Mounts Bay Marine Conservation Zone (MCZ) Characterisation Report 2016

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Mounts Bay Marine Conservation Zone (MCZ) Characterisation Report 2016

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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 Mounts Bay MCZ.

Acknowledgements

We thank the MPA Group representatives for reviewing earlier drafts of this report.

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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 Survey Co-ordination and Evidence Delivery Group (MPA 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

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

Executive Summary

Under the UK Marine & 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. 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).

SNCB responsibilities for nature conservation in the marine environment are split inshore and offshore around the 12 nm boundary. Natural England are responsible for nature conservation within the Mounts Bay MCZ. Natural England utilise evidence gathered by targeted environmental and ecological surveys and site specific MPA reports in conjunction with other available evidence (e.g. activities, pressures, historical data, survey data collected from other organisations or data collected to meet different obligations). These data are collectively used to make assessments of the condition of designated features within sites, to inform and maintain up to date site specific conservation advice and produce advice on operations and management measures for anthropogenic activities occurring within the site. This report, as a stand-alone document, therefore, **does not** aim to assess the condition of the designated features or provide advice on management of anthropogenic activities occurring within the site.

This characterisation report is informed by data acquired during a number of dedicated surveys carried out within the Mounts Bay Marine Conservation Zone (MCZ) (in 2012 and 2016) and will form part of the ongoing time series data and evidence for this MPA.

Mounts Bay MCZ is an inshore site located on the southern coast of Cornwall within the ‘Western Channel and Celtic Sea’ Charting Progress 2 (CP2) sea area. A number of features of conservation importance (FOCI), including both habitats and species, are designated for protection within the Mounts Bay MCZ. This report provides a characterisation of two designated Broadscale Habitats (BSHs) (‘A3.2 Moderate energy infralittoral rock’ and ‘A5.2 Subtidal sand’) and additional habitats (‘A5.1 Subtidal coarse sediment’ and ‘A5.4 Subtidal mixed sediments’) and the habitat feature of conservation importance (FOCI) (‘Seagrass Beds’) within the MCZ.

Subtidal sand and infralittoral rock features were surveyed inside and outside of the MCZ boundary to provide a baseline characterisation (e.g., to inform the ’before’ element of a ‘before-after, control-impact’ (BACI) survey design), using a Day Grab and drop-down camera respectively (Table 4). Diversity and community analyses were undertaken on the species abundance data obtained from the infauna samples and still images. Sediment particle size and sediment contaminant concentrations were also included as part of the monitoring strategy at this MCZ.

There were no significant differences in taxa richness or community structure between samples collected in association with the subtidal sand feature, located inside and outside of the MCZ. Infaunal quality (assessed using the Infaunal Quality Index) and biomass were significantly higher outside of the site boundary. 'A5.1 Subtidal coarse sediment' and 'A5.4 Subtidal mixed sediments' were confirmed as being present inside the MCZ. The structure of the communities associated with the 'Infralittoral rock' feature was observed to differ between examples of the feature located inside and outside of the MCZ boundary. Areas identified as 'A3.1 High energy infralittoral rock' following the 2012 verification survey, were assessed as 'A3.2 Moderate energy infralittoral rock' following the baseline monitoring survey. This change could be due to differing camera methodologies or biotope identification but is supported by the outputs of hydrodynamic models applied to the Mounts Bay region. Due to the difficulties in differentiating between the energy levels which influence the classification of infralittoral rock features, 'High' and 'Moderate' energy infralittoral rock features should be reported and monitored as a single 'infralittoral rock' category in the future.

1 Introduction

The Mounts Bay 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 signatory.

Under the Marine & 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 characterisation report primarily explores data acquired from the first dedicated monitoring survey of Mounts Bay MCZ, which will form the initial point in a monitoring time series against which feature (and site) 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

Mounts Bay MCZ is an inshore site on the southern coast of Cornwall (Figure 1). Mounts Bay 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 site lies in between MPAs, with the Lands End and Cape Bank SCI and the Runnel Stone MCZ to the West and the Lizard Point SCI to the East ((© Environment Agency and Natural England 2016)

Only 5 % of infaunal taxa encountered in the grab samples collected in the 2016 survey were represented in the sample collected from within this BSH.

From the still image analyses, only 1 still image was assigned to the 'A5.4 Subtidal mixed sediments' Broadscale Habitat. The epifaunal communities observed in association with the 'A5.4 Subtidal mixed sediments' BSH contained foliose red algae

(Rhodophyceae), *Spirobranchus* worms, and encrusting sponge (**Error! Reference source not found.**).

