD	Marine Strategy Framework Directive
NE	Natural England
NLS	National Laboratory Service
NIS	Non-Indigenous Species
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PRIMER	Plymouth Routines in Multivariate Ecological Research
PSA	Particle Size Analysis
PSD	Particle Size Distribution
RV	Research Vessel
SAC	Special Area of Conservation
SACOs	Supplementary Advice on Conservation Objectives
SERCMP	Southeast Regional Coastal Monitoring Programme

SNCB	Statutory Nature Conservation Body
WFD	Water Framework Directive

Annex 2. Glossary

Definitions signified by an asterisk (*) have been sourced from Natural England and JNCC Ecological Network Guidance (NE and JNCC, 2010).

Activity	A human action which may have an effect on the marine environment; e.g. fishing, energy production (Robinson, Rogers and Frid, 2008).*
Annex I Habitats	Habitats of conservation importance listed in Annex I of the EC Habitats Directive, for which Special Areas of Conservation (SAC) are designated.
Anthropogenic	Caused by humans or human activities; usually used in reference to environmental degradation.*
Assemblage	A collection of plants and/or animals characteristically associated with a particular environment that can be used as an indicator of that environment. The term has a neutral connotation, and does not imply any specific relationship between the component organisms, whereas terms such as ‘community’ imply interactions (Allaby, 2015).
Benthic	A description for animals, plants and habitats associated with the seabed. All plants and animals that live in, on or near the seabed are benthos (e.g. sponges, crabs, Seagrass Beds).*
Benthic-pelagic coupling	Processes which connect the benthic zone (seabed) and the pelagic zone (water column) through the exchange of materials, energy or nutrients. These processes are important for the functioning of marine ecosystems.
Biotope	The physical habitat with its associated, distinctive biological communities. A biotope is the smallest unit of a habitat that can be delineated conveniently and is characterised by the community of plants and animals living there.*
Broadscale habitats	Habitats which have been broadly categorised based on a shared set of ecological requirements, aligning with level 3 of the EUNIS habitat classification. Examples of broadscale habitats are protected across the MCZ network.
Community	A general term applied to any grouping of populations of different organisms found living together in a particular environment; essentially the biotic component of an ecosystem. The organisms interact and give the community a structure (Allaby, 2015).
Conservation Objective	A statement of the nature conservation aspirations for the feature(s) of interest within a site, and an assessment of those human pressures likely to affect the feature(s).*

EC Habitats Directive	The EC Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) requires Member States to take measures to maintain natural habitats and wild species of European importance at, or restore them to, favourable conservation status.
Epifauna	Fauna living on the seabed surface.
EUNIS	A European habitat classification system, covering all types of habitats from natural to artificial, terrestrial to freshwater and marine.*
Favourable Condition	When the ecological condition of a species or habitat is in line with the conservation objectives for that feature. The term 'favourable' encompasses a range of ecological conditions depending on the objectives for individual features.*
Feature	A species, habitat, geological or geomorphological entity for which an MPA is identified and managed.*
Feature Attributes	Ecological characteristics defined for each feature within site-specific Supplementary Advice on Conservation Objectives (SACO). Feature Attributes are monitored to determine whether condition is favourable.
Features of Conservation Importance (FOCI)	Habitats and species that are rare, threatened or declining in Secretary of State waters.*
General Management Approach (GMA)	The management approach required to achieve favourable condition at the site level; either maintain in, or recover to favourable condition.
Habitats of Conservation Importance (HOCI)	Habitats that are rare, threatened, or declining in Secretary of State waters.*
Impact	The consequence of pressures (e.g. habitat degradation) where a change occurs that is different to that expected under natural conditions (Robinson, Rogers and Frid, 2008).*
Infauna	Fauna living within the seabed sediment.
Joint Nature Conservation Committee (JNCC)	The statutory advisor to Government on UK and international nature conservation. Its specific remit in the marine environment ranges from 12 - 200 nautical miles offshore.
Marine Strategy Framework Directive (MSFD)	The MSFD (EC Directive 2008/56/EC) aims to achieve GES of EU marine waters and to protect the resource base upon which marine-related economic and social activities depend.

