# Newquay and The Gannel Marine Conservation Zone (MCZ) Monitoring Report 2017

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## Further information

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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 Newquay and the Gannel 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 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 Newquay and The Gannel Marine Conservation Zone (MCZ) (during 2017) and will form part of the ongoing time series data and evidence for this MPA.

Newquay and The Gannel MCZ is an inshore site located on the north coast of Cornwall within the ‘Western Channel and Celtic Sea’ Charting Progress 2 (CP2) sea area. Twelve Broadscale Habitats (BSH), two habitat Features of Conservation Importance (FOCI) and one species FOCI have been protected under the MCZ designation order. This report provides a characterisation of the BSHs ‘A3.1 High energy infralittoral rock’, ‘A3.2 Moderate energy infralittoral rock’, ‘A4.1 High energy circalittoral rock’, ‘A4.2 Moderate energy circalittoral rock’, ‘A5.1 Subtidal coarse sediment’, and ‘A5.2 Subtidal sand’ designated within the MCZ.

Habitat distributions recorded in 2017 were broadly similar to those recorded in 2013. For the seabed imagery data, the poor visibility and low image quality recorded in 2017 made it difficult to compare data between survey years. However, the distribution of BSHs were generally similar between the two.  Rocky habitats were dominated by BSH ‘A3.1 High energy infralittoral rock’, with occurrences of ‘A3.2 Moderate energy infralittoral rock’ and ‘A4.1 High energy circalittoral rock’ also present.

# 1 Introduction

Newquay and The Gannel 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 (between 0 nm and 12 nm from the coast) is Natural England (NE) 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).

This monitoring report primarily explores data acquired from the first dedicated monitoring survey of Newquay and The Gannel MCZ, which will form the initial point in a monitoring time series against which feature condition can be assessed in the future. The specific aims of the report are discussed in more detail in Section 1.2.

## 1.1 Site overview

Newquay and The Gannel MCZ is an inshore site on the north coast of Cornwall (Figure 1). Newquay and The Gannel MCZ was recommended as a MCZ by the 'Finding Sanctuary' regional stakeholder group project. It is located in the jurisdictional area of the Cornwall Inshore Fisheries Conservation Authority (IFCA) and falls within the wider 'Charting Progress 2' (CP2) area 'Western Channel and Celtic Sea'. The MCZ extends 1 km from the shoreline, ranging from the intertidal to a water depth of 24 metres below chart datum, stretching from Kelsey Head West of Crantock Beach, to Trevelgue Head at Porth Beach. Covering a total area of 9 $km^2$, the site includes The Gannel estuary as far as the tidal limit (near the A3075 road bridge). The site is neighboured by Padstow Bay and Surrounds and Hartland Point to Tintagel MCZs and also overlaps with the Bristol Channel Approaches / Dynesfeydd Môr Hafren Special Area of Conservation for Harbour Porpoise.

The site overlaps with the Water Framework Directive (WFD) waterbodies 'Lands End to Trevose Head' and 'Gannel'. Neither have regular water quality monitoring as they are not part of the WFD surveillance monitoring programme. Eight beaches within the site are designated bathing waters and are monitored between May and September for the Bathing Waters Directive (http://environment.data.gov.uk/bwq/profiles/). The site was designated due to the presence of important intertidal and subtidal habitat features and a number of associated species of conservation interest[1] (Table 1). At the time of writing, there is a byelaw restricting net fishing in the Gannel Estuary, but no areas closed to fishing activities in the MCZ.

The Newquay and Gannel MCZ protects a high variety of habitats and species. The habitats protected include exposed sandy beaches and rocky shores, home to important species such as the rare Giant goby (*Gobius cobitis*) which is not well protected in existing marine protected areas in this region. The estuarine rocky habitats in the site are important for a range of plants and animals. On the shores of the estuary, rocks provide a habitat for large seaweeds and sheltering barnacles, snails and shrimp-like animals. Within the estuary area, coastal saltmarsh also provides refuge and food for animals and plants. The rich and sheltered waters of estuary and saltmarsh habitat provide (Defra, 2016).

[1] http://www.legislation.gov.uk/ukmo/2016/13/contents/created

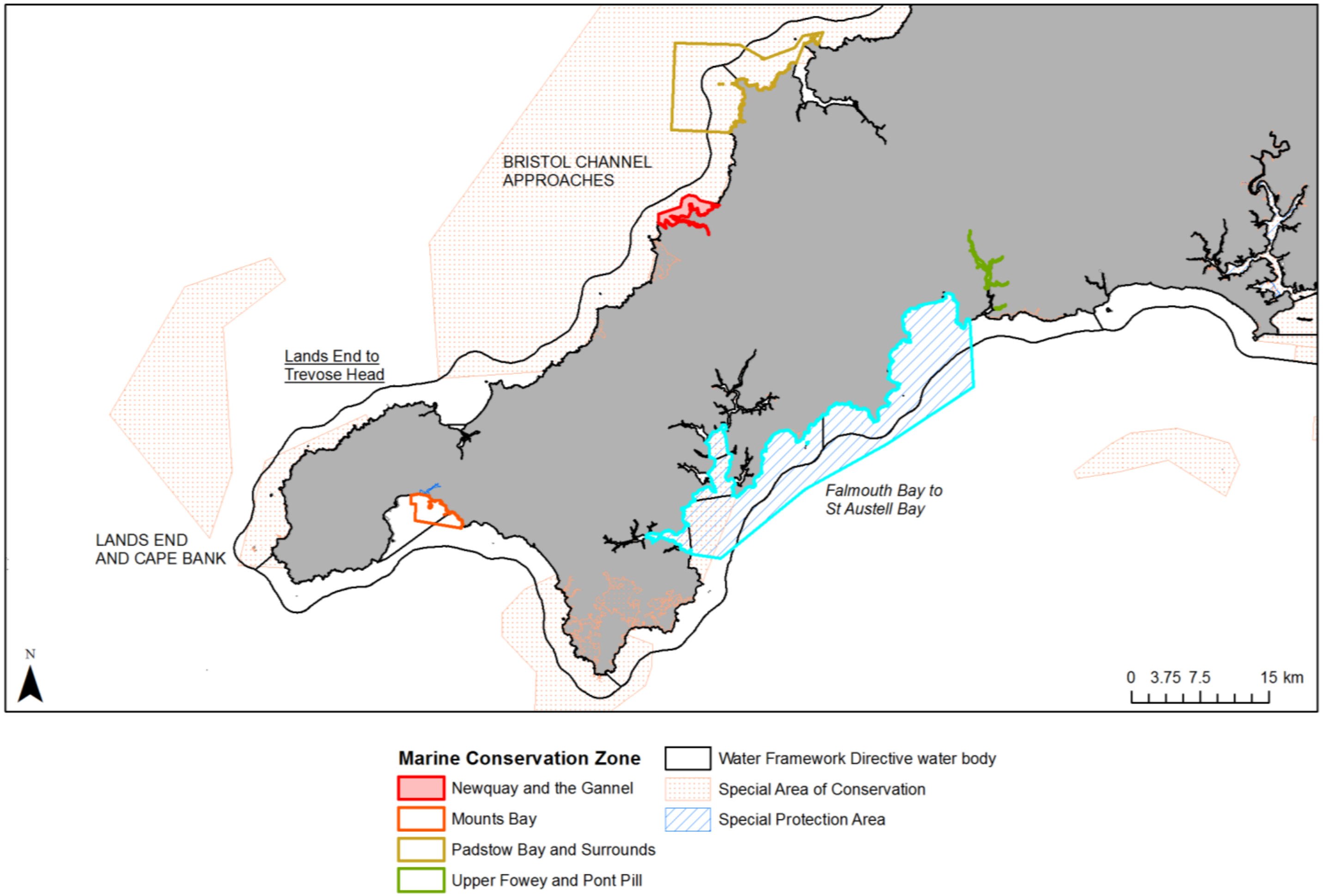



**Figure 1. Location of the Newquay and the Gannel MCZ in the context of Marine Protected Areas and management jurisdictions proximal to the site. Selected SACs (CAPITALISED), SPAs (*italicised*) and WFD water bodies (underlined) are labelled (© Natural England and Environment Agency 2022).**

**Table 1. Newquay and The Gannel MCZ site overview (© Natural England and Environment Agency 2022).**

| | |
|---|---|
| **Charting Progress 2 Region**[2] | Western Channel and Celtic Sea |
| **Spatial Area ($km^2$)** | 8.99 |
| **Water Depth Range (m)** | 0-23 |
| **Broadscale Habitat (BSH) Features Present** | **Designated** |
| A1.1 High energy littoral rock* | ✓ |
| A1.2 Moderate energy intertidal rock* | ✓ |
| A1.3 Low energy intertidal rock* | ✓ |
| A2.1 Intertidal coarse sediment* | ✓ |
| A2.2 Intertidal sand and muddy sand* | ✓ |
| A2.3 Intertidal mud* | ✓ |
| A2.4 Intertidal mixed sediments* | ✓ |
| A3.1 High energy infralittoral rock | ✓ |
| A3.2 Moderate energy infralittoral rock | ✓ |
| A4.1 High energy circalittoral rock | ✓ |
| A5.1 Subtidal coarse sediment | ✓ |
| A5.2 Subtidal sand | ✓ |
| **Habitat FOCI Present** | |
| Estuarine Rocky Habitats* | ✓ |
| Coastal Saltmarshes and Saline Reedbeds* | ✓ |
| **Species FOCI Present** | |
| Giant goby (*Gobius cobitis*)** | ✓ |

** The monitoring survey reported here did not extend into the intertidal.*

***The monitoring survey was not specifically designed to target species FOCI.*

## 1.2 Existing data and habitat maps

The 2017 survey builds on the verification survey conducted by the Environment Agency in 2013 (Arnold and Godsell, 2014; Le Bas, 2015). This was undertaken between February and April 2013 to verify the presence of subtidal features proposed for designation within the Newquay and The Gannel recommended MCZ. A drop down video camera survey was undertaken and following review of the captured images, additional stations were selected for grab sampling. The data gathered from these surveys was used to produce a map of Broadscale Habitats within the MCZ (Figure 2).

The 2013 survey recorded that the majority of the MCZ was subtidal sandy and coarse sediment habitats, with prominent moderate energy infralittoral rock habitats. The

[2]http://webarchive.nationalarchives.gov.uk/20141203170558tf_/http://chartingprogress.defra.gov.uk/ [accessed 25/03/2019]

current survey report uses the 2013 data as a baseline, comparing the data gathered in 2013 with those in 2017.

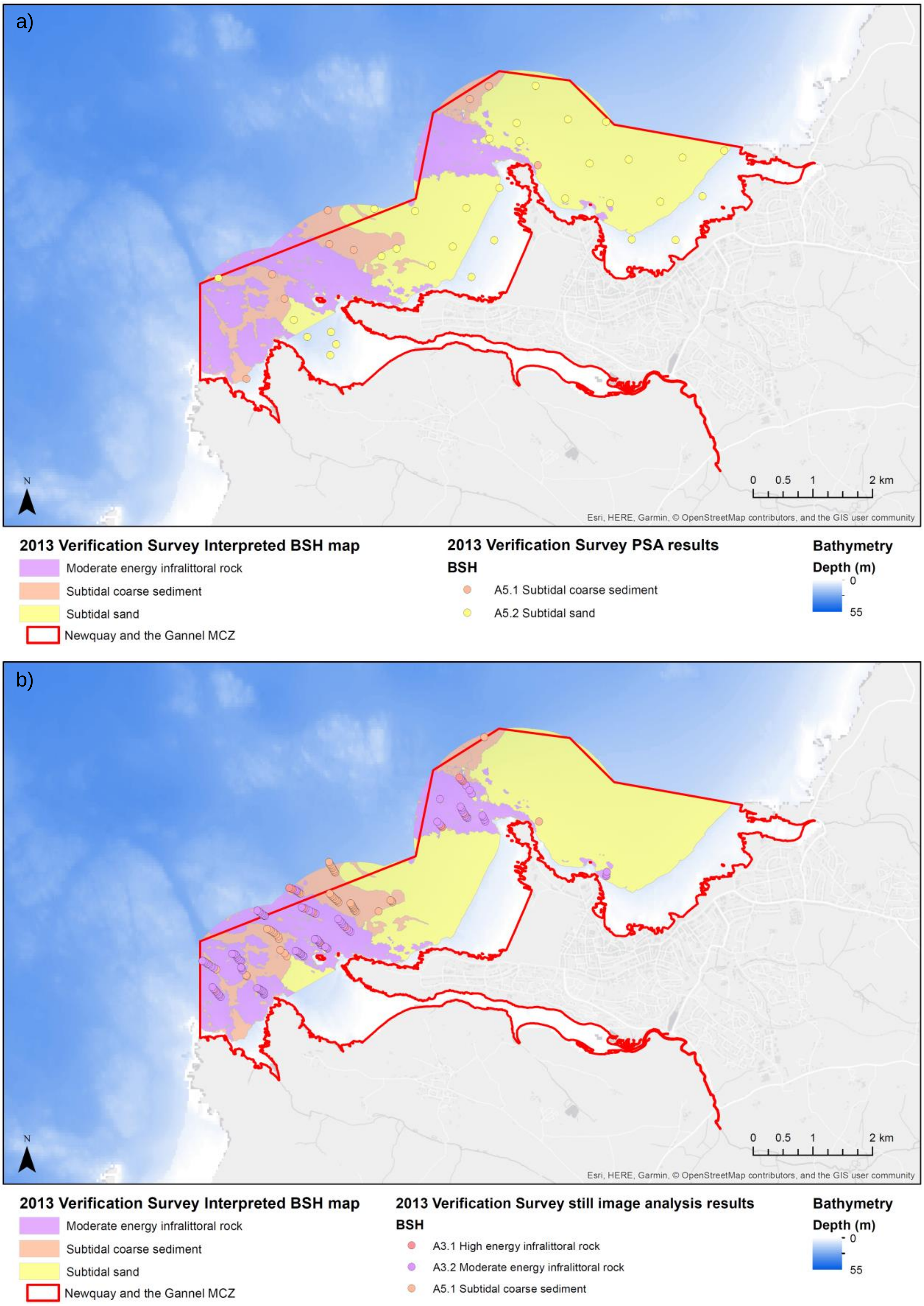



**Figure 2. Acoustically-derived Broadscale Habitat map of the Newquay and The Gannel MCZ 2013 verification survey (Arnold and Godsell, 2014; Le Bas, 2015), indicating a) particle size analysis (PSA) results and b) still image analysis results (© Natural England and Environment Agency 2022).**

## 1.3 Aims and objectives

### 1.3.1 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 Newquay and The Gannel 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.

### 1.3.2 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 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.

### 1.3.3 Report aims and objectives

The primary aim of this monitoring report is to explore and describe the attributes of the designated features within Newquay and The Gannel MCZ, to enable future assessment and monitoring of feature condition. The survey work was designed around the Plan of Action (PoA) document (Miller, 2017). The objective detailed within the PoA ('Objective 1', Miller, 2017) was to conduct a baseline survey of subtidal sand and subtidal coarse habitats, using 76 grab samples, in addition to surveys of moderate energy infralittoral rock habitats using drop camera (DC) deployments at 60 sites. In addition, point records of designated habitat and species FOCI was also an objective identified in the PoA (Miller, 2017). Grab and DC sites were located both within and in the vicinity of Newquay and The Gannel MCZ.

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[3], distribution, structural** and **functional** attributes of the designated features within the site (see Table 2 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;

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

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.

### 1.3.4 Reporting sub-objectives (Objective 1)

To achieve report objective 1, 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 Newquay and Gannel MCZ [4]). 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. The Feature Attributes were therefore rationalised according to SNCB priorities, resulting in a smaller sub-set.

The list of reporting sub-objectives for selected Feature Attributes (and supporting processes) of the designated features is presented in Table 2, alongside the generated outputs for each.

[4] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0037&SiteName=newquay&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

**Table 2. Reporting sub-objectives addressed to achieve report objective 1, for Feature Attributes of Newquay and The Gannel MCZ (© Natural England and Environment Agency 2022).**

| Reporting Sub-objective | Feature Attribute* | Features |
|---|---|---|
| Discuss the physical structure of the rock habitats, as determined using imagery and acoustic data. | **Physical structure** | A3.1 High energy infralittoral rock<br>A3.2 Moderate energy infralittoral rock<br>A4.1 High energy circalittoral rock<br>A4.2 Moderate energy circalittoral rock |
| 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<br>A5.2 Subtidal sand |
| Conduct multivariate analysis of infaunal and epifaunal data to:<br>- Identify patterns in biological assemblages<br>- Assign biotopes (where possible)<br>- Describe variance in biological assemblage structure within and between BSH and habitat FOCI.<br>- Identify key structural and influential species | **Presence and spatial distribution of biological communities**<br>**Presence and abundance of key structural and influential species**<br>**Species composition of component communities** | A3.1 High energy infralittoral rock<br>A3.2 Moderate energy infralittoral rock<br>A4.1 High energy circalittoral rock<br>A4.2 Moderate energy circalittoral rock<br>A5.1 Subtidal coarse sediment<br>A5.2 Subtidal sand |
| 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 |
| Record any incidental occurrences of the Giant goby (*Gobius cobitis*). | **Presence and distribution of the species FOCI** | Giant goby (*Gobius cobitis*). |

* As defined in Supplementary Advice on Conservation Objectives (SACO) for the Newquay and The Gannel MCZ. [https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0037&SiteName=newquay&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=]

# 2 Methods

## 2.1 Survey design

Between April and August 2017 dedicated monitoring surveys were conducted at the Newquay and The Gannel MCZ on board the Environment Agency survey vessel *Severn Guardian* (2FGL50417) (Figure 3; Lord, 2019).

Sampling station selection was based on the BSH map generated from the 2013 verification survey (Figure 2; Arnold and Godsell, 2014; Le Bas, 2015). Within the MCZ boundary, stations were chosen through a combination of random selection and re-sampling of the 2013 sample locations (NWQG 03, 04, 06, 07, 08, 13, 14, 21, 25, 27, and 36). Outside the MCZ boundary, drop camera (DC) and grab stations were selected based on bathymetry and nautical charts due to a lack of historical data. Stations were placed as far west as Holywell Bay and east as Watergate Bay and not below 25 m depth (as marked on the Admiralty Chart) in order sample within the same depth range as the stations inside the MCZ boundary.

Across the survey area, a total of 60 camera stations and 76 grab stations were chosen using a 'Before-After-Control-Impact' (BACI) sampling strategy to provide point records of the BSHs identified in the 2013 verification survey (Figure 2; Arnold and Godsell, 2014). Twenty two grab stations within the MCZ boundary were also selected to be sampled with both Day Grab and Mini-Hamon Grab for infauna and particle size analysis (PSA) as part of a comparison study. Eight stations, four inside and four outside the MCZ boundary, were also selected for sediment contaminant analysis (heavy metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and tributyltin).

The number of stations for 'A5.2 Subtidal sand' (grab samples) and 'A3.2 Moderate energy infralittoral rock' (DC samples) features were calculated using power analysis. The number of grab samples aimed to detect a 20 % change in the Shannon Index of 'A5.2 Subtidal sand' at 80 % power, and the number of still images aimed to detect a 20 % change in taxa richness of 'A3.2 Moderate energy infralittoral rock' at 80 % power. Additional stations were also included to sample 'A5.1 Subtidal coarse sediment' and 'A3.1 High energy infralittoral rock' identified in video still images captured in 2013.

Marine specialists from the Environment Agency and Natural England reviewed the plan. The following hazards were identified from the UKHO Admiralty charts: shallow water depths and underwater obstructions. Sampling stations were relocated to avoid these hazards as far as possible.

A 'Notification of an exempt activity form' was submitted to the Marine Management Organisation prior to the survey being carried out.

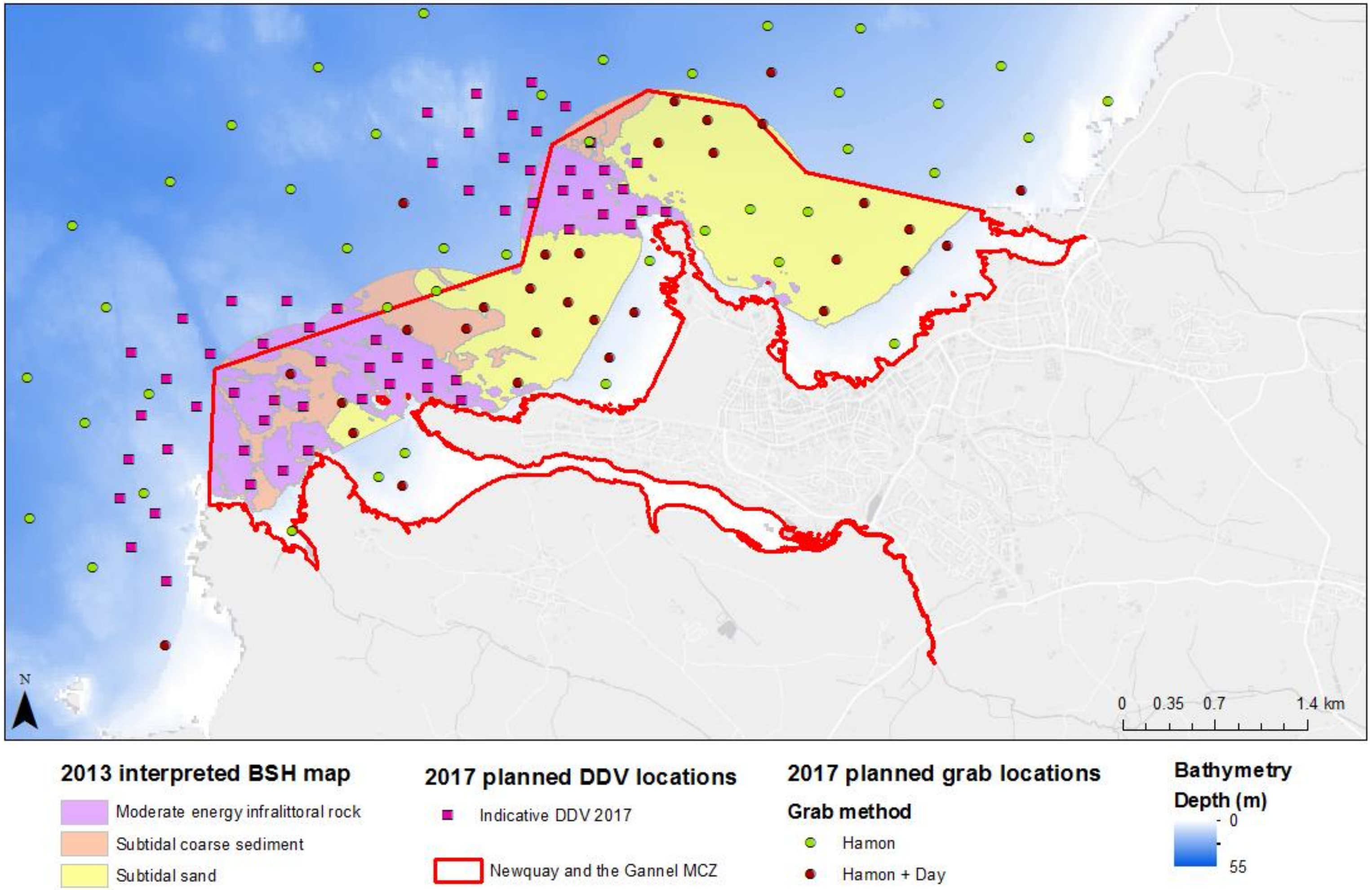



**Figure 3. Planned grab and video sampling locations for the 2017 Newquay and The Gannel MCZ baseline survey (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015) .**

## 2.2 Data acquisition and processing

### 2.2.1 Grab sampling

Seabed sediment samples for particle size distribution and benthic infauna analyses were collected using a 0.1 $m^2$ Mini-Hamon Grab and 0.1 $m^2$ Day Grab (Figure 4, Figure 5).