1.2 Habitat Features of Conservation Importance (FOCI)

1.2.1 Seagrass beds

Zostera marina plants were observed in 12 still images (stations 71 and 72) assigned to 'A5.2 Subtidal sand' and 'A5.5 Subtidal Macrophyte Dominated' BSHs near to the entrance of Penzance harbour, outside of the MCZ boundary (Figure 6). Seagrass was only dense enough (> 5 % cover) to be classified as 'A5.5 Subtidal Macrophyte Dominated Sediment - Seagrass Beds' in five of the still images (Figure 11).

1.3 Species Features of Conservation Importance (FOCI)

No observations of the Giant Goby (*Gobius cobitis*) or any of the three different species of Stalked Jellyfish (*Haliclystus spp, Calvadosia campanulata and Calvadosia cruxmelitensis*) were made during the grab or video survey. The surveys reported here were not designed to specifically monitor (or identify the presence of) species FOCI. Additionally, these species are generally found in the intertidal / shallow subtidal and therefore unlikely to be picked up by this survey. As such, this should not be interpreted as an absence of these species FOCI from the site.

One juvenile Arctic quahog (*Arctica islandica*) was identified at station MNTB 01 in the 2012 verification survey. None were present in the sediment samples collected during the 2016 survey.

1.4 Non-indigenous (NIS) & Rare and scarce species

There were no non-indigenous species identified from the infauna samples or in the still images.

All taxa identified in grab samples collected in 2016 were searched against a list of rare species and scarce species identified by Sanderson (1996). There were no rare species identified from the infauna samples or in the still images.

1.5 Supporting processes

1.5.1 Water quality parameters

Near seabed water column salinity was recorded at the stations where contaminants were sampled. It ranged from 35.10 to 35.27.

1.5.2 Sediment quality parameters

Surface sediment scrapes were taken at eight grab stations, providing a record of the most recent contaminant levels deposited in the sediment.

Levels of arsenic, chromium and copper exceeded the OSPAR Effects Range Low (ERL) at all eight stations. Levels above the OSPAR ERL are considered to have a chronic impact on macrofauna. Levels of arsenic were also elevated above the proposed Western Channel regional baseline threshold (34 mg kg-1) at all eight stations (mean (± S.D.) of 140.3 ± 81.9 mg kg-1). There was no correlation between the IQI and arsenic concentrations. Station MNTB 91 outside of the designated boundary, had elevated levels of PAHs above the OSPAR Background Assessment Criteria (BAC), but these were below the OSPAR Environmental Assessment Criteria (EAC) at which they would be considered to have a chronic impact on macrofauna.

1.5.3 Hydrodynamics: energy and exposure

Mounts Bay MCZ faces south west but is sheltered from the prevailing westerly winds by the Lands End peninsular. It has mainly weak tidal currents (< 0.5 ms-1) flowing on a west-east axis (Figure 21). The hydrodynamic model of the Mounts Bay MCZ illustrates the sheltered nature of the eastern half of the bay, with the maximum current velocity (characterised as moderate energy currents of 0.5 – 1.5 ms-1) only occurring in a limited area, in association with shallower rock features around St Michael's Mount. No high energy environment was indicated to be present within the site by the results of the model.