Marine Conservation Zone (MCZ)	MPAs designated under the Marine and Coastal Access Act (2009). MCZs protect nationally important marine wildlife, habitats, geology and geomorphology, and can be designated anywhere in English and Welsh inshore and UK offshore waters.*
Marine Protected Area (MPA)	A generic term to cover all marine areas that are ‘A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values’ (Dudley, 2008).*
Natura 2000	The EU network of nature protection areas (classified as Special Areas of Conservation and Special Protection Areas), established under the 1992 EC Habitats Directive.*
Natural England	The statutory conservation advisor to Government, with a remit for England out to 12 nautical miles offshore.
Non-indigenous Species	A species that has been introduced directly or indirectly by human agency (deliberately or otherwise) to an area where it has not occurred in historical times and which is separate from and lies outside the area where natural range extension could be expected (Eno *et al.*, 1997).*
Pressure	The mechanism through which an activity has an effect on any part of the ecosystem (e.g. physical abrasion caused by trawling). Pressures can be physical, chemical or biological, and the same pressure can be caused by a number of different activities (Robinson, Rogers and Frid, 2008).*
Special Areas of Conservation	Protected sites designated under the European Habitats Directive for species and habitats of European importance, as listed in Annex I and II of the Directive.*
Species of Conservation Importance (SOCI)	Habitats and species that are rare, threatened or declining in Secretary of State waters.*
Supplementary Advice on Conservation Objectives (SACO)	Site-specific advice providing more detailed information on the ecological characteristics or ‘attributes’ of the site’s designated feature(s). This advice is issued by Natural England and/or JNCC.

Annex 3. Infauna data truncation

Raw taxon abundance and biomass matrices can often contain entries that include the same taxa recorded differently, erroneously or differentiated according to unorthodox, subjective criteria. Therefore, ahead of analysis, data should be checked and truncated to ensure that each row represents a legitimate taxon and they are consistently recorded within the dataset. An artificially inflated taxon list (i.e., one that has not had spurious entries removed) risks distorting the interpretation of pattern contained within the sampled assemblage.

It is often the case that some taxa have to be merged to a level in the taxonomic hierarchy that is higher than the level at which they were identified. In such situations, a compromise must be reached between the level of information lost by discarding recorded detail on a taxon's identity and the potential for error in analyses, results and interpretation if that detail is retained.

Details of the data preparation and truncation protocols applied to the infaunal datasets acquired at The Needles MCZ ahead of the analyses reported here are provided below:

- Where there are records of one named species together with records of members of the same genus (but the latter not identified to species level) the entries are merged and the resulting entry retains only the name of the genus.
- Taxa are often assigned as 'juveniles' during the identification stage with little evidence for their actual reproductive natural history (with the exception of some well-studied molluscs and commercial species). Many truncation methods involve the removal of all 'juveniles'. However, a decision must be made on whether removal of all juveniles from the dataset is appropriate or whether they should be combined with the adults of the same species where present. For the infaunal data collected at The Manacles MCZ: where a species level identification was labelled 'juvenile', the record was combined with the associated species level identification, when present or the 'juvenile' label removed where no adults of the same species had been recorded.

Annex 4. Epifauna data truncation

As highlighted in Annex 3. Infauna data truncation, taxon abundance matrices can sometimes record taxa inconsistently. This means that pre-processing and truncating of data is often required so reduce the risk of distorting the interpretation of already complex data. This is particularly important for video and still imagery data where a lot of organisms are able to be recorded only at high taxonomic or broad descriptive levels. As such, a number of truncations had to be made to the data to allow them to be compared with any confidence between different areas of The Needles MCZ and between the 2014 and 2018 surveys. Taxa were truncated to the lowest taxonomic level or morphological category possible to achieve mutually exclude groupings of taxa. The protocol applied to the seabed imagery data is described below.

All fish taxa were removed from the data. Fish are highly mobile taxa and unlikely to be consistently sampled by the methods described in this report.