A 500 ml sub-sample was taken from each grab sample and stored at -20°C prior to determining the particle size distribution. Sediment samples were processed by the National Laboratory Service 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 than1 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 for coastal samples and 0.5 mm for the three estuarine samples (NWQG- 05, 06 and 07), photographed, and then fixed in buffered 4% formaldehyde. Faunal samples were processed by APEM ltd 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).

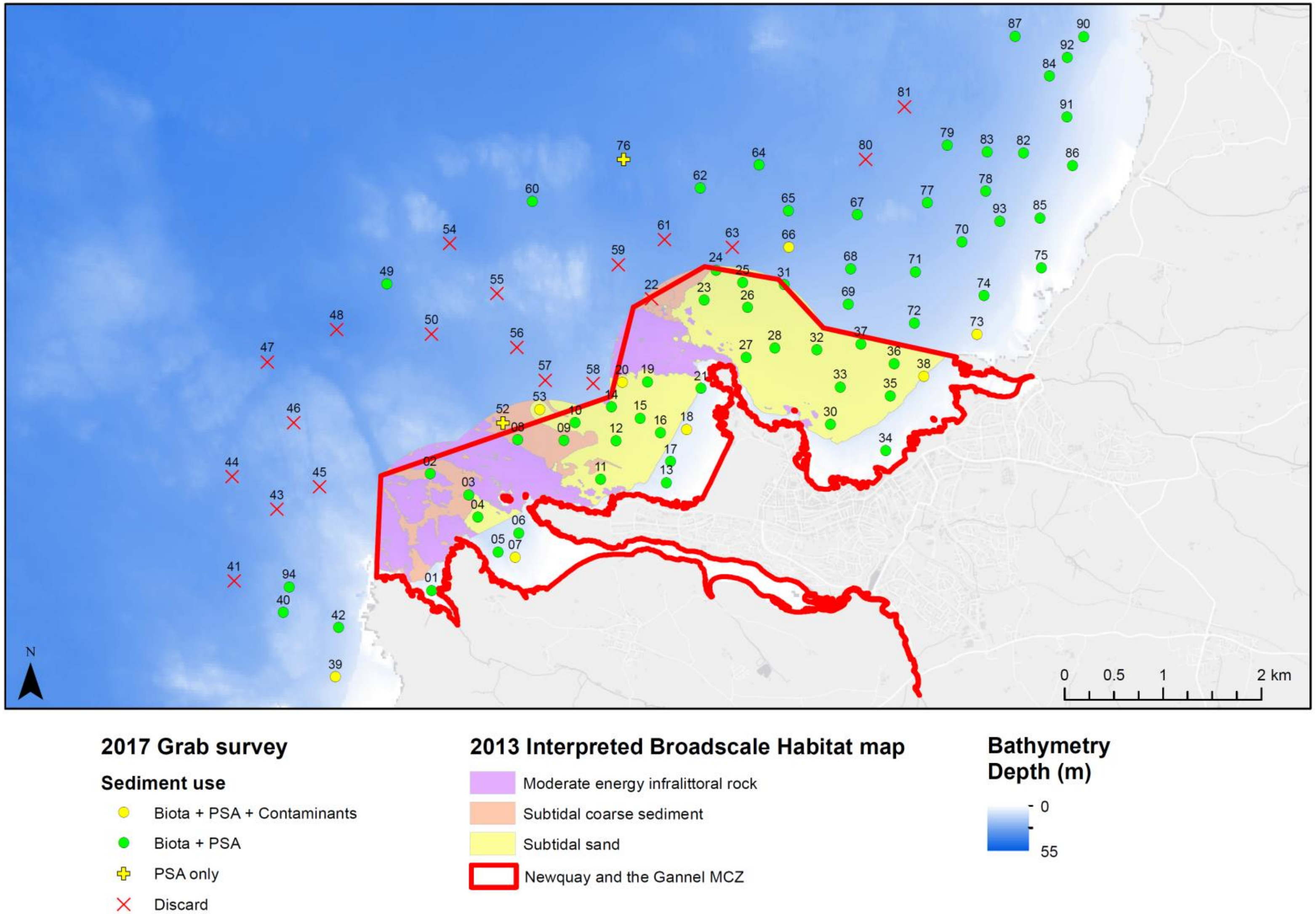



**Figure 4. Locations of viable and discarded sediment grabs sampled during the 2017 Newquay and The Gannel MCZ survey and their uses (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

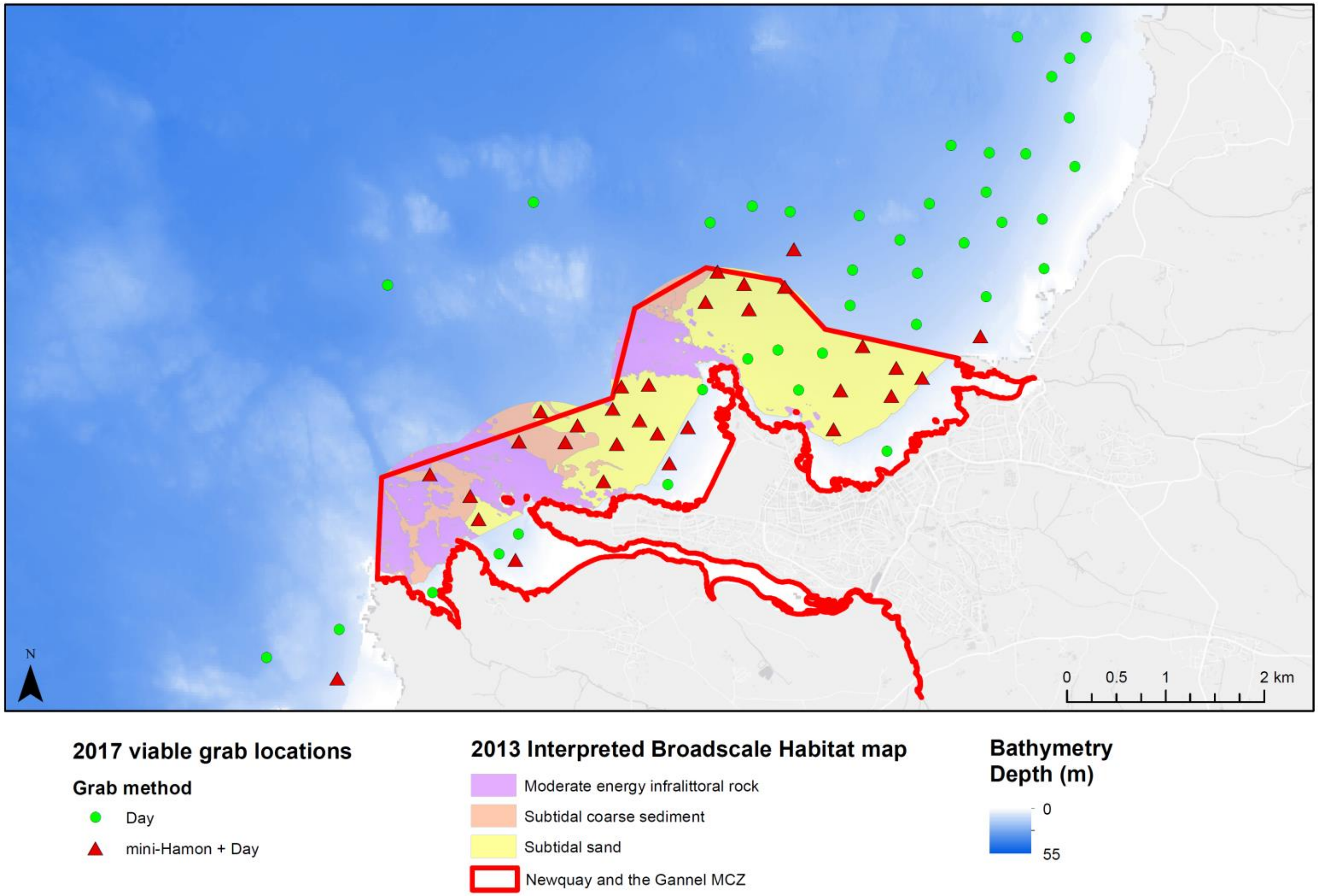



**Figure 5. Locations and sampling method of successful grab samples collected during the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

### 2.2.2 Seabed imagery

Seabed imagery data were collected between 22nd and 24th August 2017, inclusive, using a drop down video system. This system consisted of a digital stills and video camera mounted on a frame. The seabed imagery data were intended to contribute to the characterisation of epifaunal communities associated with both the rock and sediment habitat features. All data were collected following MESH Recommended Operating Guidelines (ROG) (Coggan *et al*., 2007). Video and still images were collected using an STR Seaspyder drop camera system. Real time navigation data acquisition and manual position fixing was captured via Trimble® HYDRO*pro*™ software. Full details can be found in the 2017 survey report (Lord, 2019). Images of the seabed were acquired every 10-15 m over a distance of ~150 m. Additional images were collected in heterogeneous areas of BSH and if particular habitats or species FOCI were observed to ensure, as far as possible, that the habitats and species were adequately sampled and accurately identified. The video footage was annotated with time and position using a SIMRAD MX512 DGPS referenced video overlay (uncorrected position data). The location of video deployments is provided in Figure 6.

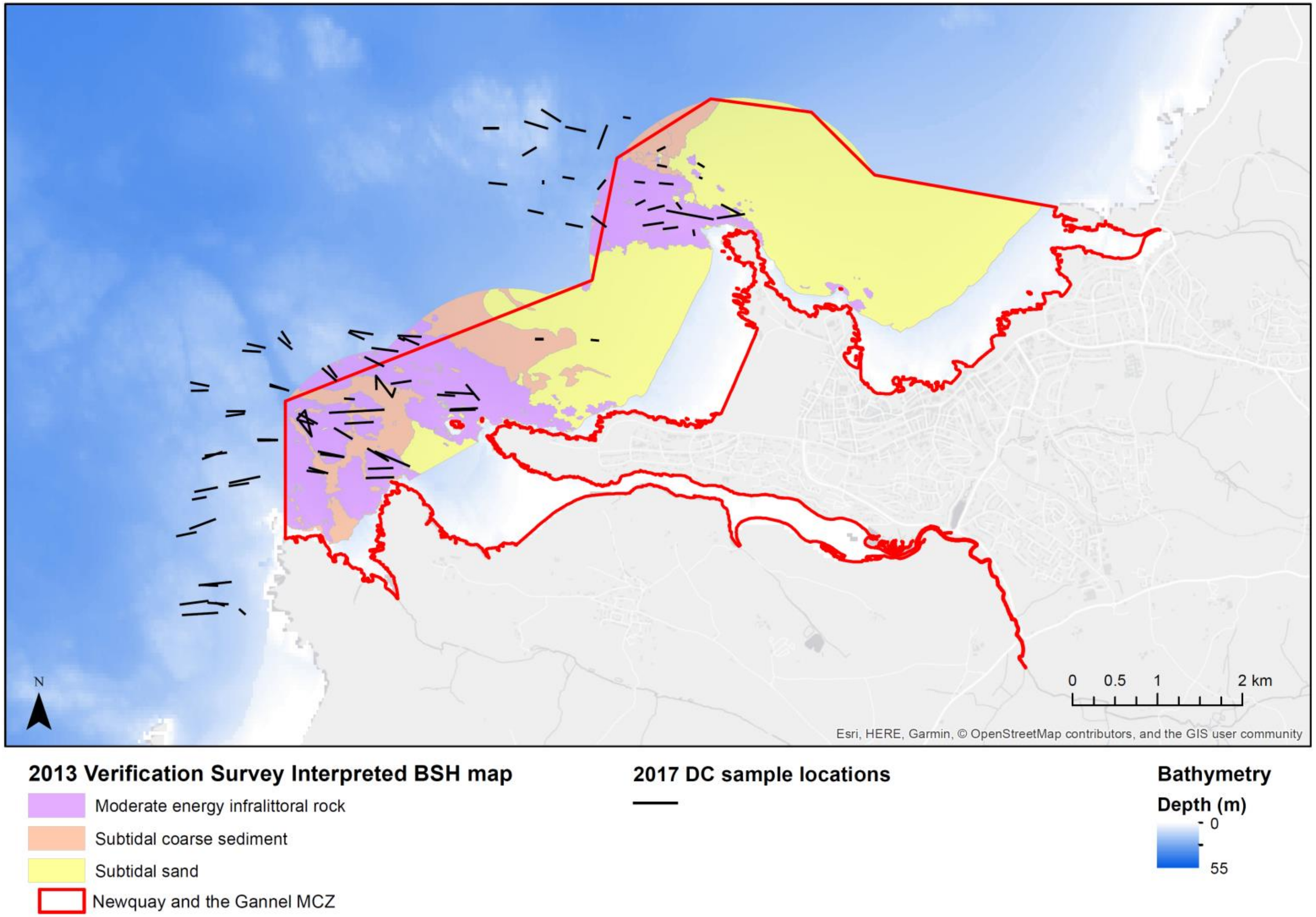



**Figure 6. Locations of drop camera (DC) deployments during the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022).Transect locations are overlain on the interpreted broadscale habitat (BSH) map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

## 2.3 Data preparation and analysis

### 2.3.1 Sediment particle size distribution

Sediment particle size distribution data (half phi classes) were grouped into the percentage contribution of gravel, sand and mud 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 Mapping European Seabed Habitats (MESH) project (Long, 2006).

### 2.3.2 Benthic infauna and epifauna data preparation

Prior to statistical analyses of faunal assemblages within the Newquay and The Gannel 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). Data truncation minimises the influence of inconsistencies in the resolution of laboratory analyses and standardises the data. This therefore increases our confidence in the interpretation of this data.

### 2.3.3 Non-indigenous species (NIS)

The infaunal taxon lists generated from the infaunal samples and seabed imagery data were cross-referenced against lists of non-indigenous target species which have been selected for assessment of Good Environmental Status 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.

### 2.3.4 Data analysis

The low image quality obtained by drop down video and camera survey meant that a considerable amount of truncation of data was required. This made statistical analysis of these data difficult. As a result, statistical analysis of seabed imagery data was limited to higher level comparisons of taxon richness. Taxon diversity was compared between samples gathered inside and outside of the MCZ boundary. To account for differences in diversity between different habitats, Broadscale Habitat was modelled as a random effect. The analysis was conducted using the R packages lme4 and lmerTest (Bates *et al*. 2015; Kuznetsova *et al*. 2017), with the model of the form:

```
fit <- lmer(NTaxa ~ IO + (1|BSH))
```

where *NTaxa* was the number of taxa identified in an image, *IO* was a binary term indicating whether the sample was captured inside or outside of the MCZ, and *BSH* was the Broadscale Habitat from which the sample was gathered).

For the sediment grab samples, the truncated species abundance data were imported into PRIMER v6 (Clarke & Gorley, 2006) to enable multivariate analysis and the derivation of various metrics for univariate analysis. Species classification information and a number of relevant factors/indicators were also assigned to the data at this stage. The number of taxa (S), total abundance of enumerable individuals (N), Shannon Index (H'Log$^{e}$), Simpson's evenness (1-λ') and Hills (N1) diversity metrics were derived for each sample using the DIVERSE function within PRIMER v6. The Infaunal Quality Index (IQI) was calculated using the 11/03/2014 update of the workbook (Phillips *et al*. 2014).

Nonmetric multidimensional scaling (NMDS) ordination, analysis of similarity (abundance square-root transformed species data and Bray-Curtis similarity) between (ANOSIM) and dissimilarity within (SIMPROF with associated SIMPER) groups were conducted in PRIMER v6 to explore differences in biological community composition for (a) between the habitat features and (b) between examples of comparable features located within and outside of the MCZ boundary.

# 3 Results

## 3.1 Environmental overview

The 2017 Newquay and The Gannel MCZ survey identified and successfully sampled all the designated subtidal sediment and rock BSHs (Table 1) and additionally recorded the BSH 'A5.4 Subtidal mixed sediments' outside the MCZ boundary. The distribution of BSHs are in good agreement with the 2013 interpreted habitat map on which the survey was designed (see Figure 13, Figure 27 and Figure 30). Table 33 shows the number of samples collected from each BSH. The most extensively sampled BSH inside and outside the MCZ was 'A5.2 Subtidal sand'. This BSH was the most species poor and least diverse of the sediment BSHs sampled (Table 4 and Section 3.4.1). Mean ± SD faunal biomasses were significantly lower in 'A5.2 Subtidal sand samples' (0.73 ± 1.58 g $sample^{-1}$) than those in 'A5.1 Subtidal coarse sediment' samples (2.97 ± 2.57 g $sample^{-1}$) (one-way ANOVA $F_{2,100} = 6.81$, $P = 0.002$). Grab sampling was unsuccessful at a number of stations (Figure 4). At these stations, there appeared to be insufficient sediment present to allow a suitable sample to be extracted. This suggests the presence of bedrock habitats beneath a relatively shallow coverage of sediment.

A total of 224 taxa were recorded in the benthic grabs. Infaunal species richness, abundance and biomass varied spatially, but were all generally, with exceptions, higher toward the north-east (Figure 7, Figure 8 and Figure 9). There were no statistically significant differences for most univariate infaunal metrics between samples taken inside and samples taken outside the MCZ boundary ($P > 0.129$). The exception was for IQI values which, after conditioning on BSH, were significantly larger outside the MCZ than inside ($F_{1, 98.9} = 16.43$, $P < 0.001$). Mean (± SE) IQI values inside the MCZ were 0.59 ± 0.01, corresponding to a Moderate WFD classification. Those outside the MCZ 0.66 ± 0.01, reflecting a Good WFD classification (Figure 10).

Subtidal rock habitats inside and outside of the MCZ were predominately recorded as the 'A3.1 High energy infralittoral rock' BSH. Comparisons with surveys conducted in 2013 revealed a broadly similar distribution of habitats in 2017.

Three species of the polychaete genus *Syllis* (*S. garciai, S. licheri* and *S. pontxioi*) and the segmented worm *Prosphaerosyllis chauseyensis,* not formally recorded in the UK, were present at several stations sampled. Three individuals of the commercially important sand eel (*Ammodytes tobianus*) were present inside the MCZ. Juveniles of the commercially important blue mussel (*Mytilus edulis*) were present inside (n = 22) and outside (n = 3) the MCZ, but no adults were observed.

**Table 3. Number of samples collected in each Broadscale Habitat (BSH) for the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022).**

| Broadscale Habitat (BSH) | Grab – PSA and Infauna | | Grab – PSA only | | Video | | Stills | |
|---|---|---|---|---|---|---|---|---|
| | In | Out | In | Out | In | Out | In | Out |
| A3.1 High energy infralittoral rock | n/a | n/a | n/a | n/a | 23 | 44 | 217 | 347 |
| A3.2 Moderate energy infralittoral rock | n/a | n/a | n/a | n/a | 0 | 1 | 11 | 15 |
| A4.1 High energy circalittoral rock | n/a | n/a | n/a | n/a | 2 | 2 | 10 | 16 |
| A5.1 Subtidal coarse sediment | 6 | 1 | - | - | 8 | 10 | 67 | 69 |
| A5.2 Subtidal sand | 58 | 35 | - | 1 | 9 | 1 | 29 | 3 |
| A5.4 Subtidal mixed sediments | 0 | 1 | - | 1 | - | - | - | - |

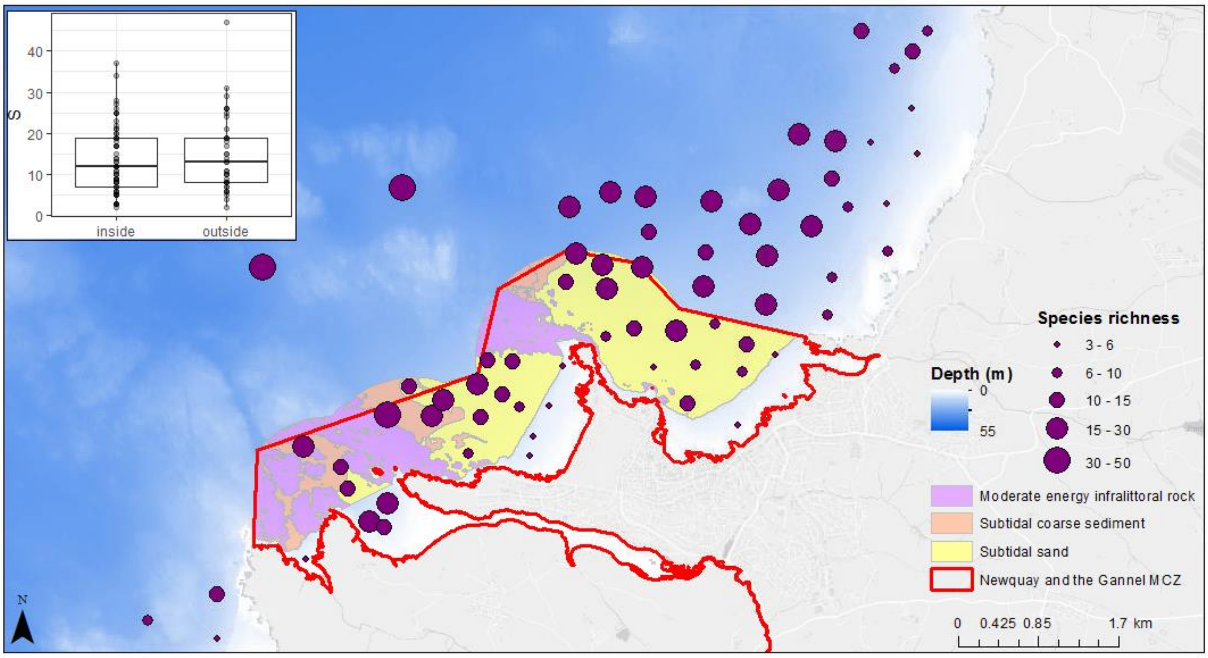



**Figure 7. Spatial pattern of infaunal species richness ($S$ sample$^{-1}$) observed in the 2017 Newquay and The Gannel MCZ benthic survey (© Natural England and Environment Agency 2022). Where stations were sampled with both Day Grab and Mini-Hamon Grabs symbols represent the mean of both methods. Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

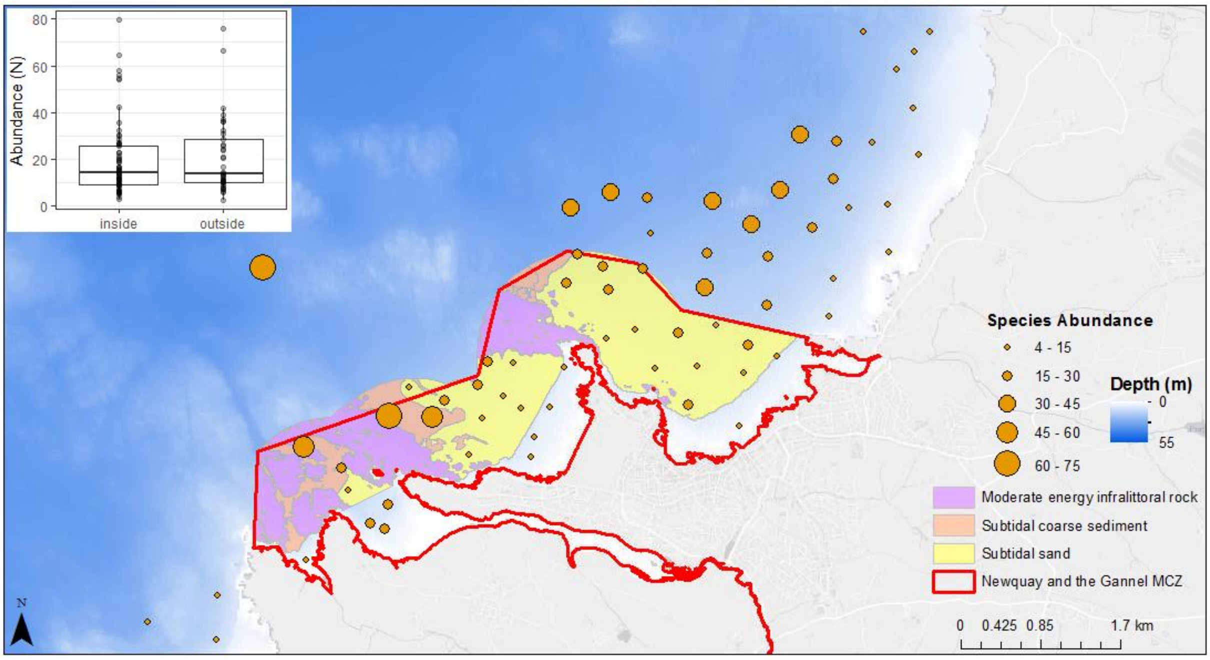



**Figure 8. Spatial pattern of infaunal species abundance (*n* sample$^{-1}$) observed in the 2017 Newquay and The Gannel MCZ benthic survey (© Natural England and Environment Agency 2022). Where stations were sampled with both Day Grab and Mini-Hamon Grabs symbols represent the mean of both methods. Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