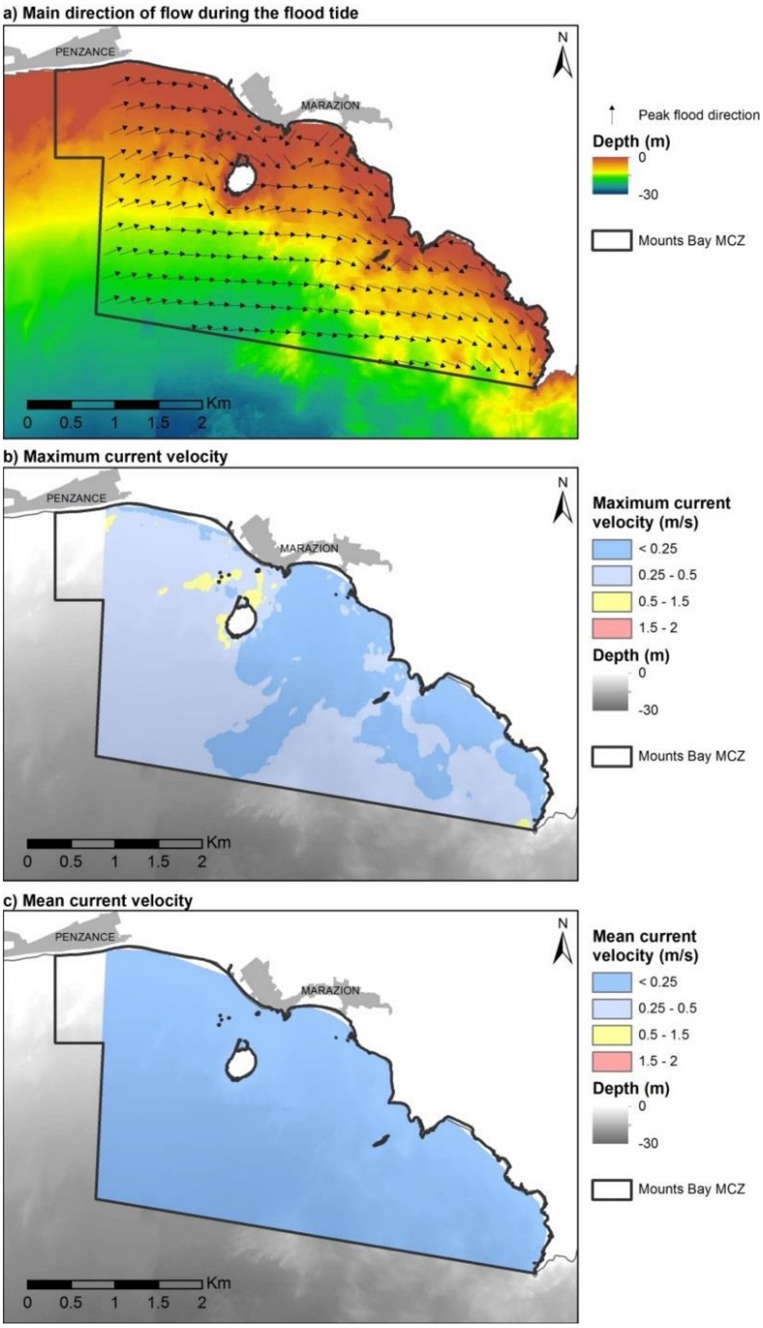


Figure 21. Physical environment at Mounts Bay Marine Conservation Zone (© Natural England and Environment Agency 2022). The maps show depth and current

conditions: (a) main direction of tidal flow during the flood phase, (b) maximum and (c) mean current velocity over a spring-neap tidal cycle.).

The ‘Penzance’ Water Framework Directive (WFD) coastal water body, which encompasses most of the bay, and the ‘Cornwall South’ WFD coastal water body, which stretches from Lands End to the East of the Lizard, both overlap the Mounts Bay MCZ. Monthly water quality surveys for WFD and Environmental Quality Standards Directive (EQSD) are undertaken by the EA in the South Cornwall water body as part of both surveillance and operational monitoring programmes. The South Cornwall water body is monitored monthly for phytoplankton, nutrients and chlorophyll under the annual WFD programme, with one sample point southeast of the MCZ at Pollurian Cove. There are two bathing water monitoring points within Mounts Bay MCZ (at Marazion and Perranuthnoe) and three outside of the site near Penzance. Physical data is also provided from the Penzance Waverider buoy, located outside of the western edge MCZ.

The MCZ encompasses a relatively sheltered area surrounding St Michael’s Mount on the south Cornish coast (Figure 1) and extends 2.8 km south from the beach at Long Rock to Cudden Point (Murray and Downie, 2014). The area of the site is 12 km^2 and the water depth ranges from the intertidal to approximately 27 metres below sea level (chart datum). The MCZ protects seagrass beds, subtidal sand and infralittoral rock habitats[1] (Table 1). Mounts Bay supports a variety of epifaunal communities in association with the soft sediments and rocky habitats present, including bivalve molluscs, annelid worms, starfish, sea squirts and anemones. It is also an important site for protecting the Giant goby *Gobius cobitis* and stalked jellyfish (*Haliclystus spp, Calvadosia campanulata and Calvadosia cruxmelitensis*)[1], this is the only MCZ to have all three stalked jellyfish species designated. The Environment Agency previously highlighted the area’s importance as a juvenile fish nursery ground and sea trout foraging area (Lieberknecht *et al*., 2011). The area is also important for over wintering birds, basking sharks and cetaceans (Leeney *et al*., 2012).

Outside of the MCZ boundary, there are three ports along the western side of the bay; Penzance, Newlyn and Mousehole. There are two dredge disposal sites within 5 km of the MCZ; the Outer Bay, south of the MCZ boundary (open for disposal of sediment from the 2014-15 dredging of Penzance harbour), and off Newlyn (closed site) (Figure 1). There are currently no byelaws restricting fishing activity within the MCZ. There are no designated shellfish waters in Mounts Bay.