Sponges (Phylum Porifera) were grouped by their morphologies.

All decapods were grouped together as Decapoda as it was not possible to combine taxa to exclusive groups below this resolution.

A large number of records were made to indicate the presence of faunal turfs, bryozoan turfs, hydrozoan turfs and various combinations of these. These descriptive terms and records of smaller and encrusting bryozoan and hydroid taxa were truncated to the level of ‘U faunal turf’ (unidentified faunal turfs). Larger and conspicuous taxa were truncated to the highest common taxonomic levels (e.g. the bryozoans Flustridae and *Alcyonidium* sp and the hydroids *Lytocarpia myriophyllum* and *Nemertesia* sp.).

Descriptive notes were also made to indicate the presence of worm casts, worm tubes and faunal burrows. These were truncated to the level of ‘U faunal bioturb’ (unidentified faunal bioturbation).

Ascidians were grouped by whether they were solitary or colonial taxa. Furthermore, all Anthozoans were grouped together.

Due to the inconsistent and generally rather high-level records of macroalgae in digital imagery, all brown algae were truncated as ‘Phaeophyceae’. Likewise, all red algae were truncated to Rhodophyta and green algae were truncated to Chlorophyta.

Annex 5. Marine litter categories

Categories and sub-categories of litter items for Sea-Floor from the OSPAR/ICES/IBTS for North East Atlantic and Baltic. Guidance on Monitoring of Marine Litter in European Seas, a guidance document within the Common Implementation Strategy for the Marine Strategy Framework Directive, MSFD Technical Subgroup on Marine Litter, 2013.

A: Plastic	B: Metals	C: Rubber	D: Glass/ Ceramics	E: Natural products/ Clothes	F: Miscellaneous
A1. Bottle	B1. Cans (food)	C1. Boots	D1. Jar	E1. Clothing/ rags	F1. Wood (processed)
A2. Sheet	B2. Cans (beverage)	C2. Balloons	D2. Bottle	E2. Shoes	F2. Rope
A3. Bag	B3. Fishing related	C3. Bobbins (fishing)	D3. Piece	E3. Other	F3. Paper/ cardboard
A4. Caps/ lids	B4. Drums	C4. Tyre	D4. Other		F4. Pallets
A5. Fishing line (monofilament)	B5. Appliances	C5. Other			F5. Other
A6. Fishing line (entangled)	B6. Car parts				
A7. Synthetic rope	B7. Cables				
A8. Fishing net	B8. Other				
A9. Cable ties					
A10. Strapping band					
A11. Crates and containers					
A12. Plastic diapers					
A13. Sanitary towels/ tampons					
A14. Other					

Related size categories
A: ≤ 5*5 cm = 25 cm^2
B: ≤ 10*10 cm = 100 cm^2
C: ≤ 20*20 cm = 400 cm^2
D: ≤ 50*50 cm = 2500 cm^2
E: ≤ 100*100 cm = 10000 cm^2
F: ≥ 100*100 cm = 10000 cm^2

Annex 6. Non-indigenous species lists

Taxa listed as non-indigenous species (present and horizon) which have been selected for assessment of Good Environmental Status in GB waters under MSFD Descriptor 2 (Stebbing *et al*., 2014).