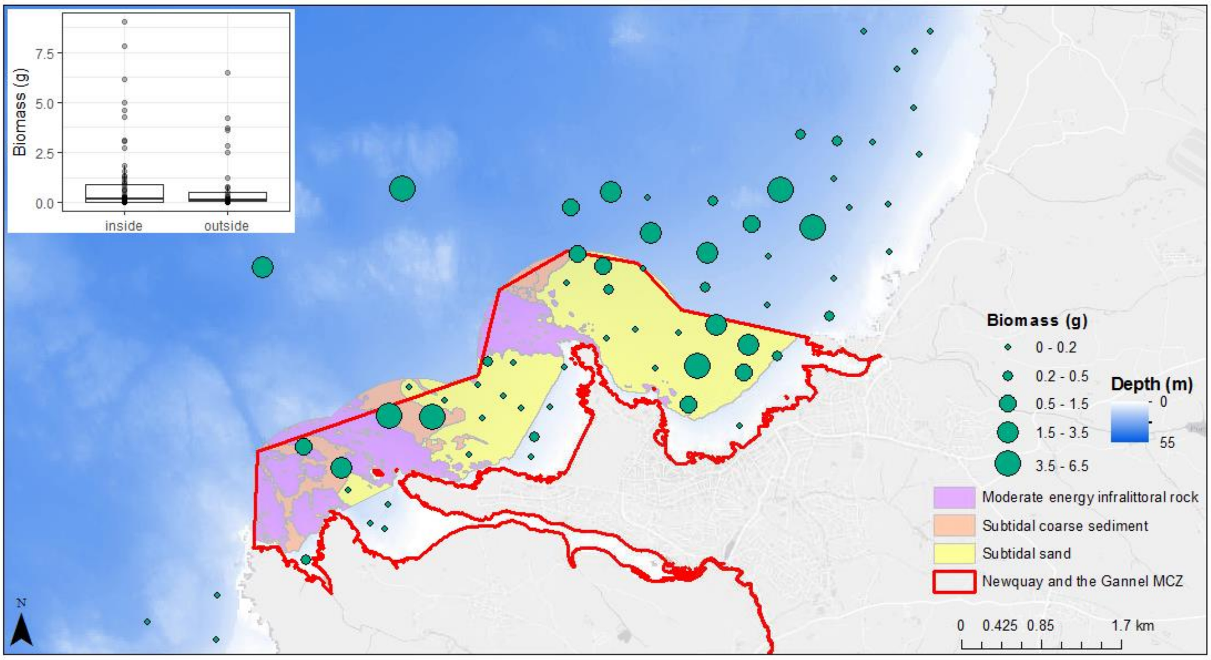



**Figure 9. Spatial pattern of infaunal biomass observed in the 2017 Newquay and The Gannel MCZ benthic survey (© Natural England and Environment Agency 2022). Where stations were sampled with both Day Grab and Mini-Hamon Grabs symbols represent the mean of both**

**methods. Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

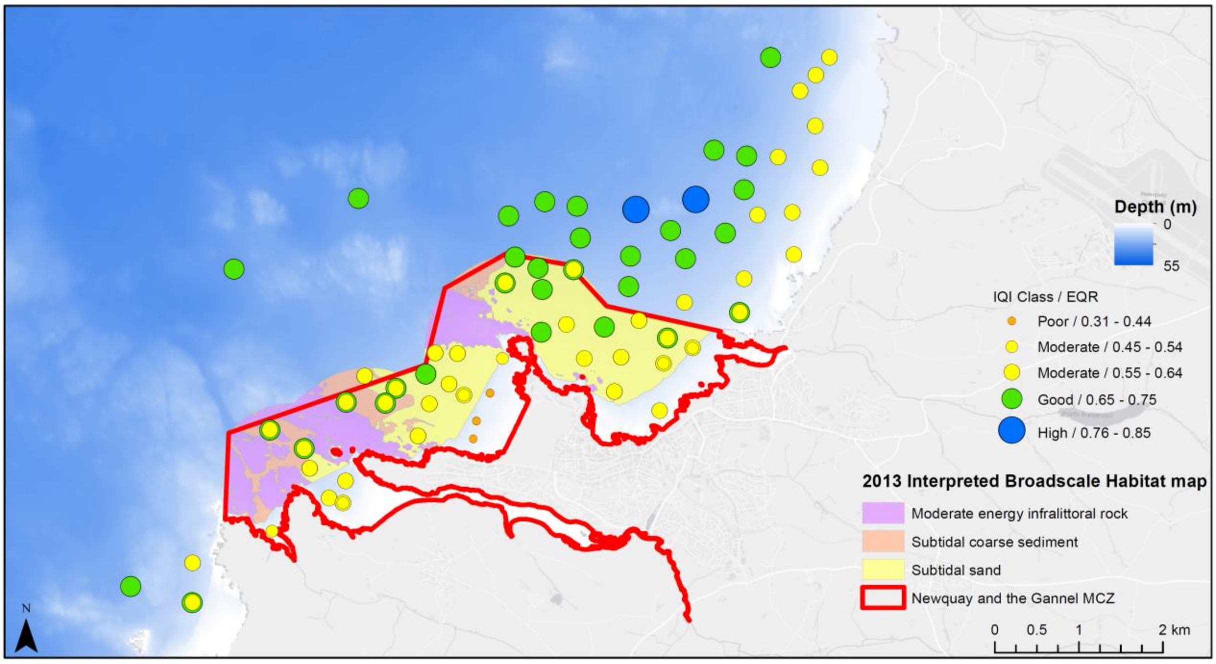



**Figure 10. Spatial pattern of Infaunal Quality Index (IQI) values recorded in the 2017 Newquay and The Gannel MCZ benthic survey (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

**Table 4. Mean (± standard error) univariate descriptors calculated from all grab samples and in each of the sediment Broadscale Habitat (BSHs) sampled inside and outside the Newquay and The Gannel MCZ in 2017 (© Natural England and Environment Agency 2022).**

| | Sample number | | Total taxa | Abundance ($n$ sample$^{-1}$) | | Taxa Richness ($S$ sample$^{-1}$) | | Biomass (g) | | Shannon Index H'(log$^e$) | | Simpsons Evenness (1-λ') | | Hill's N1 | | Infaunal Quality Index (IQI) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | ±S.E. | Mean | ±S.E. | Mean | ±S.E. | Mean | ±S.E. | Mean | ±S.E. | Mean | ±S.E. | Mean | ±S.E. |
| All | Inside | 64 | 176 | 52.30 | 11.27 | 13.25 | 1.07 | 0.93 | 0.23 | 1.96 | 0.09 | 0.80 | 0.03 | 8.65 | 0.64 | 0.59 | 0.01 |
| | Outside | 37 | 153 | 41.59 | 8.8 | 14.95 | 1.56 | 0.87 | 0.25 | 2.14 | 0.09 | 0.86 | 0.02 | 9.69 | 0.74 | 0.66 | 0.01 |
| 'A5.1 Subtidal coarse sediment' | Inside | 6 | 73 | 190.0 | 47.25 | 24.33 | 4.2 | 2.84 | 1.14 | 2.21 | 0.26 | 0.80 | 0.05 | 10.68 | 2.58 | 0.65 | 0.01 |
| | Outside | 1 | 47 | 217.0 | n/a | 47.00 | n/a | 3.73 | n/a | 2.52 | n/a | 0.79 | n/a | 12.47 | n/a | 0.70 | n/a |
| 'A5.2 Subtidal sand' | Inside | 58 | 146 | 38.05 | 9.83 | 12.10 | 0.91 | 0.73 | 0.22 | 1.93 | 0.09 | 0.80 | 0.03 | 8.44 | 0.65 | 0.59 | 0.01 |
| | Outside | 35 | 112 | 30.17 | 3.84 | 13.57 | 1.26 | 0.72 | 0.25 | 2.12 | 0.10 | 0.87 | 0.02 | 9.60 | 0.78 | 0.66 | 0.01 |
| 'A5.4 Subtidal mixed sediments' | Inside | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Outside | 1 | 31 | 266.0 | n/a | 31 | n/a | 3.06 | n/a | 2.28 | n/a | 0.83 | n/a | 9.74 | n/a | 0.68 | n/a |

## 3.2 Particle size analysis (PSA)

The results of PSA are presented in Figure 11, Figure 12 and Figure 13. A total of 107 samples taken from subtidal sediments underwent PSA (64 inside and 43 outside the MCZ boundary). Of these, 89% (n = 95) were assigned to the 'A5.2 Subtidal sand' BSH of which 61% (n = 58) were inside and 39% (n = 37) were outside the MCZ boundary. Samples assigned to the 'A5.1 Subtidal coarse sediment' BSH were the second-most numerous accounting for 8% (n = 9) of all PSA samples, of which 66% (n = 6) were inside and 33% (n = 3) were outside the MCZ boundary. A further 2% (n = 2) of samples were assigned to the undesignated BSH 'A5.4 Subtidal mixed sediments', all of which were outside the MCZ boundary. All PSA samples collected within the MCZ boundary are in good agreement with the 2013 interpreted habitat map. The majority of PSA samples collected outside the MCZ boundary in 2017 were beyond the extent of the 2013 interpreted habitat map with only two samples close to the MCZ boundary having overlap with the interpreted habitat map. Of these two samples, one was in good agreement with the sediment type predicted in the 2013 interpreted habitat map. One sample was assigned to the undesignated 'A5.4 Subtidal mixed sediments' BSH in 2017, however the predicted habitat at this site as indicated by the 2013 interpreted habitat map was 'A5.1 Subtidal coarse sediment'.

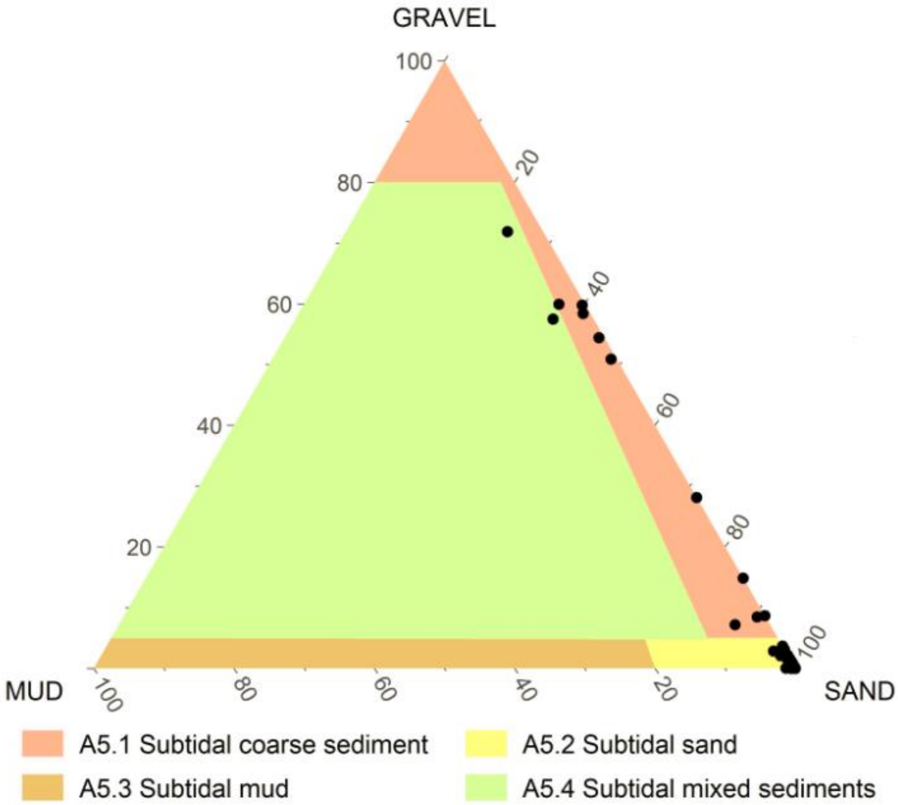



**Figure 11. Classification of particle size distribution (half phi) information for each sampling point (black dots) into one of the sediment Broadscale Habitats (coloured areas) plotted on a true scale subdivision of the Folk triangle into the simplified classification for UKSeaMap (Long, 2006; Folk, 1954) (© Natural England and Environment Agency 2022).**

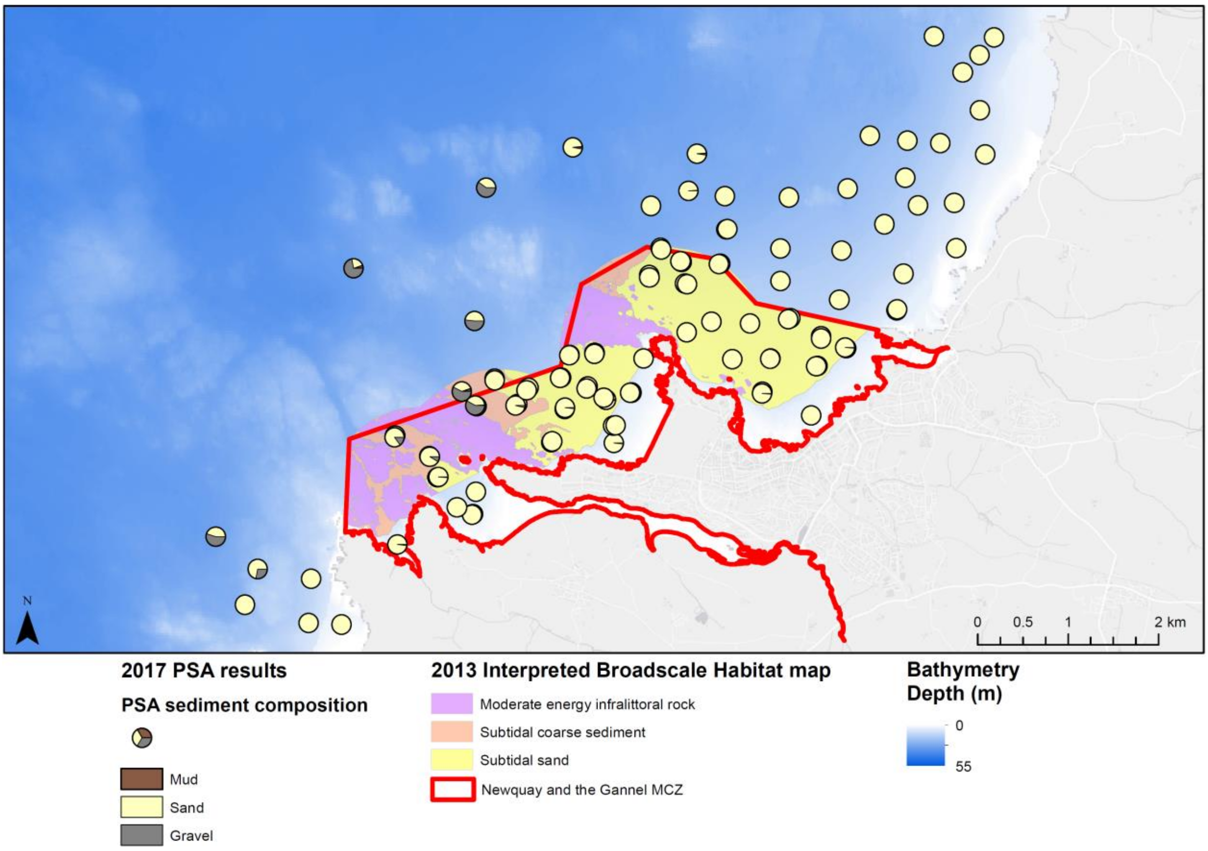



**Figure 12. Proportion of mud, sand & gravel in the 2017 Newquay and The Gannel MCZ survey particle size analysis (PSA) samples (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

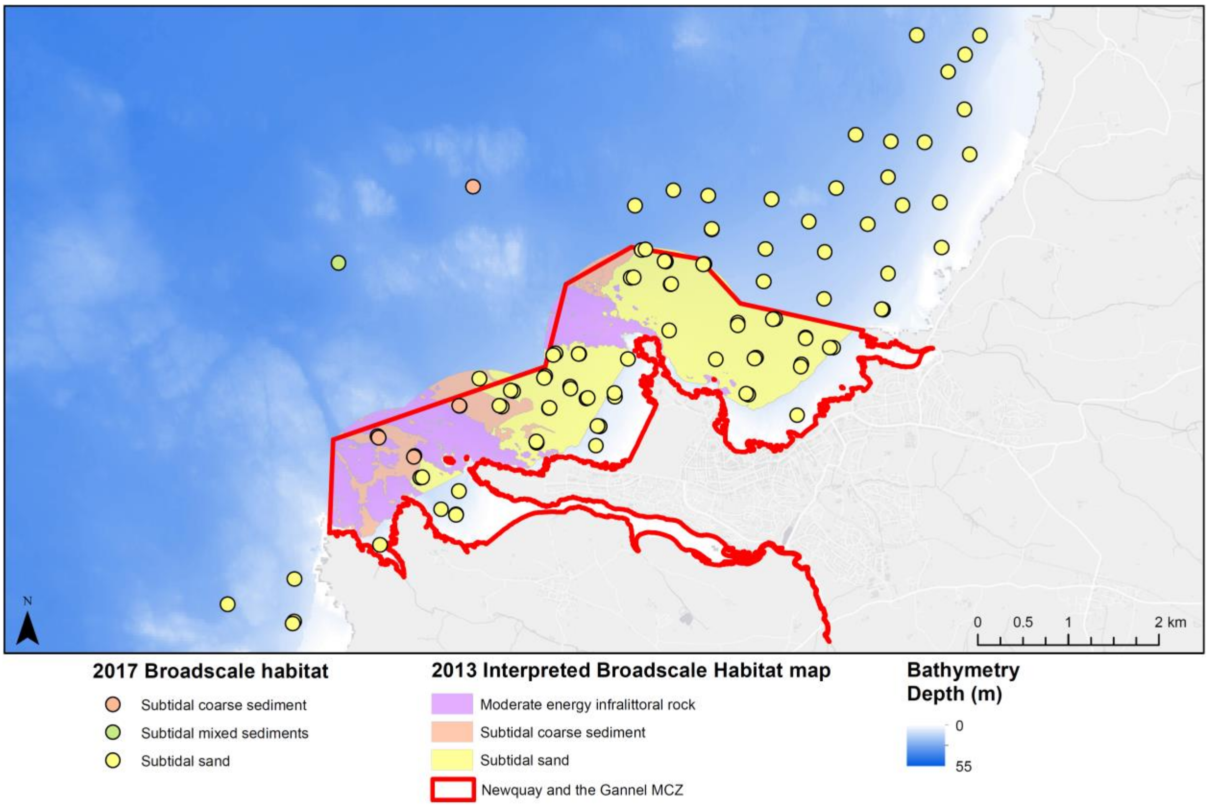



**Figure 13. Distribution of BSHs inferred from the 2017 PSA data compared with the 2013 interpreted habitat map (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

## 3.3 Comparison between Day Grab and Mini-Hamon Grab samples

Previous MCZ infaunal surveys of sediment BSHs have used the Day Grab sampling method (Day, 1978). Owing to concerns regarding the replicability of infaunal samples collected using a Day Grab (where coarse sediments may obstruct the Day Grab jaw, preventing it from operating properly and leading to some of the sample being washed out before retrieval), duplicate 'paired' sampling using both Mini-Hamon Grab (Oele, 1978) and Day Grab sampling gear was carried out at 31 stations during the 2017 Newquay and The Gannel MCZ survey (Figure 5). This section compares the infaunal communities recorded in the 'paired' Day Grab and Mini-Hamon Grab samples in order to assess whether apparent faunal differences between habitats and/or samples are genuine or an artefact of the sampling gear used.

Comparisons were made between common univariate descriptors of the infaunal communities (Figure 14, Table 5), community composition (Figure 15) and the assigned biotopes (Figure 16 and Figure 17). Comparison of species abundance (n sample$^{-1}$), species richness (*S* sample$^{-1}$), effective number of species (Hill's N1) and biomass showed no significant differences between Mini-Hamon Grab or Day Grabs across, or within, all BSHs sampled by 'paired' methods. At the community level, the results of non-metric multidimensional scaling (NMDS) showed that the Day Grab and

Mini-Hamon Grab infaunal communities generally occupy the same ordination space as a function of BSH and station (Figure 15). Analysis of similarities (ANOSIM) between Day Grab and Mini-Hamon Grab sampled infaunal communities showed no significant differences (Global $R = 0.033$, $P = 0.07$). These comparisons suggest that the Day Grab sampling method is replicable (or the Mini-Hamon Grab method is equally unreliable). Because there were low 'paired' sample numbers in the 'A5.1 Subtidal coarse sediment', the lack of significant differences here should be interpreted with caution. Where sampled together, there is generally good agreement between the biotopes assigned to Day Grab and Mini-Hamon Grab samples and where there are differences these are constrained to the fourth level of the biotope classification (Figure 15 and Figure 16).

In the interests of preserving as much useful information as possible it is desirable to use both the Day Grab and Mini-Hamon Grab results for the remainder of this report. Because the 2017 Newquay and The Gannel MCZ survey sampled more extensively using the Day Grab method than the Mini-Hamon Grab method (Figure 5) it is important to ensure that combining the results does not inappropriately represent the communities sampled with 'paired' methods. This is especially important here because these samples predominantly fall within the MCZ boundary. To this end, univariate comparisons of the magnitude of differences (Ho, 2019) between uncombined (all Day Grab and Mini-Hamon Grab raw abundances unsummed), combined (taking the sum of Day Grab and Mini-Hamon Grab raw abundance at 'paired' stations) and Mini-Hamon Grab-only samples using Day Grab only samples as the control (Figure 18 and Figure 19). It would not be appropriate to perform a comparison between combinations inside and outside the MCZ boundary because of the Mini-Hamon Grab sampling was unbalanced (only two samples were taken outside the MCZ boundary). The results of these comparisons demonstrate that simply adding the raw abundances of the Day Grab and Mini-Hamon Grab samples together results in a significant, artificial, increase in species richness and effective number of species. The small magnitude differences observed between Mini-Hamon Grab and Day Grab metrics suggests that Day Grab sampling has not introduced artificial differences in the community related to the mechanics of the sampling gear. The smallest differences are observed in the uncombined samples, which show no significant differences between Day Grab and Mini-Hamon Grab sampling methods. As such, for these data, comparisons could be made without a confounding influence of sampling method skewing the results.

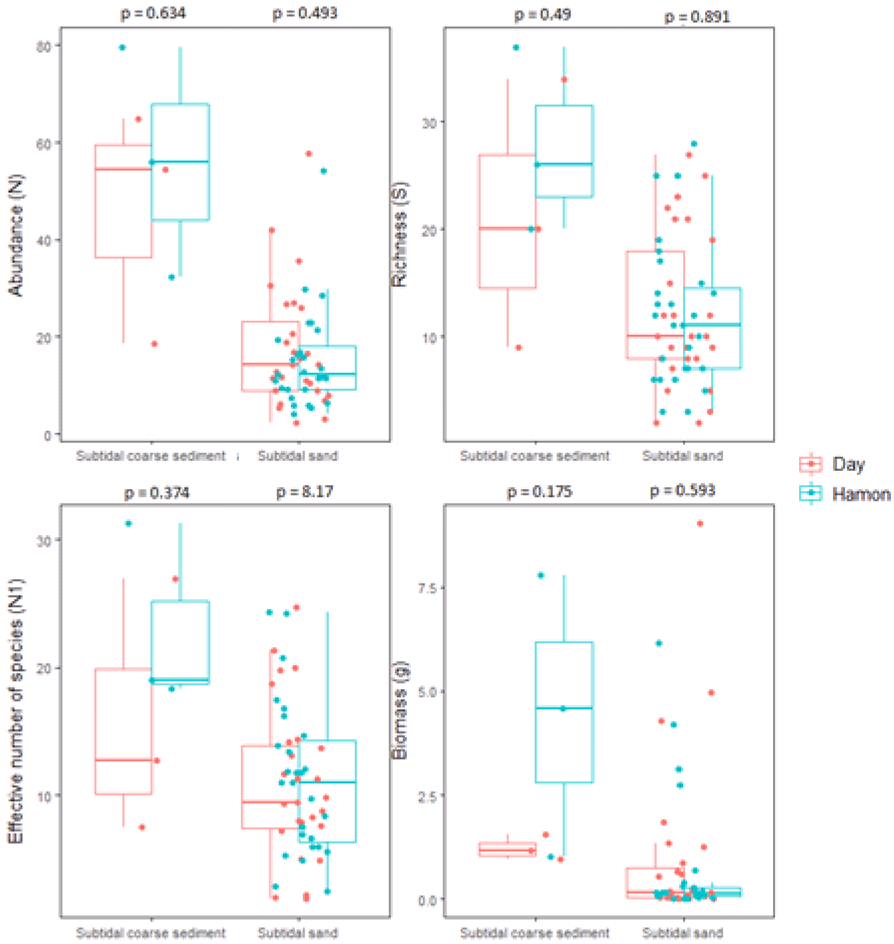



**Figure 14. Boxplot comparisons of infaunal species abundance (n sample$^{-1}$), richness (*S* sample$^{-1}$), effective number of species (Hill's N1) and biomass (g) derived from the 'paired' (n=31) Day Grab and Mini-Hamon Grab samples taken during the 2017 Newquay and The Gannel MCZ survey for each Broadscale Habitat surveyed (© Natural England and Environment Agency 2022). Points indicate the results for each sample. The significance of differences between the means (*p* values) for 'A5.1 Subtidal coarse sediment' and 'A5.2 Subtidal sand' were computed by one-way ANOVA tests.**

**Table 5. Mean (± standard error) univariate descriptors calculated for the ‘paired’ Day Grab and Mini-Hamon Grab samples in each of the sediment Broadscale Habitat (BSHs) sampled in the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022).**

| | | Sample number | Total taxa | Abundance (n sample$^{-1}$) | | Taxon Richness (S sample$^{-1}$) | | Biomass (g) | | Shannon Index H' (log$^{e}$) | | Simpson’s Evenness (1-λ') | | Hill's N1 (exp[H']) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | ± SE | Mean | ± SE | Mean | ± SE | Mean | ± SE | Mean | ± SE | Mean | ± SE |
| All | Day Grab | 31 | 128 | 40.23 | 20.4 | 13.55 | 1.43 | 1.07 | 0.34 | 2.12 | 0.12 | 0.86 | 0.04 | 9.75 | 0.85 |
| | Mini-Hamon Grab | 31 | 130 | 54.00 | 11.3 | 12.73 | 1.45 | 0.99 | 0.36 | 1.89 | 0.11 | 0.80 | 0.03 | 8.03 | 0.94 |
| 'A5.1 Subtidal coarse sediment' | Day Grab | 3 | 44 | 205. 7 | 88.1 | 21.00 | 7.23 | 1.23 | 0.17 | 1.83 | 0.34 | 0.72 | 0.07 | 7.02 | 2.58 |
| | Mini-Hamon Grab | 3 | 56 | 174.3 | 56.3 | 27.67 | 4.98 | 4.46 | 1.96 | 2.59 | 0.27 | 0.88 | 0.05 | 14.34 | 3.65 |
| 'A5.2 Subtidal sand' | Day Grab | 28 | 109 | 48.6 | 19.1 | 12.11 | 1.34 | 0.96 | 0.38 | 1.88 | 0.13 | 0.80 | 0.04 | 8.00 | 0.91 |
| | Mini-Hamon Grab | 28 | 103 | 25.9 | 7.2 | 12.04 | 1.23 | 0.71 | 0.28 | 2.06 | 0.12 | 0.86 | 0.03 | 9.26 | 0.94 |

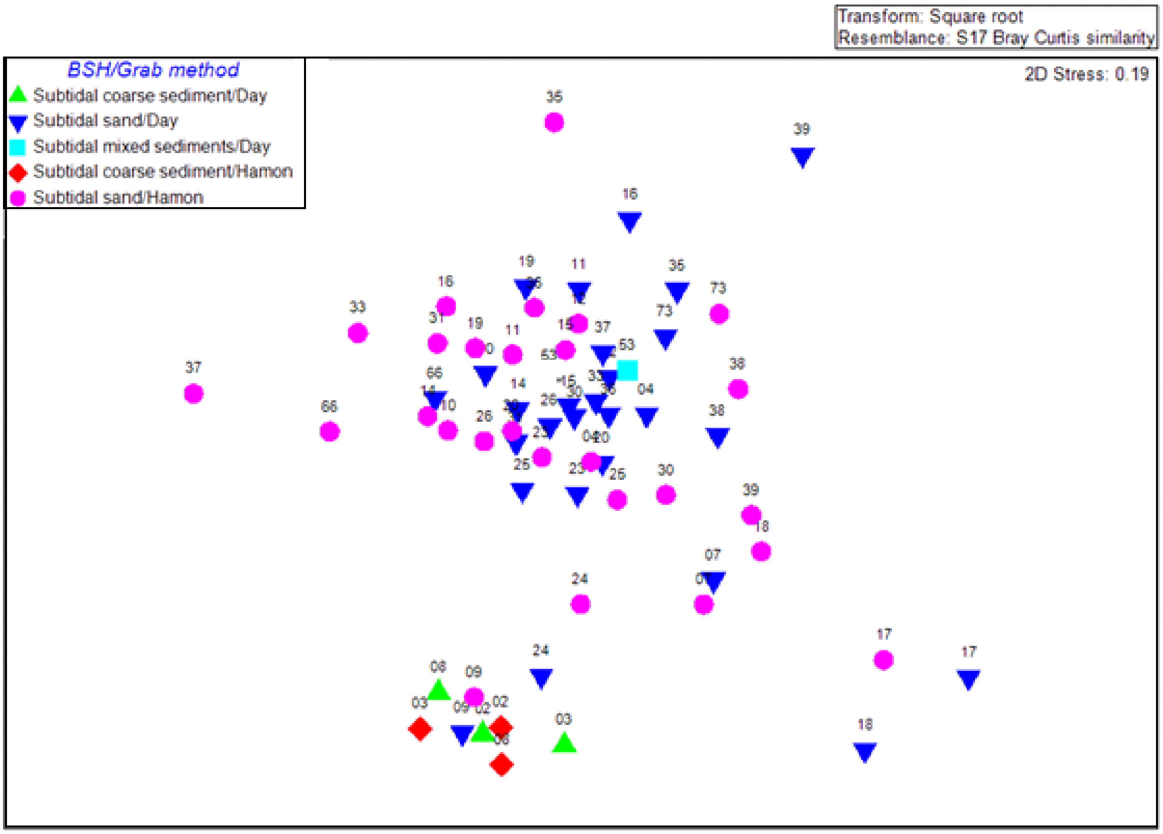



**Figure 15. Non-metric multidimensional scaling (NMDS) plot of infaunal communities in 'paired' Day Grab and Mini-Hamon Grabs sampled in the 2017 Newquay and The Gannel MCZ survey, grouped by Broadscale Habitat and grab method (© Natural England and Environment Agency 2022).**

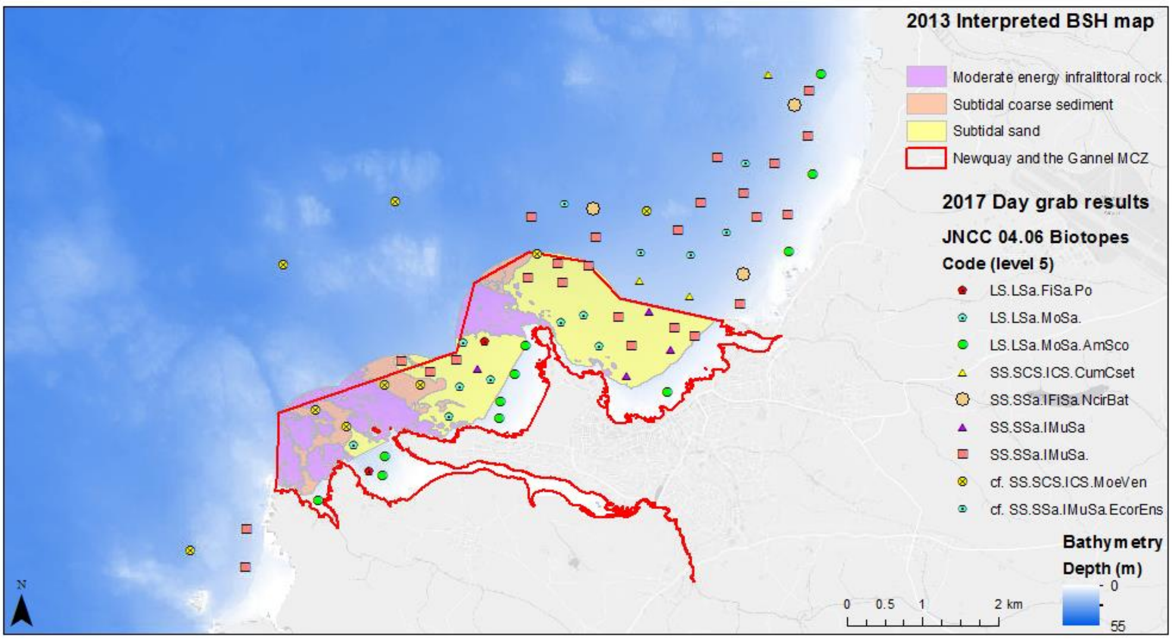



**Figure 16. Distribution of biotopes assigned to Day Grab samples collected during the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022). Point**

**locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

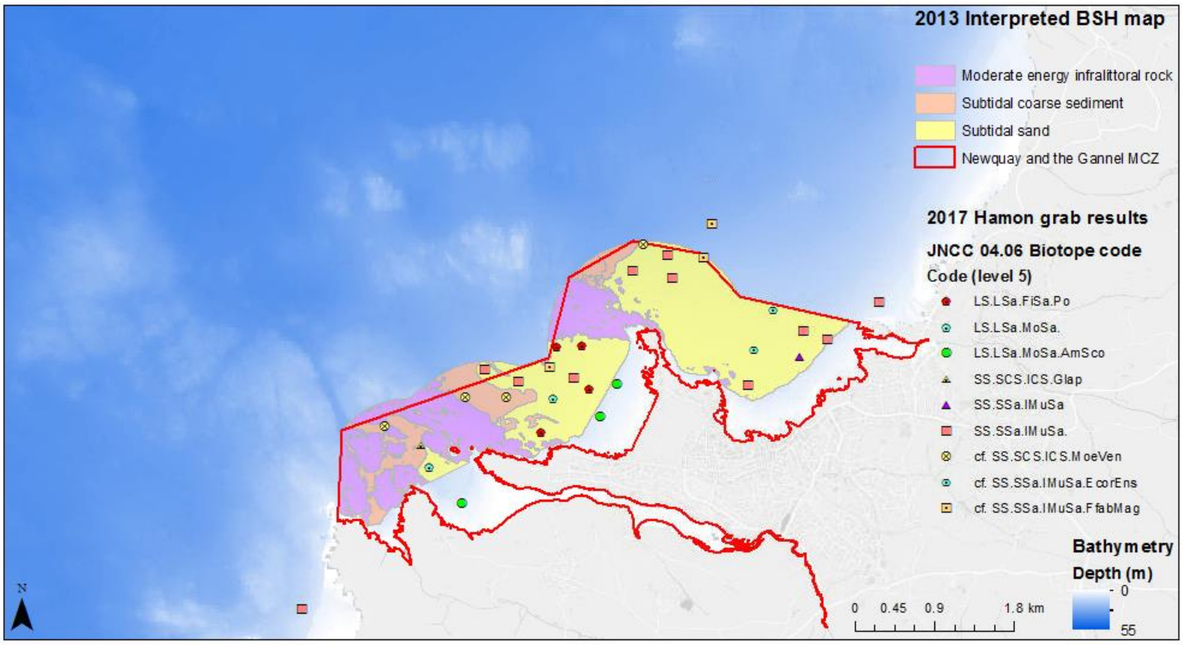



**Figure 17. Distribution of biotopes assigned to Mini-Hamon Grab samples collected during the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022).**

**Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015)**

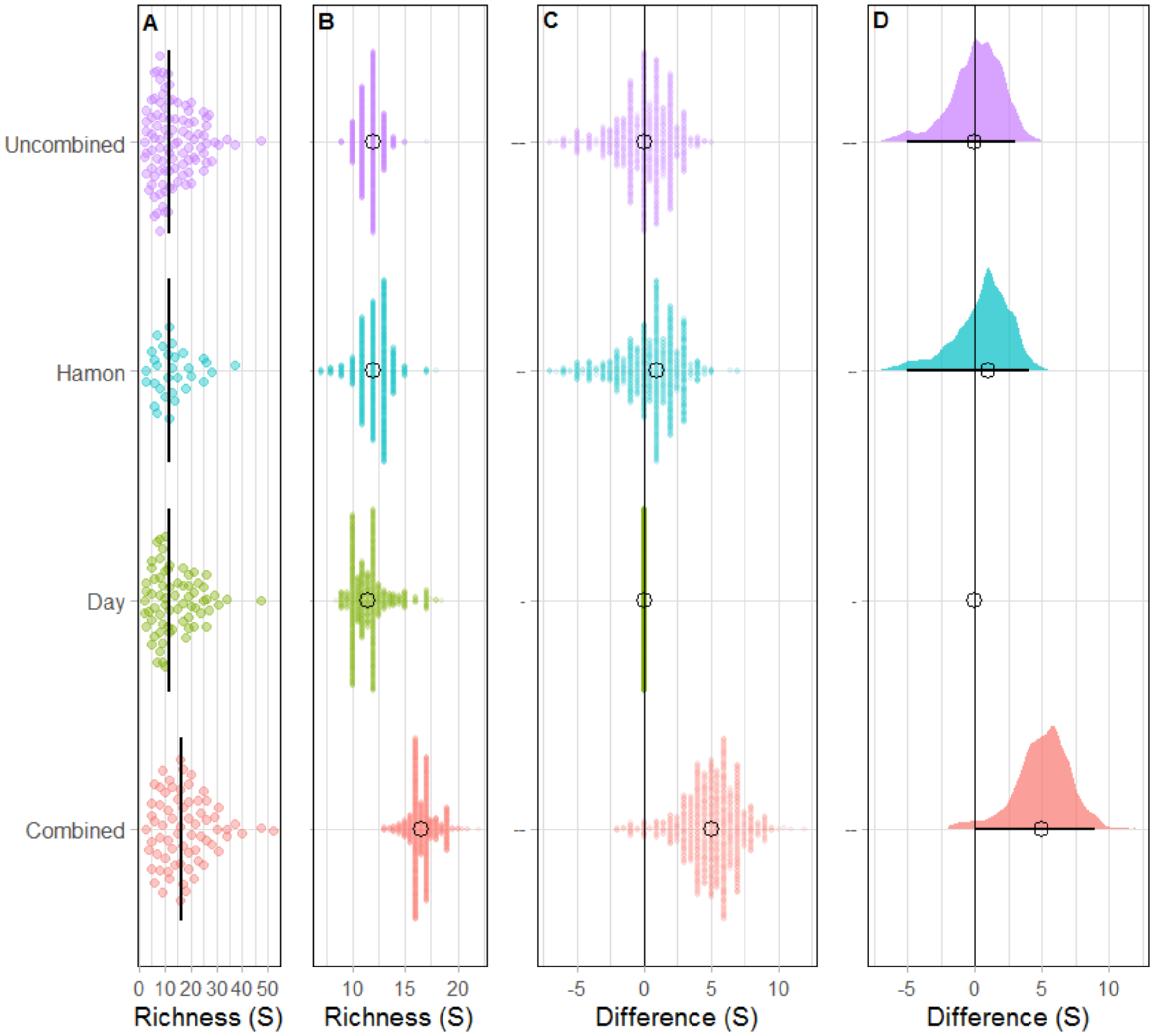



**Figure 18. Visualisation of the magnitude of difference in species richness (S sample$^{-1}$) between Mini-Hamon Grab samples, all samples uncombined (Mini-Hamon Grab and Day Grab) and combined samples (the sum of Mini-Hamon Grab and Day Grab) compared to Day Grab samples (© Natural England and Environment Agency 2022). (A): Sample species richness, vertical black line indicates the mean. (B): 1000 new mean values generated by bootstrapping. Black circles indicate the mean of the bootstrapped samples. (C): Difference between the test bootstrapped means (Uncombined, Mini-Hamon Grab and Combined) compared to the control (Day Grab). (D): Distribution of differences, horizontal black line indicates the 95% confidence interval and the black circle indicates the mean.**

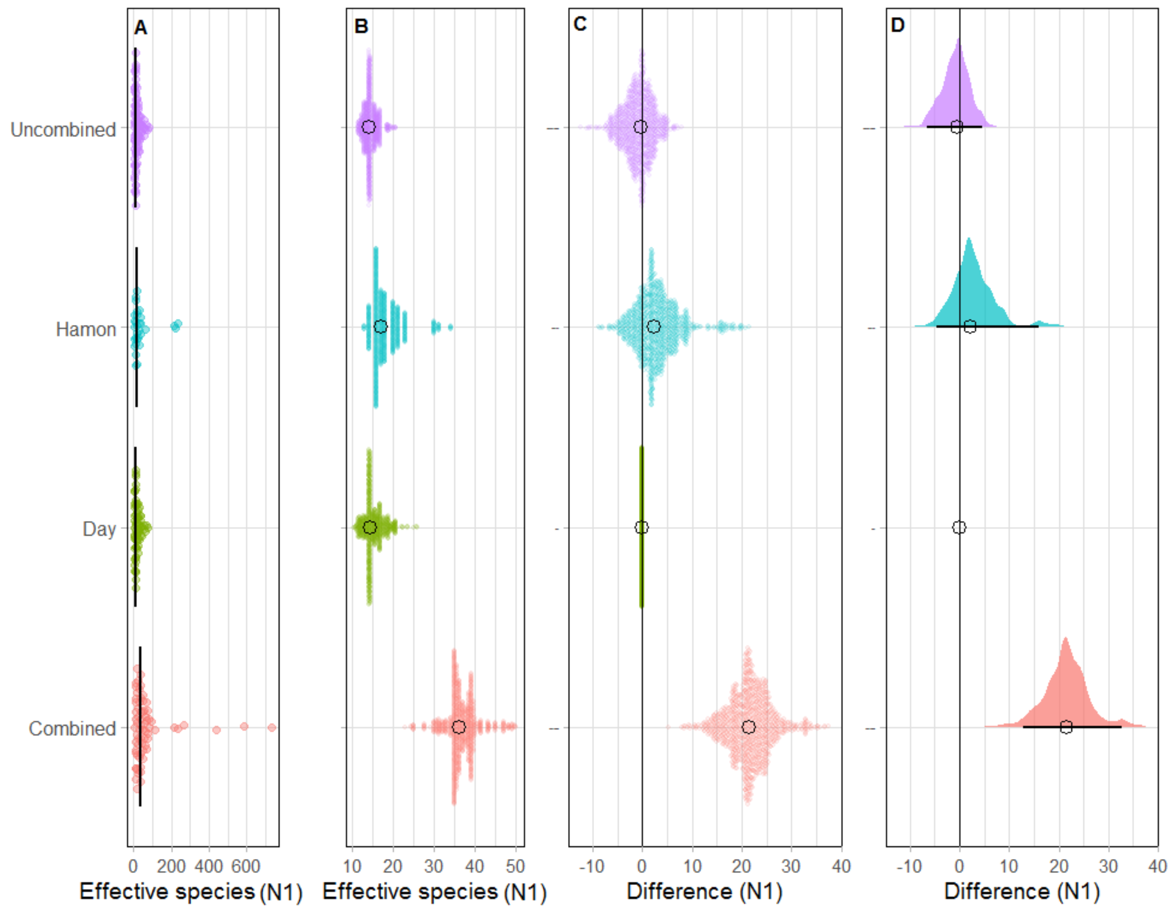



**Figure 19. Visualisation of the magnitude of difference in effective number of species (Hill's N1) between Mini-Hamon Grab samples, all samples uncombined (Mini-Hamon Grab and Day Grab) and combined samples (the sum of Mini-Hamon Grab and Day Grab) compared to Day Grab samples (© Natural England and Environment Agency 2022). (A): Sample effective number of species, vertical black line indicates the mean. (B): 1000 new mean values generated by bootstrapping (A), black circle indicates the mean of the bootstrapped samples. (C): Difference between the test bootstrapped means (Uncombined, Mini-Hamon Grab and Combined) compared to the control (Day Grab). (D): Distribution of differences, horizontal black line indicates the 95% confidence interval and the black circle indicates the mean. 'A5.2 Subtidal sand'.**

## 3.4 Infaunal community analysis

This section presents infaunal community analyses performed on all samples collected in sediment BSHs for the 2017 Newquay and The Gannel MCZ survey. Based on the comparisons between different sampling methods and combinations of these data presented in Section 3.3, the analyses presented hereafter were performed on all samples (Day Grab and Mini-Hamon Grab) without combination of stations sampled by 'paired' methods. Overall, there were significant differences indicative of a strong relationship between community composition and BSH type (ANOSIM Global $R$ = 0.506, $P$ = 0.01; Figure 20) and a significant but very weak difference in overall community compositions inside and outside the MCZ boundary (Global $R$ = 0.075, $P$ = 0.025; Figure 20).

Comparisons were made between diversity index values recorded in 2017 with those recorded in 2013[5]. Taxon richness ($F_{1,59}$ = 2.94, $P$ = 0.092), taxon abundance ($F_{1,59}$ = 2.94, $P$ = 0.057) and evenness ($F_{1,58}$ = 0.09, $P$ = 0.760) did not differ significantly between the two sampling years. Values for both Shannon Index ($F_{1,60}$ = 10.38, $P$ = 0.002) and Hill's N1 ($F_{1,60}$ = 15.70, $P$ < 0.001) were both significantly higher in 2017 compared with 2013 (Figure 20).

### 3.4.1 'A5.2 Subtidal sand'

A total of 93 infauna samples were taken from the 'A5.2 Subtidal sand' BSH (58 inside and 35 outside the MCZ boundary). The mean composition of mud, sand and gravel in samples in this BSH was 0%, 99% and 1% respectively. The samples from this BSH had at least one occurrence for 78% (n = 174) of all taxa observed in the benthic survey (146 taxa recorded inside and 112 recorded outside the MCZ boundary). Representative images of samples taken from this BSH are shown in Figure 22.

Mean similarity (SIMPER) among benthic communities in this BSH was 19.6% (20.6% for those inside and 21.1% for those outside the MCZ boundary). Twenty of the 174 taxa recorded in this BSH contribute to >90% of the abundance, of these, three taxa (*Cumopsis fagei, Bathyporeia elegans* and *Crisia*) account for 42% of the abundance. Although the bryozoans *Crisia* have an overall relative abundance in this BSH of 10%, their relative abundance inside the MCZ is more than four times greater than outside the MCZ (14.2% inside, 3.5% outside).

[5] Controlling for differences between habitats as outlined in Section 2.3.4.