Species name	List	Species name	List
Acartia (Acanthacartia) tonsa	Present	*Alexandrium catenella*	Horizon
Amphibalanus amphitrite	Present	*Amphibalanus reticulatus*	Horizon
Asterocarpa humilis	Present	*Asterias amurensis*	Horizon
Bonnemaisonia hamifera	Present	*Caulerpa racemosa*	Horizon
Caprella mutica	Present	*Caulerpa taxifolia*	Horizon
Crassostrea angulata	Present	*Celtodoryx ciocalyptoides*	Horizon
Crassostrea gigas	Present	*Chama sp.*	Horizon
Crepidula fornicata	Present	*Dendostrea frons*	Horizon
Diadumene lineata	Present	*Gracilaria vermiculophylla*	Horizon
Didemnum vexillum	Present	*Hemigrapsus penicillatus*	Horizon
Dyspanopeus sayi	Present	*Hemigrapsus sanguineus*	Horizon
Ensis directus	Present	*Hemigrapsus takanoi*	Horizon
Eriocheir sinensis	Present	*Megabalanus coccopoma*	Horizon
Ficopomatus enigmaticus	Present	*Megabalanus zebra*	Horizon
Grateloupia doryphora	Present	*Mizuhopecten yessoensis*	Horizon
Grateloupia turuturu	Present	*Mnemiopsis leidyi*	Horizon
Hesperibalanus fallax	Present	*Ocenebra inornata*	Horizon
Heterosigma akashiwo	Present	*Paralithodes camtschaticus*	Horizon
Homarus americanus	Present	*Polysiphonia subtilissima*	Horizon
Rapana venosa	Present	*Pseudochattonella verruculosa*	Horizon
Sargassum muticum	Present	*Rhopilema nomadica*	Horizon
Schizoporella japonica	Present	*Telmatogeton japonicus*	Horizon
Spartina townsendii var. anglica	Present		
Styela clava	Present		
Undaria pinnatifida	Present		
Urosalpinx cinerea	Present		
Watersipora subatra	Present		

Additional taxa listed as non-indigenous species in the JNCC 'Non-native marine species in British waters: a review and directory' report by Eno *et al*. (1997) which have not been selected for assessment of Good Environmental Status in GB waters under MSFD.

Species name (1997)	Updated name (2017)
Thalassiosira punctigera	
Thalassiosira tealata	
Coscinodiscus wailesii	
Odontella sinensis	
Pleurosigma simonsenii	
Grateloupia doryphora	
Grateloupia filicina var. luxurians	*Grateloupia subpectinata*
Pikea californica	
Agardhiella subulata	
Solieria chordalis	
Antithamnionella spirographidis	
Antithamnionella ternifolia	
Polysiphonia harveyi	*Neosiphonia harveyi*
Colpomenia peregrine	
Codium fragile subsp. atlanticum	
Codium fragile subsp. tomentosoides	*Codium fragile* subsp. *atlanticum*
Gonionemus vertens	
Clavopsella navis	*Pachycordyle navis*
Anguillicoloides crassus	
Goniadella gracilis	
Marenzelleria viridis	
Clymenella torquata	
Hydroides dianthus	
Hydroides ezoensis	
Janua brasiliensis	
Pileolaria berkeleyana	
Ammothea hilgendorfi	
Elminius modestus	*Austrominius modestus*
Eusarsiella zostericola	
Corophium sextonae	
Rhithropanopeus harrissii	

Potamopyrgus antipodarum	
Tiostrea lutaria	*Tiostrea chilensis*
Mercenaria mercenaria	
Petricola pholadiformis	
Mya arenaria	

Annex 7. Infaunal Quality Index values

Infaunal Quality Index values recorded in infaunal grab samples as part of the 2018 survey of The Needles MCZ (© Natural England and Environment Agency 2022). IQI scores were based on untransformed infaunal abundance data. The IQI tool is designed to classify infaunal assemblages in muddy and sandy habitats. The tool is not able to classify assemblages in coarse, gravelly habitats.

Site	Lat_wg84	Lon_wg84	BSH	IQI value	IQI status class
NDLS_037	50.69107	-1.53967	A5.2 - Subtidal Sand	0.577	Moderate
NDLS_038	50.68231	-1.54682	A5.2 - Subtidal Sand	0.630	Moderate
NDLS_042	50.68207	-1.54886	A5.2 - Subtidal Sand	0.536	Moderate
NDLS_043	50.68201	-1.54994	A5.2 - Subtidal Sand	0.567	Moderate
NDLS_044	50.68490	-1.55074	A5.4 - Subtidal Mixed Sediments	0.809	High
NDLS_045	50.68354	-1.56757	A5.4 - Subtidal Mixed Sediments	0.719	Good
NDLS_046	50.67974	-1.56910	A5.4 - Subtidal Mixed Sediments	0.643	Good
NDLS_047	50.68780	-1.55765	A5.4 - Subtidal Mixed Sediments	0.819	High
NDLS_048	50.67492	-1.57873	A5.1 - Subtidal Coarse Sediments	0.715	Good
NDLS_049	50.67864	-1.57523	A5.4 - Subtidal Mixed Sediments	0.622	Moderate
NDLS_051	50.68392	-1.56020	A5.4 - Subtidal Mixed Sediments	0.746	Good
NDLS_052	50.68427	-1.55800	A5.4 - Subtidal Mixed Sediments	0.719	Good
NDLS_053	50.68242	-1.55718	A5.4 - Subtidal Mixed Sediments	0.798	High
NDLS_054	50.67862	-1.56943	A5.4 - Subtidal Mixed Sediments	0.698	Good
NDLS_056	50.68867	-1.56380	A5.4 - Subtidal Mixed Sediments	0.941	High
NDLS_060	50.67717	-1.57300	A5.4 - Subtidal Mixed Sediments	0.622	Moderate
NDLS_062	50.67576	-1.58834	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_069	50.68211	-1.56569	A5.4 - Subtidal Mixed Sediments	0.682	Good
NDLS_070	50.66739	-1.60359	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_071	50.66560	-1.60197	A5.4 - Subtidal Mixed Sediments	0.756	High
NDLS_072	50.66928	-1.60044	A5.4 - Subtidal Mixed Sediments	0.666	Good
NDLS_075	50.67985	-1.57324	A5.1 - Subtidal Coarse Sediments	0.584	Moderate
NDLS_076	50.68018	-1.56560	A5.4 - Subtidal Mixed Sediments	0.686	Good
NDLS_078	50.67753	-1.56799	A5.4 - Subtidal Mixed Sediments	0.764	High
NDLS_082	50.69139	-1.56744	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_084	50.68840	-1.56944	A5.1 - Subtidal Coarse Sediments	0.660	Good
NDLS_085	50.68633	-1.57504	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_086	50.68257	-1.57852	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_087	50.68172	-1.58248	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_088	50.67889	-1.58236	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_091	50.67415	-1.59200	A5.1 - Subtidal Coarse Sediments	NA	NA
NDLS_095	50.66860	-1.57685	A5.2 - Subtidal Sand	0.612	Moderate
NDLS_098	50.66506	-1.57739	A5.4 - Subtidal Mixed Sediments	0.649	Good
NDLS_101	50.65782	-1.61315	A5.1 - Subtidal Coarse Sediments	NA	NA

Site	Lat_wg84	Lon_wg84	BSH	IQI value	IQI status class
NDLS_102	50.69710	-1.54506	A5.3 - Subtidal Mud	0.836	High
NDLS_104	50.69848	-1.54644	A5.1 - Subtidal Coarse Sediments	0.670	Good
NDLS_110	50.68569	-1.56431	A5.4 - Subtidal Mixed Sediments	0.673	Good
NDLS_112	50.68274	-1.56269	A5.4 - Subtidal Mixed Sediments	0.811	High
NDLS_113	50.68164	-1.56906	A5.4 - Subtidal Mixed Sediments	0.660	Good
NDLS_114	50.68119	-1.57637	A5.4 - Subtidal Mixed Sediments	0.848	High
NDLS_115	50.67506	-1.57460	A5.3 - Subtidal Mud	0.671	Good
NDLS_119	50.67235	-1.57722	A5.4 - Subtidal Mixed Sediments	0.770	High
NDLS_120	50.66975	-1.58189	A5.4 - Subtidal Mixed Sediments	0.781	High
NDLS_124	50.67732	-1.57665	A5.4 - Subtidal Mixed Sediments	0.692	Good
NDLS_125	50.68795	-1.56375	A5.1 - Subtidal Coarse Sediments	0.716	Good
NDLS_126	50.68692	-1.55971	A5.4 - Subtidal Mixed Sediments	0.764	High

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