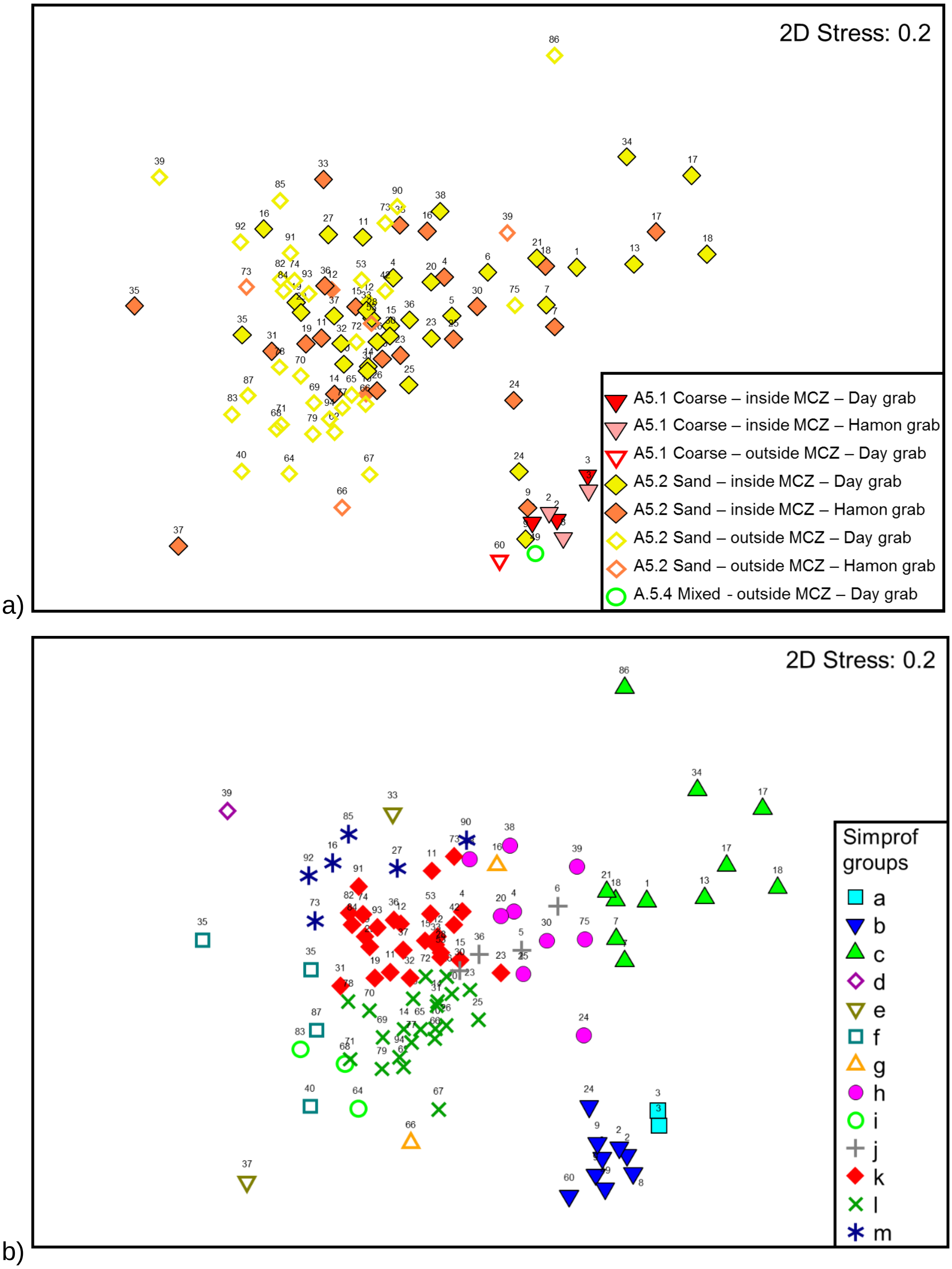



**Figure 20. Nonmetric multidimensional scaling (NMDS) plot of infaunal communities sampled in the 2017 Newquay and The Gannel MCZ survey, grouped by (a) assigned sediment Broadscale Habitats, and (b) groupings of stations with significantly different community structure, derived from SIMPROF analysis (© Natural England and Environment Agency 2022). Point labels indicate the station number.**

**Table 6. The top three species that characterise each community defined by SIMPROF analysis, assessed using SIMPER analysis on untransformed abundance data from the 2017 Newquay and The Gannel MCZ survey (© Natural England and Environment Agency 2022). SIMPROF-defined communities composed of one sample are not listed.**

| Group 'a' (Coarse sediment, inside MCZ) (n = 2) | | Group 'b' (Coarse sediment, inside & outside MCZ; Sand, inside MCZ; Mixed sediments, outside MCZ) (n = 9) | |
|---|---|---|---|
| **Species** | **% contribution to characterisation** | **Species** | **% contribution to characterisation** |
| *Pisione remota* | 33.33 | *Goodallia triangularis* | 45.35 |
| *Glycera lapidum* | 22.22 | *Polygordius* | 24.08 |
| *Polygordius* | 16.67 | *Glycera lapidum* | 7.02 |
| **Group 'c' (Sand, inside & outside MCZ) (n = 11)** | | **Group 'f' (Sand, inside & outside MCZ) (n = 4)** | |
| *Scolelepis squamata* | 89.54 | *Glycera tridactyla* | 32.15 |
| *Paraonis fulgens* | 2.07 | *Spio decorata* | 16.65 |
| *Pontocrates arenarius* | 1.95 | *Eumida bahusiensis* | 9.91 |
| **Group 'g' (Sand, inside & outside MCZ) (n = 2)** | | **Group 'h' (Sand, inside & outside MCZ) (n = 9)** | |
| *Nephtys* | 20.00 | *Crisia* | 35.96 |
| Orbiniidae | 20.00 | *Scrupocellaria scruposa* | 12.23 |
| *Spio decorata* | 20.00 | *Cumopsis fagei* | 9.36 |
| **Group 'i' (Sand, outside MCZ) (n = 3)** | | **Group 'j' (Sand, inside MCZ) (n = 4)** | |
| *Bathyporeia elegans* | 29.01 | *Cumopsis fagei* | 13.59 |
| *Echinocyamus pusillus* | 23.66 | *Spio decorata* | 11.10 |
| *Sigalion mathildae* | 15.80 | *Nemertea* | 10.40 |
| **Group 'k' (Sand, inside and outside MCZ) (n = 26)** | | **Group 'l' (Sand, inside and outside MCZ) (n = 22)** | |
| *Cumopsis fagei* | 39.25 | *Centraloecetes kroyeranus* | 22.38 |
| *Bathyporeia elegans* | 20.46 | *Bathyporeia elegans* | 14.38 |
| *Scrupocellaria scruposa* | 5.09 | *Nototropis falcatus* | 10.34 |
| **Group 'm' (Sand, inside and outside MCZ) (n = 6)** | | | |
| *Cumopsis fagei* | 30.59 | | |
| *Glycera tridactyla* | 26.61 | | |
| *Bathyporeia elegans* | 26.16 | | |

In terms of univariate summary statistics, infauna in this BSH were significantly less rich (S sample$^{-1}$ – one-way ANOVA, $F_{2,98}$ = 14.1, $P$ = <0.01) and less abundant (N sample$^{-1}$ – one-way ANOVA, $F_{2,98}$ = 28.4, $P$ = <0.01) than the other designated BSH 'A5.1 Subtidal coarse sediment' (Table 4). Of the 94 infauna samples classified as 'A5.2 Subtidal sand', five were designated as belonging to sublittoral coarse sediment biotopes, all other samples were designated to littoral or sublittoral sand habitats. This is reflected in the SIMPROF analysis, which identified 12 distinct groupings within the 'A5.2 Subtidal Sand' BSH (Figure 19). Most groupings were composed of stations from both inside and outside the MCZ (Table 6).

SIMPROF grouping *k* contained the most number of stations, predominately from inside the MCZ away from the shoreline. These stations were characterised by the abundance of the cumacean *Cumopsis fagei* and amphipod *Bathyporeia elegans*.

SIMPROF grouping *l* contained 22 stations, predominantly from outside the MCZ in Watergate Bay. These stations were characterised by the amphipods *Centraloecetes kroyeranus* and *B. elegans.*

Notably SIMPROF grouping *c* contained stations both inside and outside the MCZ, that were located very close to the shoreline in the high energy wave zone. These stations where characterised by species that were only recorded in high abundances in stations in this group: the polychaetes *Scolelepis squamata* and *Paraonis fulgens* and amphipod *Pontocrates arenarius* (Table 6).

IQI values inside the MCZ ranged from 0.310 (reflecting a ‘Poor’ WFD status) to 0.746 (‘Good’ status), with a mean ± standard deviation of 0.587 ± 0.088, equivalent to “Moderate” ecological status using the WFD status boundaries (Table 4). This suggests that there were some chemical or organic enrichment pressures in these areas. Outside the MCZ, values ranged from 0.551 to 0.845, with a mean ± SD of 0.655 ± 0.067. The IQI scores of this BSH inside the MCZ were significantly lower than ‘A5.2 Subtidal sand’ sampled outside of the MCZ boundary (Mann-Whitney W = 2250.0, $p < 0.001$).

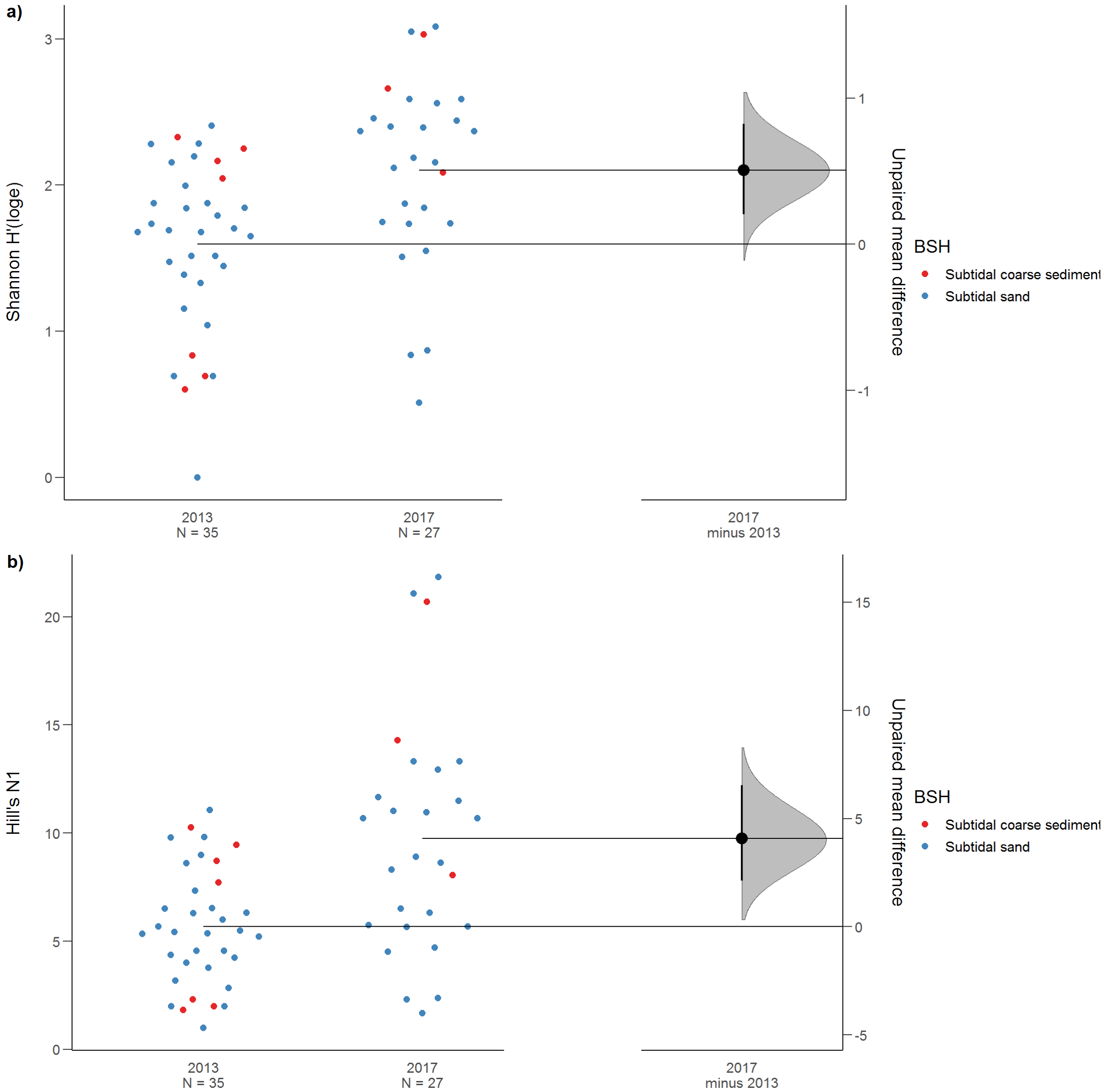



**Figure 21. Comparisons of a) Shannon entropy and b) Hill’s N1 recorded in 2013 and 2017. Points indicate the Broadscale Habitat within the Newquay and The Gannel MCZ (© Natural England and Environment Agency 2022). Plots on the right hand side show the mean distance between the two groups (black point) and the 95% confidence interval (black bar) (Ho *et al*. 2018).**

**Subtidal sand (LS.LSa.MoSa.AmSco) Amphipods and *Scolelepis* spp. in littoral medium-fine sand.**

**Subtidal sand (LS.LSa.FiSa.Po) Polychaetes in littoral fine sand. ©**

**Figure 22. Example images from the 2017 Newquay and The Gannel MCZ survey of infauna grabs as sampled (left) and sieved (right) assigned to the 'A5.2 Subtidal sand' BSH (© Environment Agency and Natural England 2017).**

### 3.4.2 'A5.1 Subtidal coarse sediment'

Seven infaunal samples were taken from the 'A5.1 Subtidal coarse sediment' BSH (six inside and one outside the MCZ boundary). The mean composition of mud, sand and gravel in samples in this BSH was 1%, 64% and 35% respectively. The samples from this BSH had at least one occurrence for 42% (n = 93) of all taxa observed in the benthic survey (47 taxa recorded inside and 73 recorded outside the MCZ boundary) (Figure 22).

Mean similarity among benthic communities in this BSH was 27.4%. Marine annelids of the genus *Polygordius* dominate the community in this BSH, followed by the polychaete *Glycera lapidum,* contributing to 19% and 13% of the total abundance respectively. SIMPROF analysis split the samples from this BSH into two groupings (*a* and *b*, Figure 19, Table 6), characterised by varying abundances of the bivalve *Goodallia triangularis*, *Polygordius* and *G. lapidum*. In terms of univariate summary statistics, infauna in this BSH were significantly richer (S sample$^{-1}$ – one-way ANOVA, $F_{2,98}$ = 14.1, $P$ <0.01) and more abundant (N sample$^{-1}$ – one-way ANOVA, $F_{2,98}$ = 28.4, $P$ <0.01) than those in any other BSH (Table 4). All samples within this BSH were designated as belonging to sublittoral coarse sediment biotopes.

IQI values from samples inside the MCZ ranged from 0.616 (corresponding to 'Moderate' WFD status) to 0.684 ('Good' status), with a mean ± standard deviation of 0.648 ± 0.031, equivalent to "Good" using the WFD status boundaries. This suggests limited levels of chemical or organic enrichment pressures in these areas. Inside the MCZ, the IQI scores of this BSH were significantly higher than those for 'A5.2 Subtidal sand' (Table 4; Mann Whitney W = 1794.0, p < 0.05).

**Subtidal coarse sediment (SS.SCS.ICS.Glap) *Glycera lapidum* in impoverished infralittoral mobile gravel and sand.**

**Subtidal coarse sediment (cf. SS.SCS.ICS.MoeVen) cf. *Moerella* spp. with venerid bivalves in infralittoral gravelly sand.**

**Figure 23. Example images from the 2017 Newquay and The Gannel MCZ survey of infauna grabs as sampled (left) and sieved (right) assigned to the 'A5.1 Subtidal coarse sediment' BSH (© Environment Agency and Natural England 2017).**

### 3.4.3 ‘A5.4 Subtidal mixed sediments’

‘A5.4 Subtidal mixed sediments’ were sampled at two stations (one PSA only, one PSA and infauna sample) outside of the MCZ boundary. The biotope assigned to the faunal sample (at station NWQG 49) was cf. *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (cf. SS.SCS.ICS.MoeVen) (Figure 16). This is a sublittoral coarse sediment biotope, which aligns with the results of the SIMPROF analysis that places NWQG 49 in the same grouping (*b*) as most of the ‘A5.1 Subtidal coarse sediment stations’ (Figure 19, Table 6). Representative images of samples taken from this BSH are shown in Figure 24.

**Subtidal mixed sediments (cf. SS.SCS.ICS.MoeVen)** cf. *Moerella* spp. with venerid bivalves in infralittoral gravelly sand.

**Figure 24. Example images from the 2017 Newquay and The Gannel MCZ survey of infauna grabs as sampled (left) and sieved (right) assigned to the ‘A5.4 Subtidal mixed sediments’ BSH (© Environment Agency and Natural England 2017).**

## 3.5 Subtidal Rock BSH: physical structure and biological communities

The 2017 data was not intended to be used to update the BSH distribution maps produced in 2013 (Le Bas, 2015). However, the overall distribution of rocky habitats throughout the MCZ is broadly in line with the observations made in 2013 (Figure 2) and there is no evidence to suggest that the broad distribution of habitats has changed between the two survey events.

The still images captured by the imagery survey were mostly of less than good quality O’Dell 2018). The majority of images (53.2%) were considered as ‘very poor’ or ‘poor’ (19.1%), with just over a quarter of images (27.6%) considered at ‘good’ quality. Only a single image (0.1%) captured was of ‘excellent’ image quality. In comparison, the images gathered in 2013 were mostly of ‘moderate’ (79%) or ‘poor’ (19.4%) quality, with relatively few ‘very poor’ images (1.6%) (Arnold and Godsell, 2014; Figure 25).

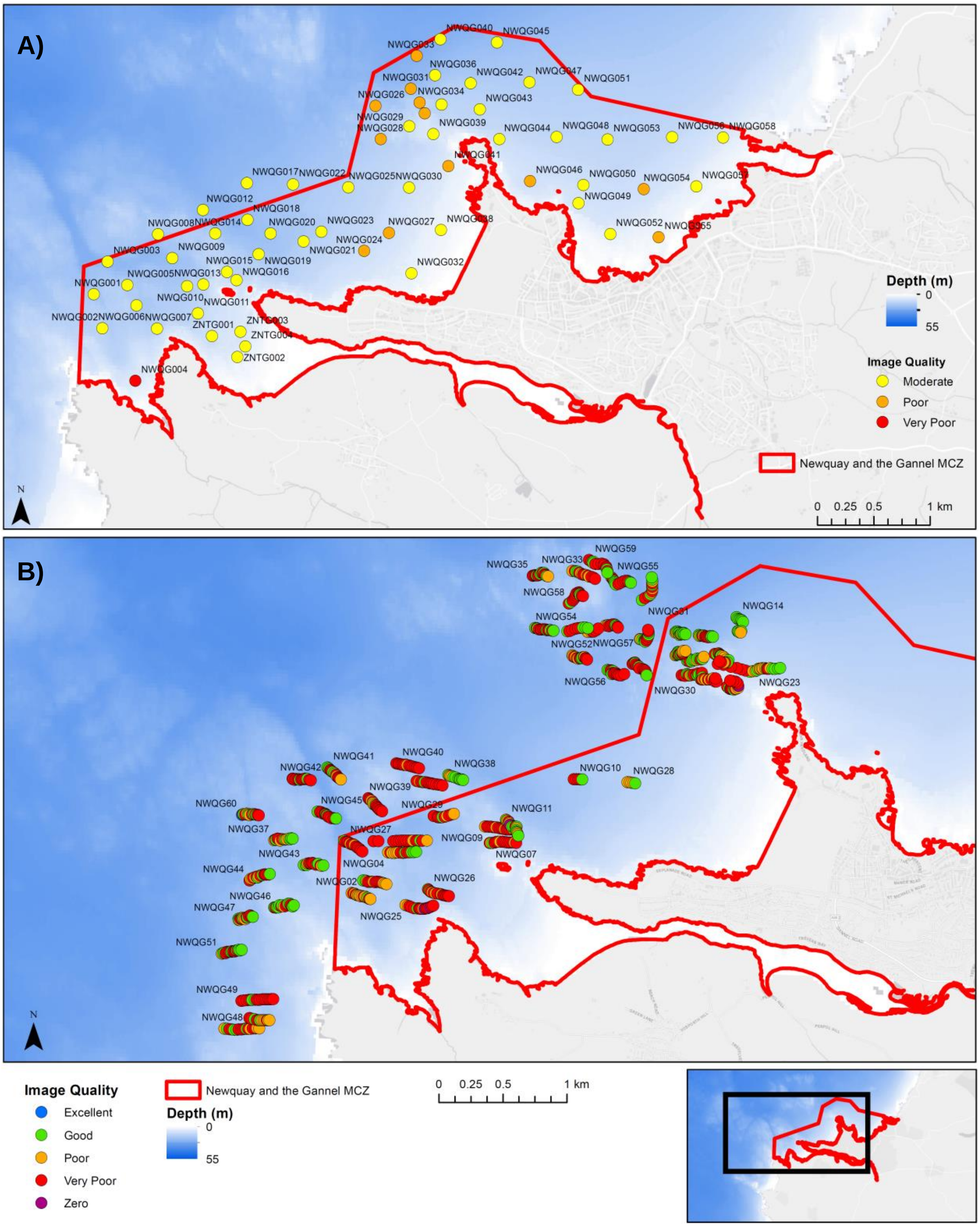



**Figure 25. Image quality assigned to still images during surveys of Newquay and The Gannel MCZ A) in 2013 and B) in 2017 (© Natural England and Environment Agency 2022).Note that analysis of image data in the two years was conducted by different laboratories.** The poor quality of images in the 2017 survey was considered to be related partly to the high transit speed, which caused motion blurring in output images. In addition the height of

the camera above the seabed meant that smaller and cryptic fauna may have been missed or identified to a coarse taxonomic level (O'Dell, 2018).

The low image quality from the 2017 survey means that it is difficult to gain much insight into the ecology and physical and biological structure of the subtidal rock habitats. It also meant that the image data required extensive taxonomic truncation to avoid the potential duplication of taxa. As such, the interpretation of the following analyses are necessarily high-level.

Subtidal rock habitats within Newquay and The Gannel MCZ were characterised by bedrock, with areas overlain by coarse sediments and sands (Figure 2).The survey area incorporated areas of infralittoral and circalittoral rock in both high and moderate energy environments. The number of occurrences of each Broadscale Habitat is summarised in Table 3.

Taxon diversities were compared between images taken inside and outside the MCZ boundary. Controlling for differences between Broadscale Habitats, taxon richness values showed statistically significant differences inside and outside of the MCZ boundary ($F_{1,612}$ = 7.43, $P$ = 6.59 x $10^{-3}$). Samples outside the MCZ were slightly more diverse than those inside. However, the scale of these differences was rather low, with considerable variability in the data. Furthermore, these differences were not consistent across all rocky BSH's, with differences only significant within the high energy infralittoral rock (A3.1) BSH (Figure 26).

The largest differences in the number of taxa were recorded within the high energy infralittoral rock BSH (A3.1), where mean ± SE taxon richness inside the MCZ was 13.0 ± 0.6 taxa, compared with 15.5 ± 0.5 outside the MCZ. Although this difference was statistically significant, it is less clear that this mean difference of 1.5 taxa per sample represents an ecologically-meaningful difference between assemblages inside and outside the MCZ. Following Cohen's (1988) guidance, the difference between the two groups would be considered as small ($d$ = 0.27). As such, it is possible that the observed difference does not reflect an underlying difference in the ecology of stations inside and outside of the MCZ boundary.

### 3.5.1 'A3.1 High energy infralittoral rock' and 'A3.2 Moderate energy infralittoral rock'

The most commonly encountered rock habitats within the 2017 seabed imagery survey was 'A3.1 High energy infralittoral rock' (Figure 27). Within this Broadscale Habitat, eight biotopes were recorded. The most commonly recorded biotope was IR.HIR.KFaR.FoR.Dic (Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock), which was recorded in 60% of BSH images. The biotope IR.HIR.KFaR.LhypR (*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock) was recorded in 26% of BSH images (Figure 28). The remaining five biotopes were recorded in less than 5% of HIR images.

The ‘A3.2 Moderate energy infralittoral rock’ Broadscale Habitat was less widely distributed, but was recorded both inside and outside the MCZ boundary. A single biotope was associated with the habitat, IR.MIR.KR.LhypT (*Laminaria hyperborea* on tide-swept, infralittoral rock) (Figure 29).

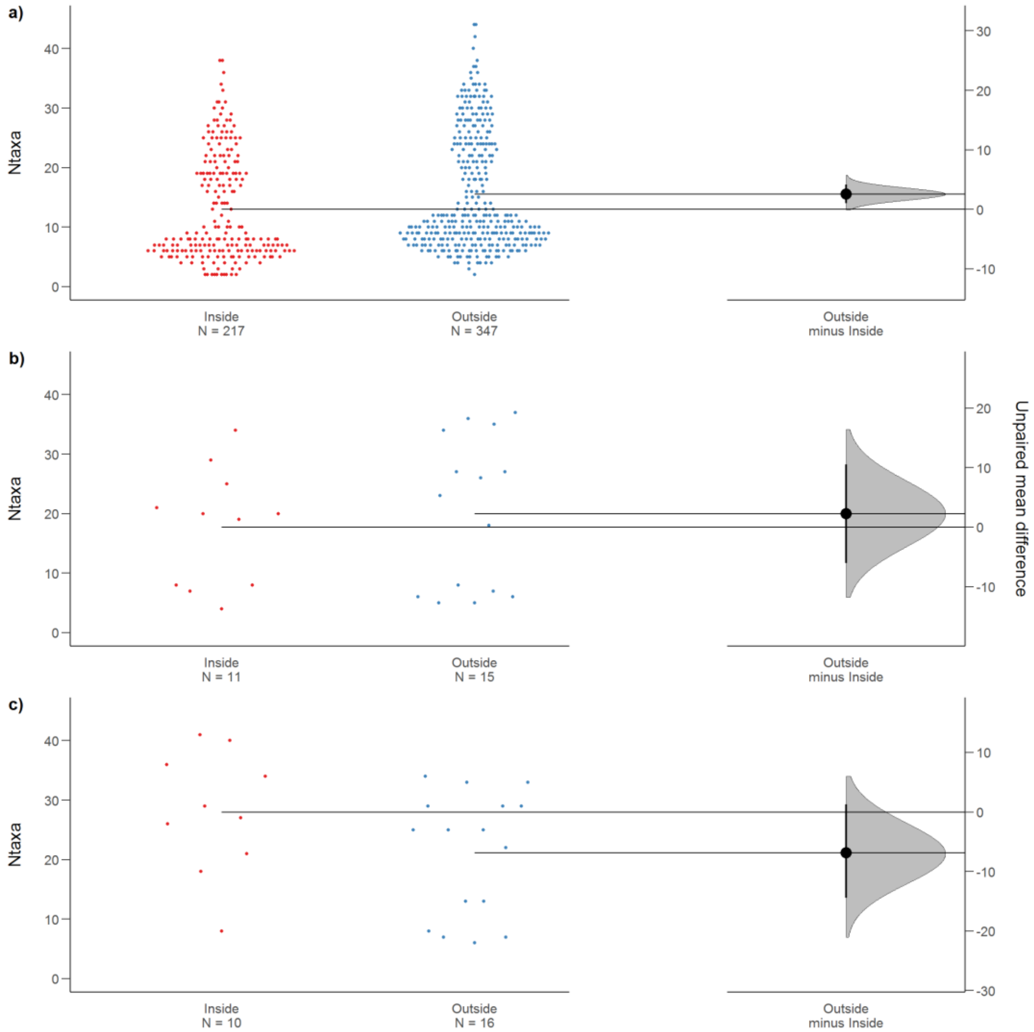



**Figure 26. Comparisons of total taxon richness recorded from seabed imagery within three Broadscale Habitats a) ‘A3.1 High energy infralittoral rock’, b) ‘A3.2 Moderate energy infralittoral rock’, c) ‘A4.1 High energy circalittoral rock’ (© Natural England and Environment Agency 2022). For each BSH, data are displayed for stations inside and outside the MCZ boundary (left hand side plots). Plots on the right hand side show the mean distance between the two groups (black point) and the 95% confidence interval (black bar) (Ho *et al*. 2018).**

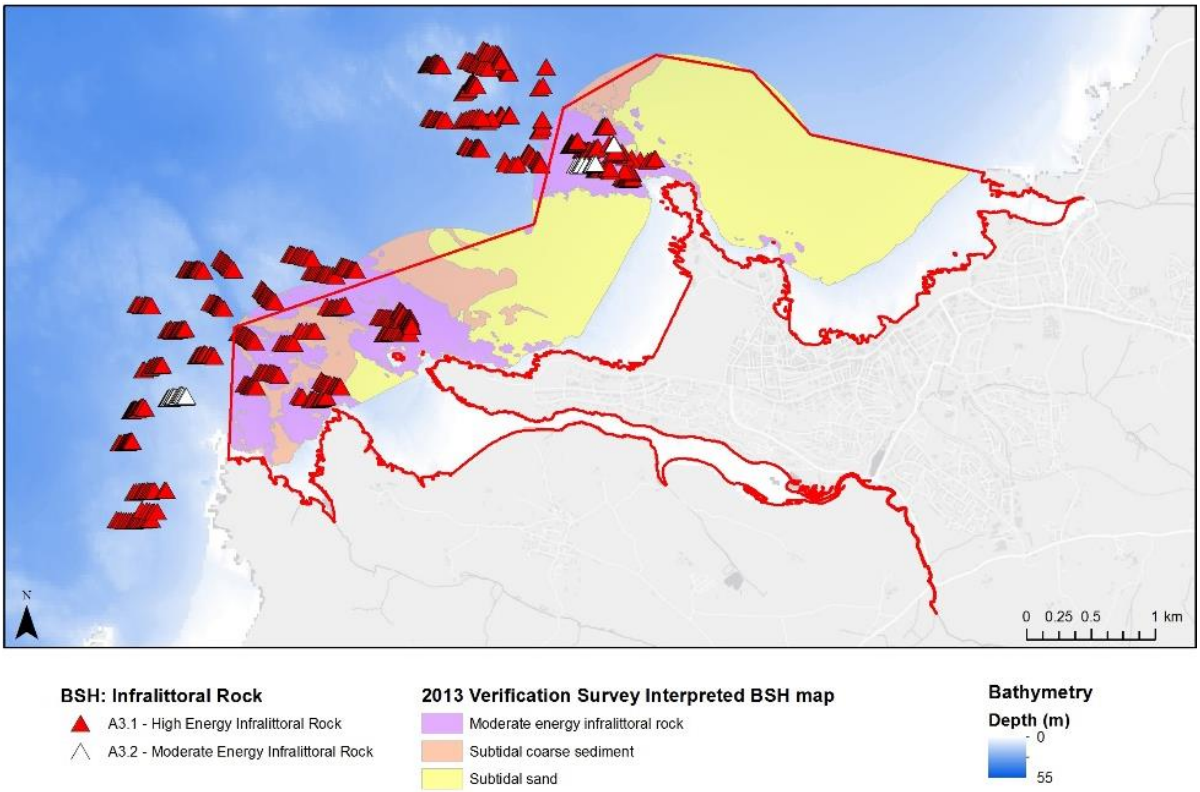



**Figure 27. Distribution of infralittoral rock Broadscale Habitats recorded from still images inside and outside of Newquay and The Gannel MCZ (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

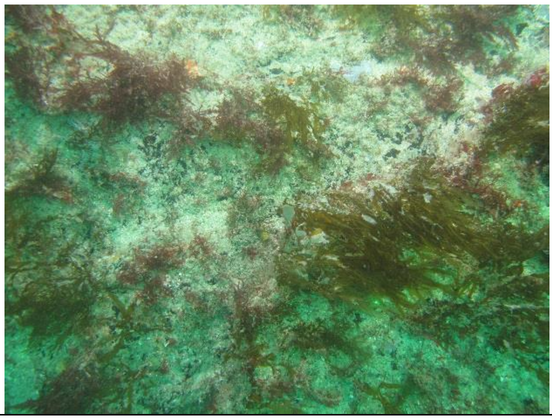
| **IR.HIR.KFaR.FoR.Dic (Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock)** | **IR.HIR.KFaR.LhypR (*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock)** |
|---|---|
|  |  |

**Figure 28. Example images of the two most common biotopes recorded within the 'A3.2 High energy infralittoral rock' Broadscale Habitat acquired at Newquay and The Gannel MCZ (© Environment Agency and Natural England 2017).**

| **IR.MIR.KR.LhypT (*Laminaria hyperborea* on tide-swept, infralittoral rock)** |
| --- |
|  |

**Figure 29. Example image of the biotope recorded in the 'A3.2 Moderate energy infralittoral rock' Broadscale Habitat at Newquay and The Gannel MCZ (© Environment Agency and Natural England 2017).**

### 3.5.2 'A4.1 High energy circalittoral rock'

Aside from the high and moderate energy infralittoral rock habitats outlined above, areas classified as 'A4.1 High energy circalittoral rock' were also recorded. This habitat was mostly confined towards and beyond the offshore extent of the MCZ boundary, with most recordings offshore of Towan Head (Figure 30). Within this BSH, three biotopes were recorded. The most commonly recorded biotope was CR.HCR.XFa (Mixed faunal turf communities) which was classified in ~92% of images within the A4.1 BSH (Figure 31). Two biotopes, CR.HCR.XFa.ByErSp (Bryozoan turf and erect sponges on tide-swept circalittoral rock) and CR.HCR.XFa.CvirCri (*Corynactis viridis* and a mixed turf of crisiids, *Bugula*, *Scrupocellaria*, and *Cellaria* on moderately tide-swept exposed circalittoral rock) were each recorded in single images only, each representing approximately 4% of images recorded in the A4.1 BSH (Figure 31).

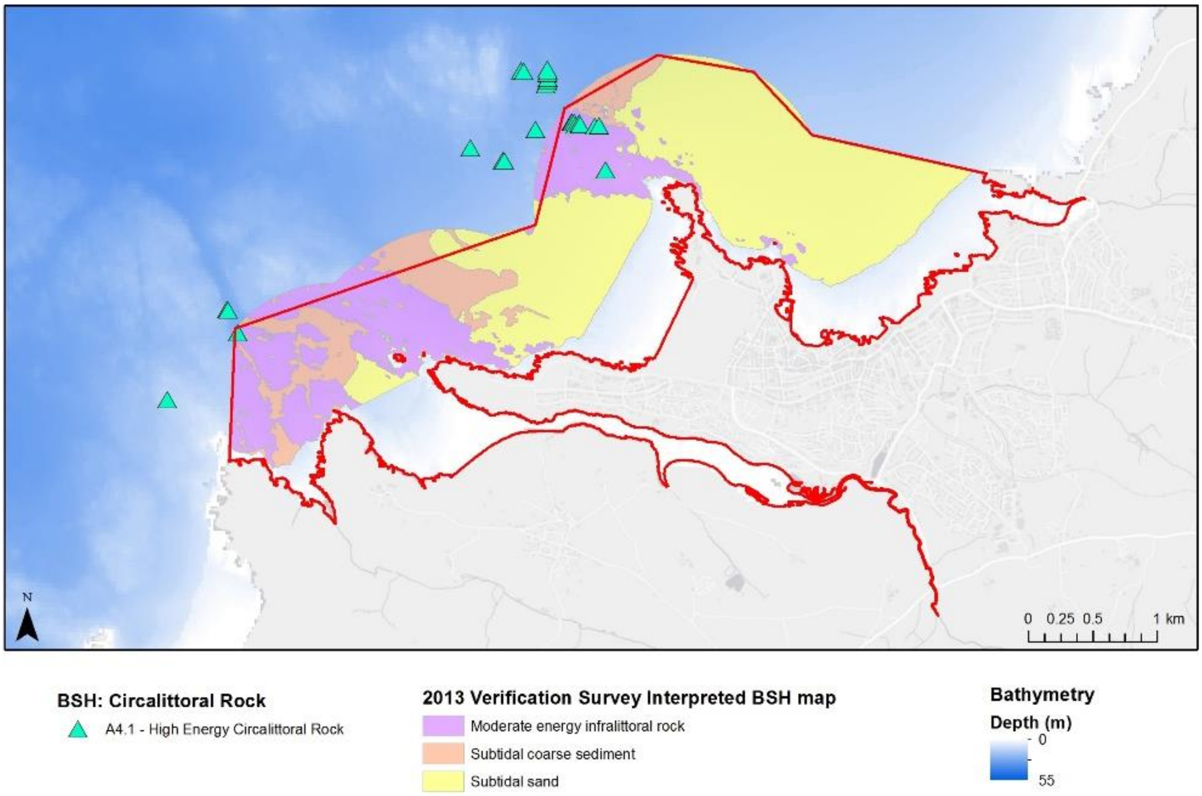



**Figure 30. Distribution of circalittoral rock Broadscale Habitats recorded in epibenthic images inside and outside of Newquay and The Gannel MCZ (© Natural England and Environment**

**Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

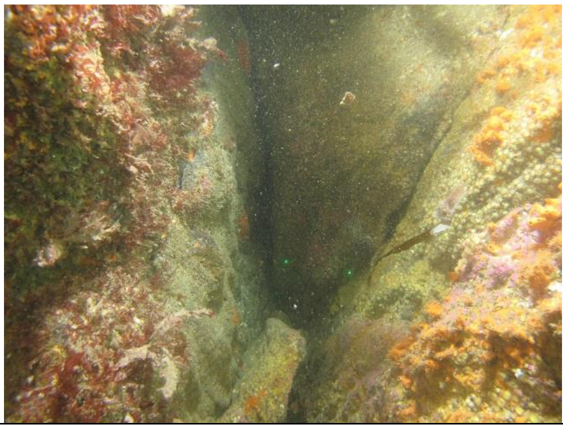
| **Mixed faunal turf communities (CR.HCR.XFa)** | **Bryozoan turf and erect sponges on tide-swept circalittoral rock (CR.HCR.XFa.ByErSp)** |
|---|---|
|  |  |
| **CR.HCR.XFa.CvirCri (*Corynactis viridis* and a mixed turf of crisiids, *Bugula*, *Scrupocellaria*, and *Cellaria* on moderately tide-swept exposed circalittoral rock)** | |
|  | |

**Figure 31. Example images of the biotopes recorded in the 'A4.1 High energy circalittoral rock Broadscale Habitat' at Newquay and The Gannel MCZ (© Environment Agency and Natural England 2017).**

## 3.6 Habitat Features of Conservation Importance (FOCI)

The habitat FOCI 'Coastal Saltmarshes and Saline Reedbeds' and 'Estuarine Rocky Habitats' are both designated within the Newquay and The Gannel MCZ. These are both intertidal habitats within the mid-upper reaches of the Gannel Estuary and so were not observed during the subtidal surveys conducted in 2017.

## 3.7 Species FOCI

The Giant goby is designated as a species FOCI within the Newquay and The Gannel MCZ. No observations were made of this species during the 2017 survey. While the species FOCI for the MCZ was not recorded, one individual of the species *Thorogobius ephippiatus* belonging to the same Family was recorded. In addition, individuals classified only at the Family level (Gobiidae) were also recorded. It is not possible to identify whether these individuals were *G. cobitis* or belonged to one of the many other goby species common to UK waters.

It should be noted that the surveys were not designed to specifically target Giant goby. In addition, the data collection methods used meant that incidental sampling of this species was unlikely. As such, the apparent absence of Giant goby in the 2017 data should not be interpreted as the absence of this species FOCI from the MCZ.

Although not a species FOCI for Newquay and The Gannel MCZ, the sighting of a bottlenose dolphin (Family Delphinidae) was noteworthy. The sighting was made in the video imagery in an area characterised by ‘A3.1 High energy infralittoral rock’ habitat outside of the MCZ boundary (Figure 32).


**Figure 32. Video still showing a Bottlenose dolphin (Family Delphinidae) recorded within the ‘A3.2 High energy infralittoral rock’ Broadscale Habitat outside the boundary of Newquay and The Gannel MCZ (© Environment Agency and Natural England 2017).**

## 3.8 Non-indigenous species (NIS)

All taxa identified in grab samples collected in 2017 were cross-referenced with the list of non-native target species compiled in Eno *et al*. (1997), and the 49 non-indigenous target species which have been selected for assessment of Good Environmental Status (GES) in UK waters under MSFD D2 (Stebbing *et al.,* 2014; Annex 6). One confirmed non-indigenous species, the Polychaete *Goniadella gracilis,* was present at five stations (Figure 33). Additionally, three genera (*Ascidiacea, Sessilia* and *Streblospio*) which contain non-indigenous taxa were identified, but as individuals were not identified at species level these are considered potential non-indigenous species.

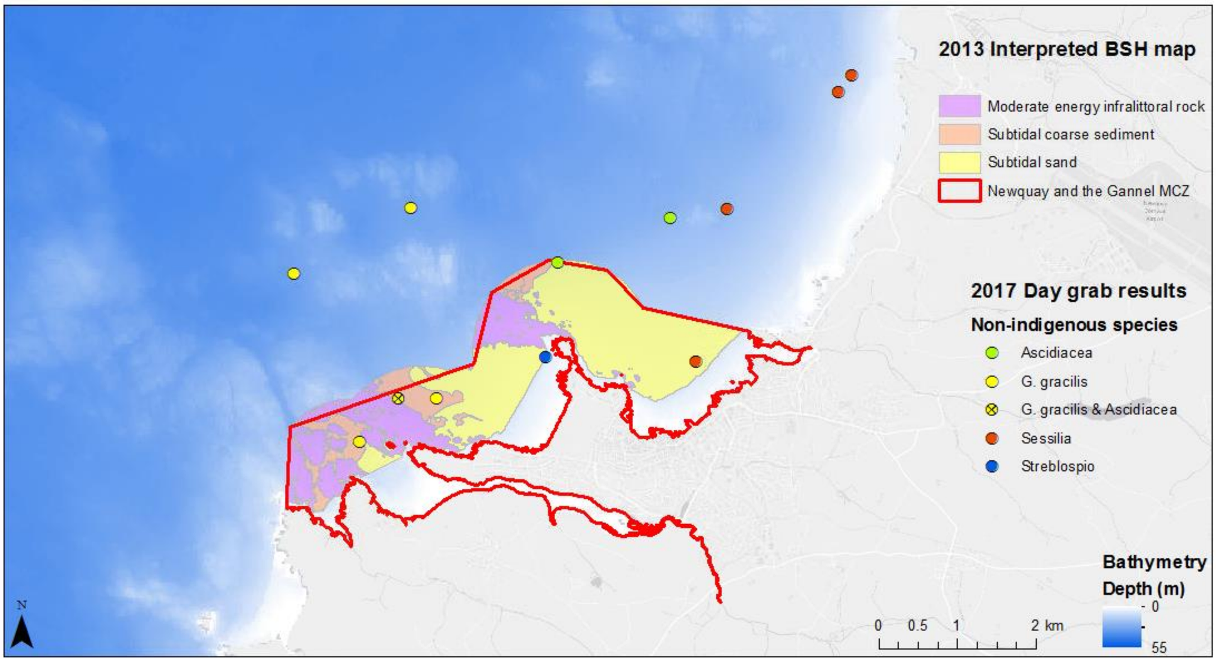



**Figure 33. Distribution of the non-indigenous species *Goniadella gracilis* and potentially non-indigenous species of the genera *Ascidiacea, Sessilia* and *Streblospio* recorded in grab samples taken from the Newquay and The Gannel MCZ in 2017 (© Natural England and Environment Agency 2022). Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).** The confirmed non-indigenous species *Goniadella gracilis* was present both inside and outside the MCZ and in all the subtidal sediment BSHs (Figure 17; Table 7). *Goniadella gracilis* was most abundant in the 'A5.1 Subtidal coarse sediment' BSH with a total of seven individuals being recorded across three stations, a single individual was recorded in the 'A5.2 Subtidal sand' and the 'A5.4 Subtidal mixed sediments' BSHs respectively.

Taxa recorded in the benthic imagery data were typically recorded at too low a taxonomic resolution to readily allow identification of non-native taxa. Of the taxa identified to species level in the imagery data, none were listed as non-native or non-indigenous by Eno *et al.* (1997) or Stebbing *et al.* (2014). It is possible that individuals or populations of non-native or non-indigenous taxa were grouped together at a higher taxonomic level. For example, the most commonly recorded red algae was "Unidentified red algae: foliose", which represented over 60% of red algae recorded. There is the potential that a number of non-native taxa were included within this grouping, for example the foliose *Grateloupia doryphora*. We are not however able to identify the taxa recorded in the imagery survey at any higher taxonomic precision. As such, we cannot comment further on the presence or otherwise of non-native or non-indigenous taxa.

**Table 7. Abundance of confirmed and potential non-indigenous species present in the 2017 Newquay and The Gannel grab samples and their associated Broadscale Habitat (BSH) (© Natural England and Environment Agency 2022).**

| Station | BSH | Species | | | |
|---|---|---|---|---|---|
| | | *G. gracilis* | *Streblospio* | *Sessilia* | *Ascidiacea* |
| NWQG03 | A5.1 Subtidal coarse sediment | 3 | 0 | 0 | 0 |
| NWQG08 | A5.1 Subtidal coarse sediment | 3 | 0 | 0 | 1 |
| NWQG09 | A5.2 Subtidal sand | 1 | 0 | 0 | 0 |
| NWQG21 | A5.2 Subtidal sand | 0 | 1 | 0 | 0 |
| NWQG24 | A5.2 Subtidal sand | 0 | 0 | 0 | 1 |
| NWQG35 | A5.2 Subtidal sand | 0 | 0 | 1 | 0 |
| NWQG49 | A5.4 Subtidal mixed sediments | 1 | 0 | 0 | 0 |
| NWQG60 | A5.1 Subtidal coarse sediment | 1 | 0 | 0 | 0 |
| NWQG67 | A5.2 Subtidal sand | 0 | 0 | 0 | 1 |
| NWQG77 | A5.2 Subtidal sand | 0 | 0 | 1 | 0 |
| NWQG90 | A5.2 Subtidal sand | 0 | 0 | 1 | 0 |
| NWQG92 | A5.2 Subtidal sand | 0 | 0 | 1 | 0 |

## 3.9 Marine litter

A total of 517 pieces of plastic litter were recorded in the infaunal grab samples collected in 2017, all of which falls within the 'A14 – Other' category of marine litter under OSPAR/ICES/IBTS guidance (Annex 5). Of the 101 samples taken, plastic was present in 68 samples (67% of samples, Figure 34). The majority, 447 pieces, of the plastic present was found inside the MCZ. The highest concentration of plastic (n=152) was found at station NWQG07 at the mouth of the Gannel.

Only a single comment relating to marine litter was made in the seabed imagery analysis report (O'Dell, 2018). A possible item of litter (commented as "litter?") was identified within the 'A5.1 subtidal coarse sediment' BSH inside the MCZ boundary (at station GT19_STN_151_A1_01) (Figure 35). No other litter or anthropogenic activity or pressure was reported for seabed imagery data either inside or outside of the MCZ boundary.

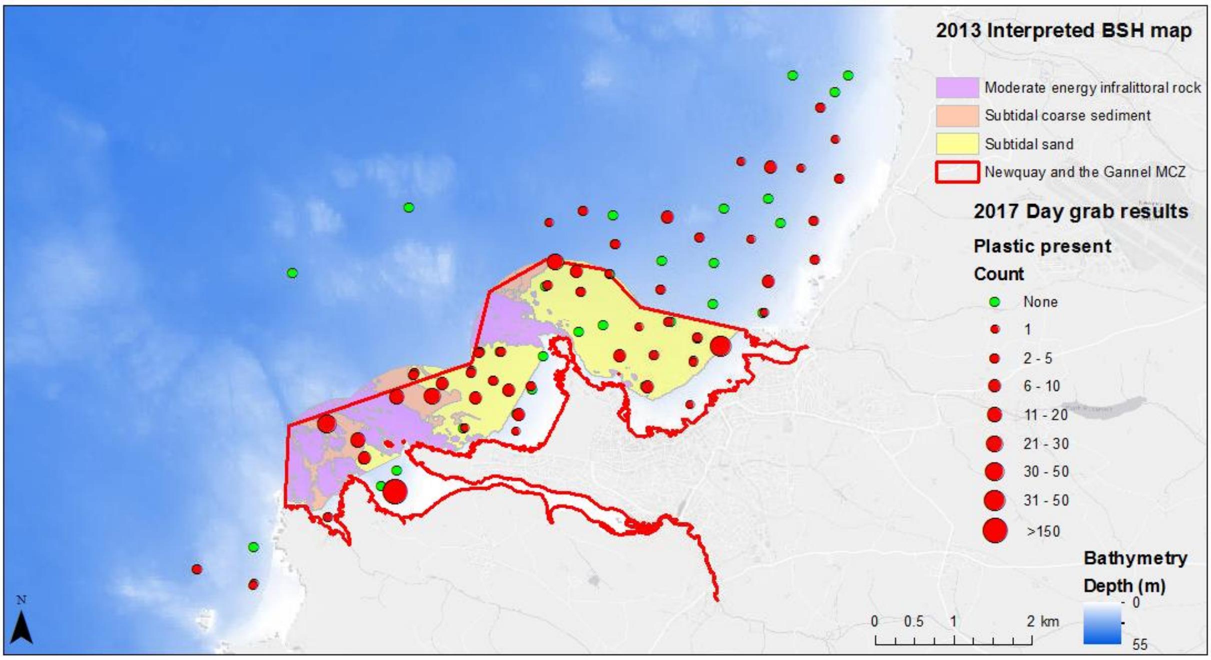



**Figure 34. Presence and distribution of plastic litter found in the 2017 Newquay and The Gannel grab samples (© Natural England and Environment Agency 2022).Point locations are overlain on the interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

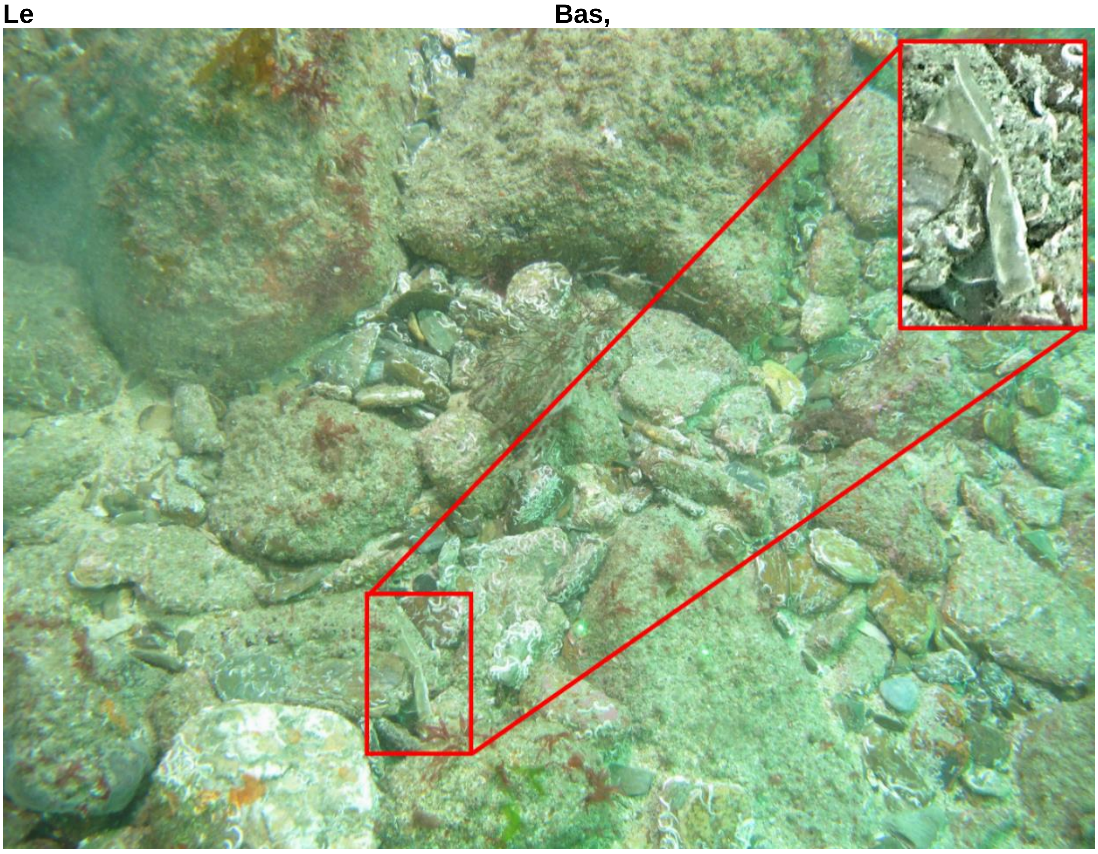


**Figure 35. Image taken at station GT19_STN_151_A1_01 inside Newquay and The Gannel MCZ. Zoomed inset shows a potential piece of litter identified as part of SeaStar Survey's analysis (O'Dell 2018). Inset image colour and contrast were edited to further highlight the item (© Environment Agency and Natural England 2017).**

## 3.10 Anthropogenic activities and pressures

Surface sediment scrapes were taken at eight grab stations, four inside and four outside the MCZ boundary (Figure 36), to provide a record of the most recent heavy metal and organic contaminant levels.

**No clear pattern was observed for metal contaminants, where concentrations were elevated above OSPAR thresholds they were elevated both inside and outside the MCZ. Arsenic and Zinc concentrations were elevated above the OSPAR background assessment concentration (BAC) at all contaminant stations (**

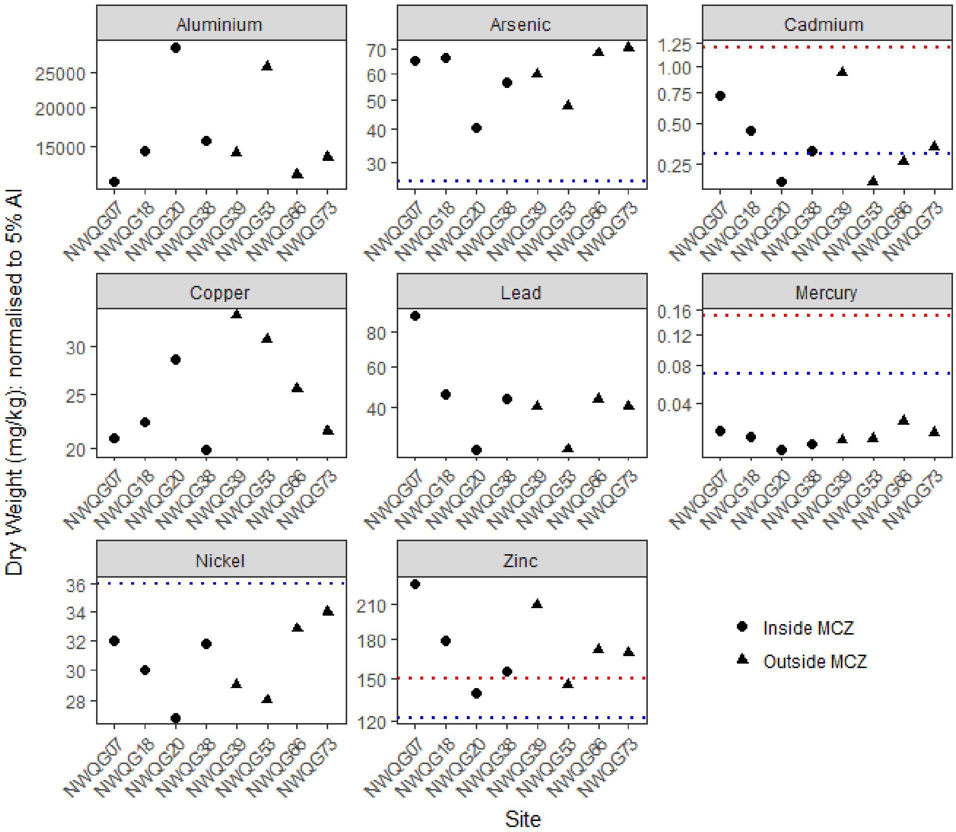



Figure 37). Zinc concentrations were further elevated above the OSPAR effects low range (ERL) threshold at six stations (three inside and three outside the MCZ). Cadmium concentrations were elevated above BAC at three stations inside the MCZ and two stations outside the MCZ. Where applicable, all other metal contaminants were below BAC thresholds at all contaminant stations. There was no consistent relationship between heavy metal concentrations and infaunal IQI values (Figure 38).

Organic contaminants were generally of greater concentration at stations outside the MCZ (Figure 39), but never elevated above the OSPAR environmental assessment criteria (EAC) thresholds at any station (where applicable). The OSPAR BAC thresholds were, however, exceeded for several organic contaminants inside and outside the MCZ. Two organic contaminants, Benzo(*g,h,i*)perylene and Indeno(1,2,3-*cde*)pyrene, had concentrations well below BAC thresholds at all stations. Benzo(*a*)anthracene, Chrysene + Triphenylene, Naphthalene and Phenanthrene concentrations were elevated above BAC thresholds at all stations (except for

NWQG07 where the Benzo(a)anthracene concentrations was just below BAC). Polybrominated diphenyl ethers (PBDEs), for which no BAC or EAC thresholds have been established, all show a similar pattern in concentrations among the contaminant stations. With the exception of PBDEs 47 and 99, all PBDEs analysed were within the range of concentrations in all OSPAR contaminants assessment areas (OSPAR 2017). All other organic contaminants were close to the BAC thresholds. There was no consistent relationship between organic contaminant concentrations and infaunal IQI values (Figure 40).

No additional evidence of anthropogenic activities or pressures was observed in the camera survey.

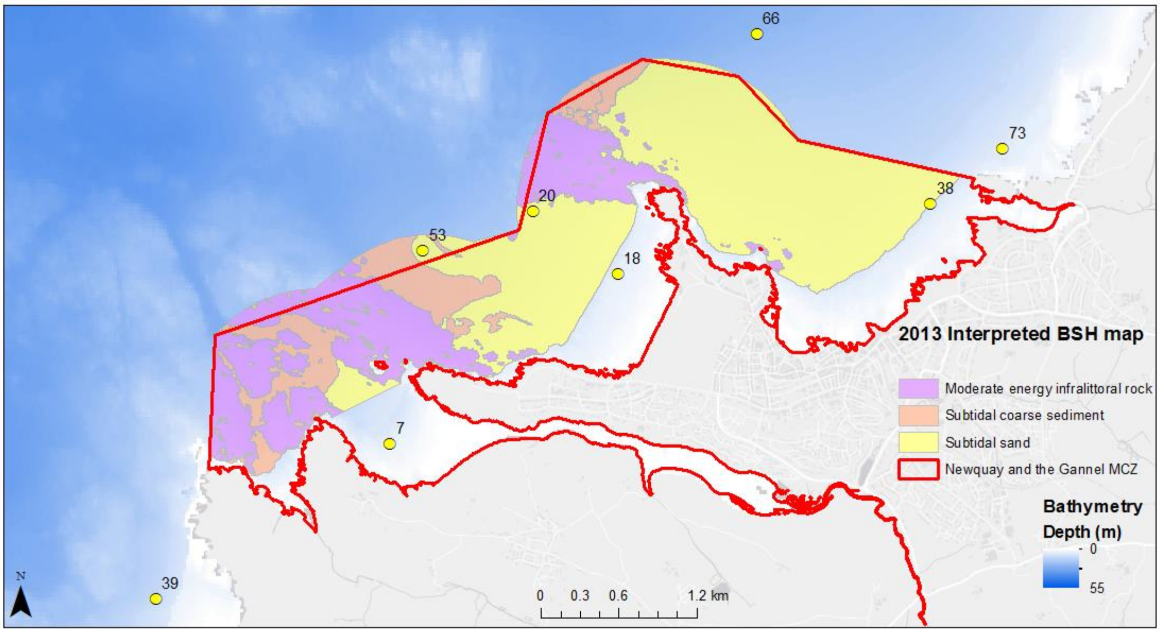



**Figure 36. Location of contaminant samples taken in the Newquay and The Gannel MCZ in 2017 (© Natural England and Environment Agency 2022).Point locations are overlain on the**

**interpreted BSH map derived from the 2013 acoustic survey (Arnold and Godsell, 2014; Le Bas, 2015).**

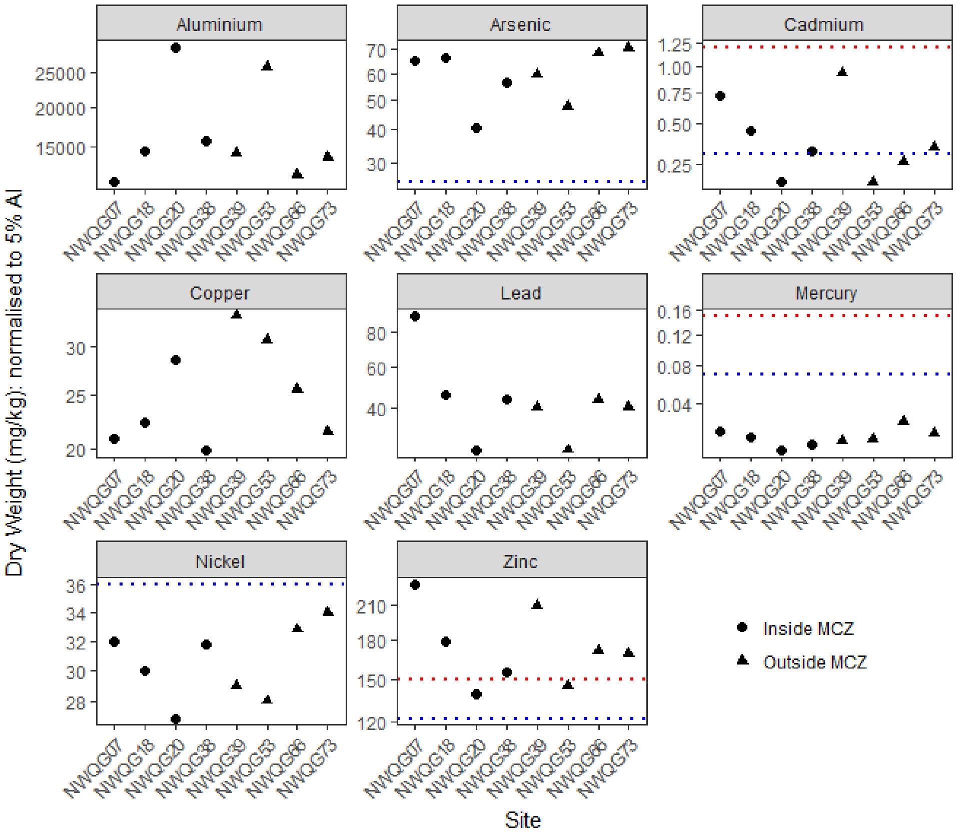



**Figure 37. Results of heavy metal contaminant analyses of sediment samples collected during the 2017 Newquay to the Gannel MCZ survey (© Natural England and Environment Agency 2022). The blue reference lines indicate the OSPAR background assessment concentrations (BAC) thresholds and the red reference lines indicate the OSPAR effects range low (ERL) thresholds.**

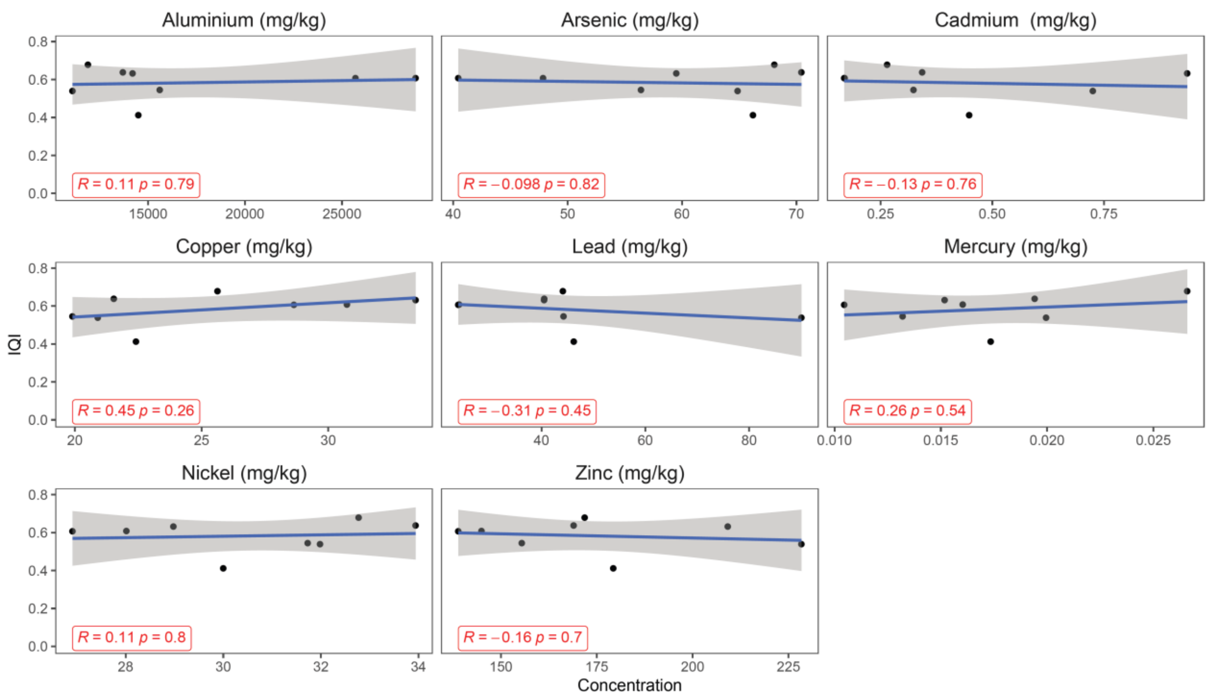


**Figure 38. Correlations of heavy metal contaminants with IQI values recorded during the 2017 Newquay to the Gannel MCZ survey (© Natural England and Environment Agency 2022). *R* values represent the strength of the correlation between heavy metal concentrations and associated IQI values.**

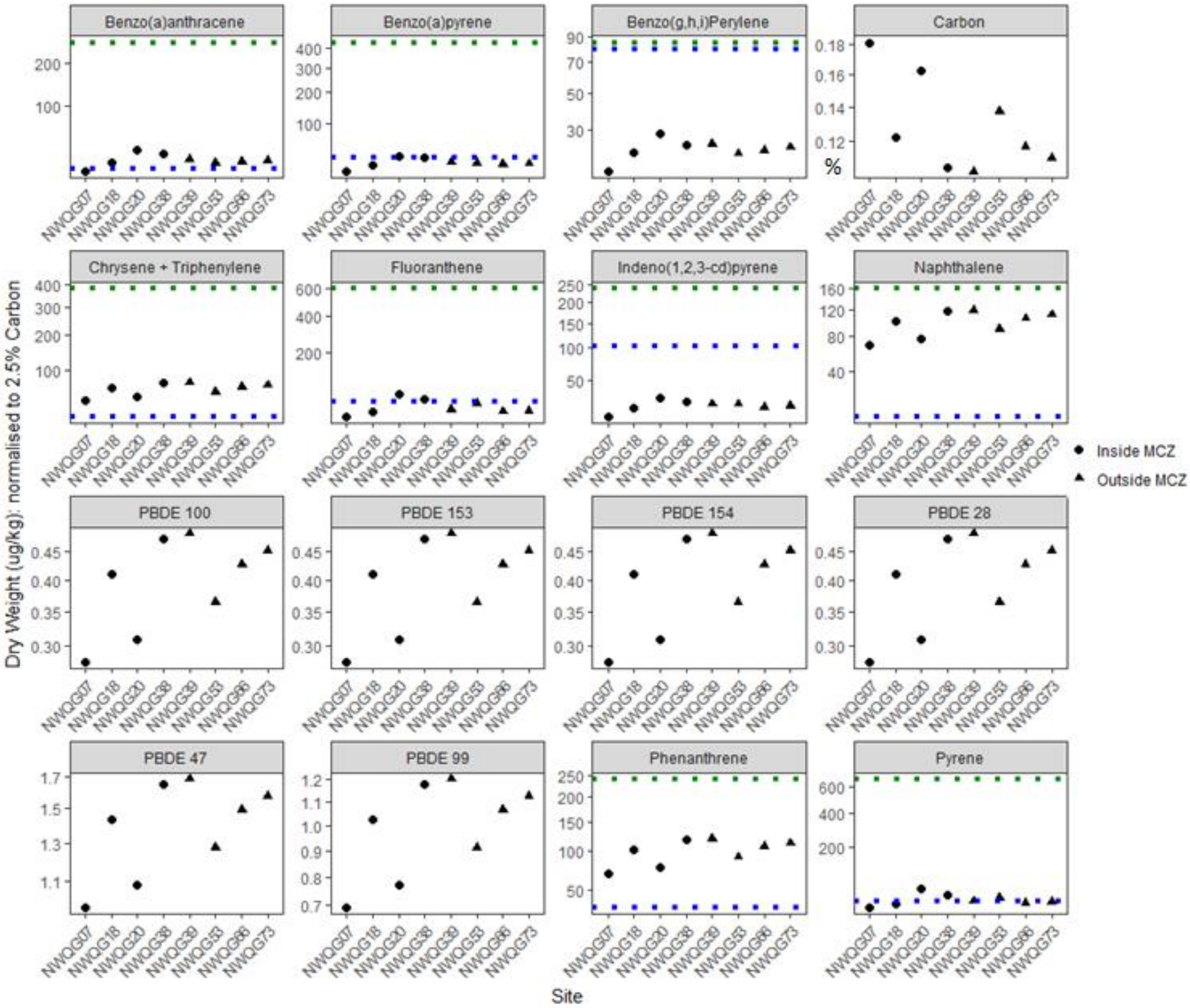



**Figure 39. Results of organic contaminant analyses of sediment samples collected during the 2017 Newquay and the Gannel MCZ survey (© Natural England and Environment Agency 2022).The blue reference lines indicate the OSPAR background assessment concentration**

**(BAC) thresholds and the green reference lines indicates the OSPAR environmental assessment criteria (EAC) thresholds.**

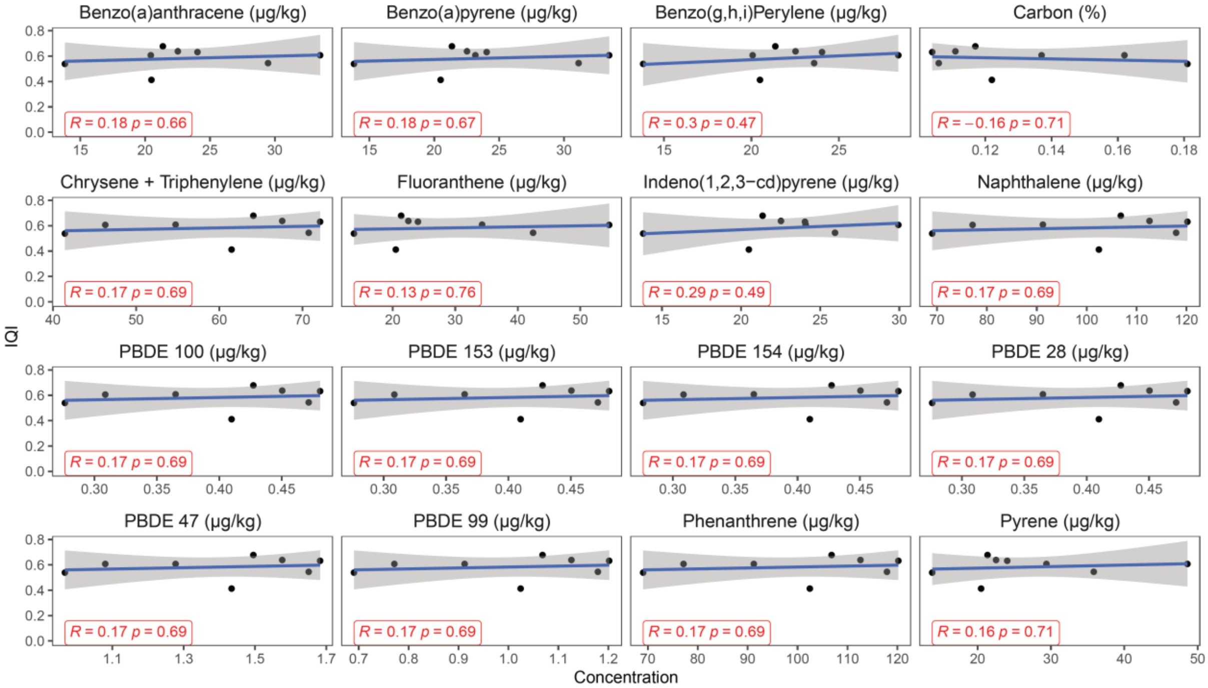



**Figure 40. Correlations of organic contaminants with IQI values recorded during the 2017 Newquay and the Gannel MCZ survey (© Natural England and Environment Agency 2022).*R* values represent the strength of the correlation between organic contaminant concentrations and associated IQI values.**

# 4 Discussion

## 4.1 Benthic and environmental overview

The data gathered from the benthic surveys conducted in 2013 and 2017 show that the Newquay and The Gannel MCZ is characterised by a mixture of sediment and rock habitats. Sediment habitats are characterised by sands, with mixed sediments and gravels also present. The benthic environments are characteristic of those experiencing tidal pressure, with mobile sediments and moderate and high energy rocky environments the most commonly observed. These habitats are discussed in more detail below. A primary objective of the 2017 survey data was to define a baseline for a number of broadscale habitats within the MCZ and to allow future comparisons to be made (Miller, 2017). This baseline could, in principal, allow future comparisons of temporal trends to be made.

## 4.2 Subtidal rock Broadscale Habitats

The data gathered in the imagery surveys were broadly similar inside and outside of the MCZ boundary. Overall, the imagery data recorded in the 2017 survey were also broadly similar to those data gathered in 2013. The findings are discussed further in the sections below.

### 4.2.1 Extent and distribution

Some differences were apparent between the data gathered in 2017 and those gathered in 2013. The BSH maps in 2013 classified all of the subtidal rocky habitat within the MCZ as 'A3.2 Moderate energy infralittoral rock'. 'A3.2 Moderate energy infralittoral rock' was therefore the targeted BSH highlighted in the PoA objective for the 2017 digital imagery data collection (Miller, 2017). Whilst 'A3.2 Moderate energy infralittoral rock' was also recorded in 2017, it was less frequently occurring than 'A3.1 High energy infralittoral rock' and 'A4.1 High energy circalittoral rock' habitats. Much of this difference is likely due to differences in the quality of images captured in the two surveys in addition to inconsistent assigning of BSH categories between the two surveys. There are several possible explanations for the observed differences in communities between the two survey periods and these are summarised below:

- **Seasonality** – Images for 2013 were gathered in February 2013. Those for 2017 were gathered in August. Temporal shallow-water environments often show considerable temporal variability throughout the year (e.g. Airoldi *et al*., 1995). As such, it is likely that the observed differences were confounded, at least in part, by seasonal trends between the two survey events (i.e. late winter *versus* late summer). Similar changes have been observed in previous a previous baseline survey of Mounts Bay MCZ (Arnold and Green 2019). The change in algal density could be due to increased period of algal growth during the month separation between the two survey years.

- **Visibility** – The images gathered in 2017 were generally very poor, with much blurring. In the 2013 survey, the majority of images captured were considered 'moderate' (Arnold and Godsell, 2014). The low image quality in 2017 likely made it difficult to confidently identify habitats and features. Even disregarding differences in image quality, there is considerable inherent subjectivity in assigning Broadscale Habitats to image data. This is exacerbated when dealing with imperfect image quality. Such data are susceptible to analytical bias, where the observed information and apparent taxa can potentially fit a number of habitat descriptions. Increased visibility would have also facilitated the identification of more cryptic epifaunal species, which could explain why significantly more taxa were observed in 2013 than in 2017.

These issues considered, it is therefore highly unlikely that the apparent change from moderate energy to high energy rocky habitats is a real change to the tidal energy within the habitats of the MCZ. Instead, these differences highlight the difficulty in assigning energy regimes from image data, particularly when additional data are lacking.

As such, the imagery data gathered in 2017 do not provide any indication of change in the distribution of rocky subtidal Broadscale Habitats in comparison with those recorded in 2013.

### 4.2.2 Biological communities

As discussed above, the low quality of images gathered in the 2017 survey meant that biological data were typically at a very coarse resolution and much truncation of the data was required prior to analysis. This made it difficult to identify all but the most general patterns in the data and meant that analyses of community compositions would not provide meaningful insight into the ecology of the Newquay and The Gannel MCZ. As such, analyses were restricted to high level comparisons of taxon richness inside and outside of the MCZ boundary.

A statistically significant difference in taxon diversity was recorded, with samples outsize of the MCZ boundary more diverse than those inside. However, the size of this different was rather small and as such, the observed statistically significant difference was considered unlikely to reflect a significant difference in the ecology inside and outside the MCZ boundary.

## 4.3 Subtidal sediment BSH

Benthic grab data gathered in 2017 were broadly similar to those gathered in 2013. Three sediment Broadscale Habitats were recorded in 2017: subtidal coarse sediment, subtidal sand, and subtidal mixed sediments. These habitats are discussed in the sections below.

### 4.3.1 Extent, distribution sand sediment composition

Two subtidal sediment habitats are designated as BSH features within Newquay and The Gannel MCZ: ‘A5.1 Subtidal coarse sediment’ and ‘A5.2 Subtidal sand’. Both of these BSH features were targeted as part of the 2017 survey objectives (Miller, 2017). It is considered that the ‘A5.2 Subtidal sand’ habitat was sufficiently sampled within the MCZ in 2017. This habitat was found at 58 of the stations sampled inside the MCZ boundary. As would be expected, samples from this habitat were characterised by sandy sediments, with a relatively low gravel content. In contrast, ‘A5.1 Subtidal coarse sediment’ was only successfully sampled at six stations inside the MCZ and at two stations outsize of the boundary. These habitats were mostly comprised of sandy sediments, with some gravel content and a relatively low composition of muddy sediments.

A third, undesignated BSH was also recorded: ‘A5.4 Subtidal mixed sediments’. However, observances of this BSH were restricted to two stations located outside the MCZ boundary.

### 4.3.2 Biological communities

Infaunal assemblages differed between sediment BSH types. More taxa in total were recorded in the ‘A5.2 Subtidal sand’ BSH compared with the ‘A5.1 Subtidal coarse sediment’ designated BSH and the undesignated ‘A5.4 Subtidal mixed sediments’ BSH. However, mean per sample diversity index values were lower in ‘A5.2 Subtidal sand’. This apparent discrepancy is likely a result of the number of samples recorded in each habitat, with over ten times as many samples taken within ‘A5.2 Subtidal sand’ compared with ‘A5.1 Subtidal coarse sediment’. As such, the greater sampling effort within A5.2 is reflected by the greater number of taxa recorded, despite these samples being relatively less taxon rich than those from other habitats.

Taxa recorded in the ‘A5.2 Subtidal sand’ BSH are considered typical of those found in the sandy subtidal, with polychaete worms, crustaceans, bivalve molluscs and colonial bryozoa dominating abundances. Polychaete worms were typically more abundant within this BSH than within other sampled habitats, with orders Spionidae and Phyllodocidae particularly common.

Infaunal assemblages within ‘A5.1 Subtidal coarse sediment’ were also characterised by polychaete worms as well as bivalve molluscs. Polychaetes belonging to the genus *Polygordius* were particularly common and this taxon is typical of coarse sediment habitats. Similarly, the relatively abundant bivalve *Goodallia triangularis* is also typical of these habitats.

No infaunal taxa were recorded in 2017 that are afforded specific conservation status. However, three recorded taxa were identified as being rarely recorded in UK habitats: the polychaete *Psammodrilus balanoglossoides*, and the bivalves *Musculus costulatus* and *Irus irus* (Sanderson, 1996). *P. balanoglossoides* and *M. costulatus* were both recorded in the A5.2 Subtidal sand BSH inside the MCZ boundary. *I. irus* was recorded in the’A5.1 Subtidal coarse sediment’ BSH inside the MCZ boundary.

The mean Infaunal Quality Index across the site indicated that the largest BSH, ‘A5.2 Subtidal sand’, was at ‘Moderate’ ecological status (IQI between 0.44 and 0.64) for equivalent Water Framework Directive classifications. This suggests that there are some anthropogenic pressures impacting the site and reflect the level of urbanisation between the inside and outside of the MCZ. The MCZ encompasses most of the urban area of Newquay, and also includes several active sewage discharge outlets into the Gannel estuary, Fistral Beach and near Towan Head.

Conversely, most stations outside the MCZ were from between Watergate Bay and Mawgan Porth, an area of much lower urbanisation and fewer active sewage discharge outlets (Environment Agency, 2019). This differing urbanisation between inside and outside the MCZ may be responsible significantly lower IQI scores inside the site. It should be noted, that the IQI has not been shown to consistently respond to the presence of non-indigenous species (notably *Crepidula fornicata*) or abrasion pressure from fishing activities on faunal communities (Phillips and Green, in prep). At the time of writing, the site is still open to fishing using bottom-towed gear, so this cannot be ruled out as potentially impacting the sediment features of the site.

## 4.4 Undesignated BSH

Two benthic grab samples were classified as ‘A5.4 Subtidal mixed sediments’. Both of these stations were outside of the MCZ boundary. This habitat was not predicted by the existing habitat map. Given that this habitat was only recorded in two samples, it is considered unlikely that this habitat represents a substantial area on the Newquay and The Gannel MCZ. Future surveys should aim to characterise the extent of this habitat to potentially allow assessment of the condition of this currently undesignated habitat.

## 4.5 Habitat and species FOCI

The PoA document (Miller, 2017) indicated that point records should be made of habitat and species FOCI observes as part of the 2017 survey. As indicated in Section 3.6, all of the BSH rock features within the Newquay and The Gannel MCZ boundary are considered to comprise the habitat FOCI ‘estuarine rocky habitats’. As such, the same estimated distribution and extent described for the rock BSHs also apply to this habitat FOCI.

The habitat FOCI ‘Coastal saltmarshes and saline reedbeds’ was not observed during the 2017 survey. This is an intertidal habitat and so was not recorded as part of the 2017 subtidal survey work.

No observation was made in 2017 of the species FOCI Giant goby, though the confamilial *Thorogobius ephippiatus* was recorded. In addition, individuals identified at the familial level (Family Gobiidae) were also not recorded. The current survey was not specifically targeted at sampling fish species and the methods used were unlikely to observe these taxa inadvertently. As such, the fact that Giant gobies were not observed in 2017 should not be interpreted as the absence of this species from the MCZ.

## 4.6 Non-indigenous species

The polychaete *Goniadella gracilis* is a free living predatory species originally described from North America and South Africa and recorded in subtidal sediment habitats throughout the southern Irish Sea (Walker 1972). Currently, information on the invasive potential of this taxon is unknown therefore it is uncertain what impact the presence of this species may have with regards to maintaining favourable condition.

## 4.7 Marine litter

Marine litter was recorded in 67% of benthic infaunal samples. Marine litter was more common at stations within the MCZ compared with those outside. This is likely linked to the positioning of the MCZ boundary, which incorporates the lower extent and mouth of the River Gannel. Given the location of the MCZ at the mouth of an estuary and its proximity to nearby population centres (a source of litter), the presence of such items is not unexpected.

## 4.8 Anthropogenic activities and pressures

The recorded exceedances of EAC thresholds for organic contaminants (Figure 39) should be treated with caution as the multiplication factors used for normalisation were relatively large because organic carbon concentrations were all below 2% of the sample dry weight. As there are no assessment criteria available for PBDEs in sediment, it is not possible to assess the environmental significance of the concentrations observed.

# 5 Recommendations for future monitoring

- The ‘A5.2 Subtidal sand’ feature would be a potential BSH to use for a future ‘sentinel’ monitoring programme, as it is has a wide diversity of communities, is present both inside and outside the MCZ, and the BSH is spatially distributed across the site. A combination of BACI (before-after, control-impact) and temporal change sampling designs could then be implemented to assess the efficacy of the current general management approach.
- The data gathered as part of this report can feed into power analyses to allow the design of statistically-robust future surveys. It is essential that due consideration is given to the ‘effect size’ that we wish to detect for each of the response variables measured.
- Consistency and clarity in the gathering and analysis of video and still imagery is required to achieve repeatable and statistically robust data. The majority of imagery data gathered in 2017 was of ‘very poor’ or ‘poor’ quality. This severely limited the degree to which these data could be analysed. Such issues have not been unique to the Newquay and The Gannel MCZ, but have been noted in other near-shore MCZ imagery data. It is recommended that discussions are held to identify appropriate procedures for gathering imagery data. These discussions should include: suitable camera equipment and appropriate settings, in-the-field determination of image quality, indications of quality thresholds beyond which gathering of imagery data is halted, rapid pre-analyses in the analytical lab to summarise the quality of data gathered and appraisal of whether it is suitable to further analyse images.
- Due to the poor quality of the imagery data, only high-level and qualitative interpretations of these data were possible. Investigations, possibly using simulated data, could be carried out to assess whether such data give different conclusions to those gained from quantitative analyses conducted on high quality imagery data.
- The creation of a hydrodynamic model to simulate tidal current velocities over subtidal rock Broadscale Habitats may assist in determining whether communities are considered ‘High’ or ‘Moderate’ energy.
- For the purposes of monitoring and in particular for monitoring for the detection of change, it is important for data to be collected at the same time each year. Seasonality is an important driver of assemblage composition, particularly in subtidal sediment habitats and infralittoral rock habitats where algal cover and diversity strongly influences the community characterisation.
- Future monitoring should involve a survey tailored to baseline Giant goby populations in the site, using a stratified intertidal survey of rock pool habitats at low water springs to assess their abundance.

- Future monitoring should also involve a survey tailored to monitor the ‘Coastal Saltmarshes and Saline Reedbeds’ Habitat FOCI, found at the head of the Gannel estuary. Aerial photography and associated quadrat surveys will provide information on the extent, zonation and vegetation community of the saltmarsh. This can be repeated over time to assess erosion pressures.
- Species composition and biodiversity measures provide only limited information on the functioning of assemblages. The identification of key species and/or suites of biological and ecological traits would provide valuable insights into the condition of designated BSHs.

# 6 References

Airoldi, L., Rindi, F. and Cinelli F. (1995). Structure, seasonal dynamics and reproductive phenology of a filamentous turf assemblage on a sediment influenced, rocky subtidal shore. Botanica Marina, 38: 227-237.

Arnold, K. and Godsell, N. (2014). Newquay and The Gannel rMCZ Survey Report. Environment Agency, Bristol, UK.

Allaby, M. (2015). A dictionary of ecology (5th edition). Oxford University Press, UK.

Bates, D., Maechler, M., Bolker, B. and Walker S. (2015). Fitting linear mixed-effects models using lme4. Journal of Statistical Software, 67, 1-48.

Cohen, J. (1988). Statistical power analysis for the behavioural sciences. 2nd edition. Lawrence Erlbaum Associates, Inc., Hillsdale, NJ.

Clarke, K., R. and Gorley, R., N. (2006). PRIMER v6: user manual/tutorial (Plymouth routines in multivariate ecological research). *Plymouth: Primer-E Ltd*.

Day, G. F. (1978). The Day Grab - a simple sea-bed sampler. *Report of the Institute of Oceanographic Sciences 52.*

Department for Environment and Rural Affairs (Defra). (2016). Newquay and The Gannel Marine Conservation Zone – Factsheet. [Online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492387/mcz-newquay-gannel-factsheet.pdf [Accessed 13/09/2019].

Dudley, N. (2008). Guidelines for applying Protected Area management categories. IUCN, Gland.

Elliott, M., Nedwell, S., Jones, N., Read, S. J., Cutts, N. D. and Hemingway, K.L. (1998). Volume II: Intertidal sand and mudflats and subtidal mobile sandbanks. An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. UK Marine SACs project, Oban, Scotland.

Eno, N. C., Clark, R. A., and Sanderson, W.G. (Eds.). (1997). Non-native marine species in British waters: a review and directory. Peterborough: Joint Nature Conservation Committee.

Environment Agency. (2019). Consented Discharges to Controlled Waters with Conditions. Dataset downloaded from data.gov.uk. [Online]. Available from: https://data.gov.uk/dataset/55b8eaa8-60df-48a8-929a-060891b7a109/consented-discharges-to-controlled-waters-with-conditions. [Accessed 01/09/2019].

Folk, R.L. (1954). The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology 62, 344-359.

Ho, J., Tumkaya, T., Aryal, S., Choi, H. and Claridge-Chang A. (2018). Moving beyond P values: Everyday data analysis with estimation plots. bioRxiv, doi: https://doi.org/10.1101/377978.

JNCC. (2004). Common standards monitoring guidance for littoral sediment habitats. Joint Nature Conservation Committee, Peterborough.

Kuznetsova, A., Brockhoff, P.B. and Christensen, R. H. B. (2017). lmerTest package: tests in linear mixed effects models. Journal of Statistical Software, 82, 1–26. doi: http://doi.org/10.18637/jss.v082.i13.

Le Bas, T. (2015). Newquay and The Gannel rMCZ Post-survey Site Report. Marine Protected Areas Data and Evidence Co-ordination Programme MB0120 Report 26. Department for Environment, Food and Rural Affairs (Defra), London.

Long, D. (2006). BGS detailed explanation of seabed sediment modified folk classification.

Lord, T. (2019). Newquay and The Gannel MCZ 2017 Survey Report. Environment Agency, Bristol, UK.

Mason, C. (2011). NMBAQC's Best Practice Guidance Particle Size Analysis (PSA) for Supporting Biological Analysis.

Miller, C. (2017) Plan of Action. MPA evidence gathering programme – Newquay and The Gannel MCZ Baseline. Environment Agency: Peterborough, UK.

MSFD GES Technical Subgroup on Marine Litter. (2013). Guidance on Monitoring of Marine Litter in European Seas. Publications Office of the European Union. EUR 26113. [Online]. Available from: http://publications.jrc.ec.europa.eu/repository/handle/JRC83985 [Accessed 13/09/2019].

NE and JNCC. (2010). The Marine Conservation Zone Project: Ecological Network Guidance. Sheffield and Peterborough, UK.

O'Dell, J. (2018). Marine underwater video and stills analysis of Newquay and The Gannel MCZ. A report to Cefas by Seastar Survey Ltd., 43p.

Oele, E. (1978). Sand and gravel from shallow seas. *Geologie en Mijnbouw* 57: 45-54.

OSPAR. (2012). MSFD Advice Manual and Background Document on Biodiversity: Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptors 1, 2, 4 and 6. Version 3.2. Prepared by the OSPAR Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG COBAM) under the responsibility of the OSPAR Biodiversity Committee (BDC), OSPAR Commission, London.

OSPAR. (2017). Trends in Concentrations of Polybrominated Diphenyl Ethers (PBDEs) in Sediments. Intermediate assessment HASEC17/D808. [Online]. Available from: www.oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/pbde-sediment/ [Accessed 08/04/19].

Phillips, G. R., Anwar, A., Brooks, L., Martina, L. J., Prior, A. and Miles, A. C. (2014). Infaunal quality index: WFD classification scheme for marine benthic invertebrates. Environment Agency, Peterborough, UK. 193pp.

Robinson, L. A., Rogers, S., and Frid, C. L. J. (2008). A marine assessment and monitoring framework for application by UKMMAS and OSPAR – Assessment of pressure and impacts (Contract No. C-08-0007-0027 for JNCC). University of Liverpool and the Centre for the Environment, Fisheries and Aquaculture Science (Cefas).

Sanderson, W.G. (1996). Rare marine benthic flora and fauna in Great Britain. The development of criteria for assessment. Report by the Joint Nature Conservation Committee. JNCC: Peterborough. 36 pp.

Stebbing, P., Murray, J., Whomersley, P., and Tidbury, H. (2014). Monitoring and surveillance for non-indigenous species in UK marine waters. Defra Report. 57 pp.

Walker, A. J. M. (1972). *Goniadella gracilis*, a polychaete new to British seas. Marine Biology, 14: 85-87.

Worsfold, T. M., Hall., D. J., and O'Reilly, M. (2010). Guidelines for processing marine macrobenthic invertebrate samples: a processing requirements protocol version 1 (June 2010). Unicomarine Report NMBAQCMbPRP to the NMBAQC Committee. 33 pp.

# Annex 1. Abbreviations

| | |
|---|---|
| BSH | Broadscale Habitats |
| Cefas | Centre for Environment, Fisheries and Aquaculture Science |
| CP2 | Charting Progress 2 |
| 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 |
| GMA | General Management Approach |
| IFCA | Inshore Fisheries and Conservation Authority |
| JNCC | Joint Nature Conservation Committee |
| NMBAQC | North East Atlantic Marine Biological Analytical Quality Control Scheme |
| MBES | Multibeam echosounder |
| MCZ | Marine Conservation Zone |
| MPA | Marine Protected Area |
| MPAG | Marine Protected Areas Group |
| MSFD | Marine Strategy Framework Directive |
| NE | Natural England |
| NIS | Non-Indigenous Species |
| OSPAR | The Convention for the Protection of the Marine Environment of the North-East Atlantic |
| PSA | Particle Size Analysis |
| PSD | Particle Size Distribution |
| RV | Research Vessel |
| SAC | Special Area of Conservation |
| SNCB | Statutory Nature Conservation Body |
| SOCI | Species of Conservation Interest |
| SSS | Sidescan sonar |

# 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).* |
| 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 | The EC Habitats Directive (Council Directive 92/43/EEC on the |

| | |
|---|---|
| Directive | 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 Good Environmental Status (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 Newquay to the Gannel 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 Newquay to the Gannel 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.
- Records of meiofauna (i.e. nematodes) were removed.
- Records of fish species were removed.

# Annex 4. Epifauna data truncation protocol applied to seabed imagery data

As described 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.

Eggs and fish were removed from the data. The presence of eggs tells us very little about the ecology within a sampled location. Fish are highly mobile taxa and unlikely to be consistently sampled by the methods described in this report.

Many taxa were recorded as Present (‘P’). These values were converted to 1.

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.

Sponges were truncated into morphological categories. Typically, each morphotype represented one or two observed species.

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

An indistinct category of Hydroid/Bryozoan turf was included in a very large number of images. All smaller bryozoan & hydroid taxa were truncated to this level, regardless of growth to include the information in those images. Large conspicuous species, which should be clearly identifiable in adequate and above photos, including the bryozoans *Pentapora foliacea*, Flustridae and *Alcyonidium* sp. and the hydroids *Nemertesia* sp., *Tubularia* sp. and Aglaopheniidae were truncated to the highest common level. All encrusting bryozoans were placed into one group.

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

For brown algae, taxa belonging to the genus *Laminaria* were grouped at genus level. Non-*Laminaria* brown algae were grouped together as ‘other brown algae’.

Encrusting red algae were recorded as “Corallinacea”. All other red algae were grouped as “Rhodophyta Other”.

# Annex 5. Marine litter categories

**Table A5.1. 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 GES 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

**Table A6.1. 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 | | |

**Table A6.2. 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* | |

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