Table 2 lists the Broadscale Habitats (BSH) and Features of Conservation Importance (FOCI) that have been reported at the site in the Site Assessment Document (SAD) (Lieberknecht *et al*., 2011) and the 2012 and 2016 Survey Reports (Godsell *et al*., 2013; Arnold, 2016) based on dedicated MCZ verification surveys. The features

[1] http://www.legislation.gov.uk/ukmo/2016/12/pdfs/ukmo_20160012_en.pdf [Accessed 10/01/2019].

protected in the site designation order and considered as part of the General Management Approach (GMA) to be applied to each feature are shown in Table 1.

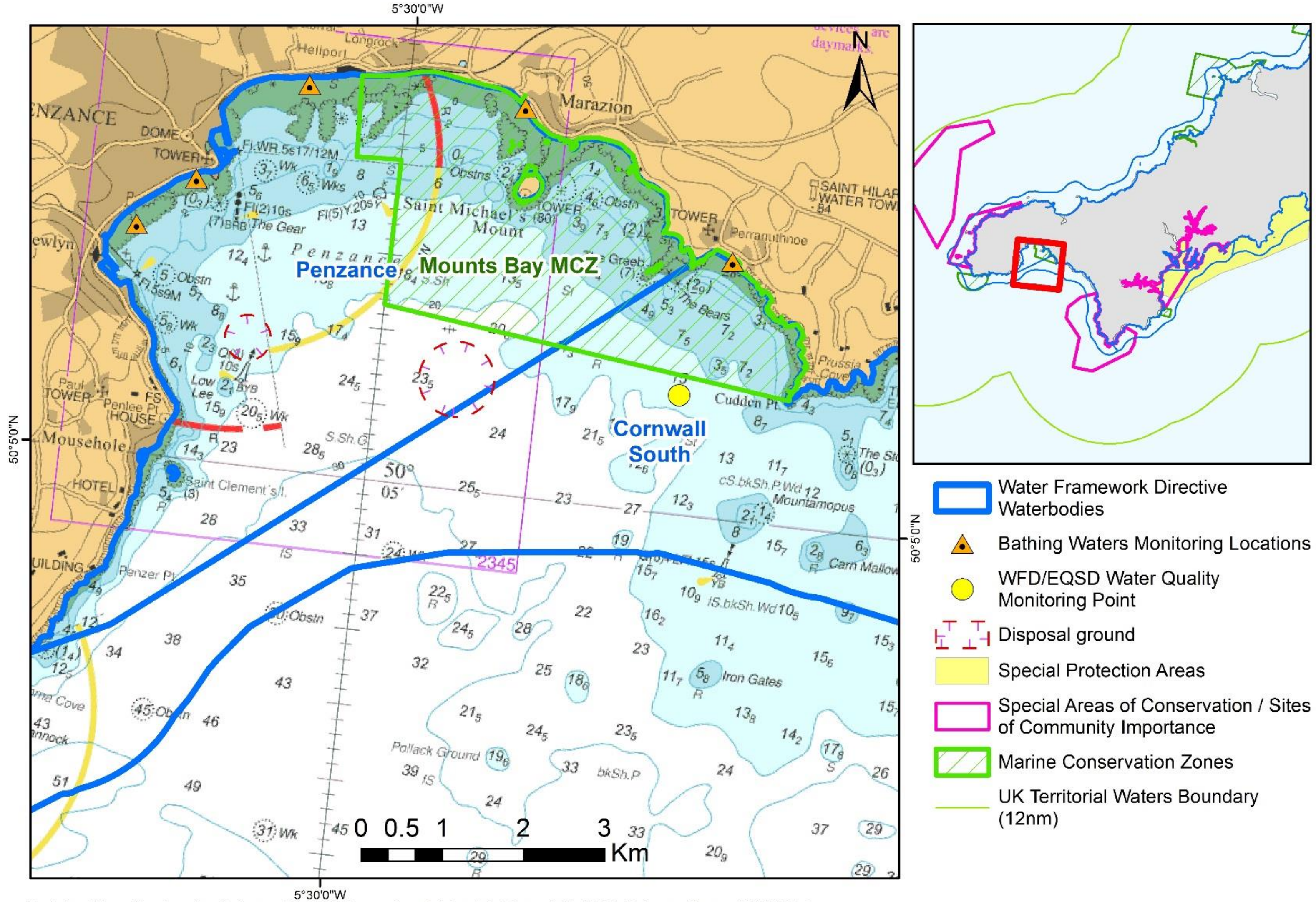


Figure 1. Location of Mounts Bay Marine Conservation Zone. Water Framework Directive waterbodies, locations of monitoring stations and nearby Marine Protected Areas are also shown.

Table 1. Designation status and General Management Approach (GMA) for features of conservation importance present in the Mounts Bay Marine Conservation Zone (© Natural England and Environment Agency 2022).

Charting Progress 2 Region[2]	Western Channel and Celtic Sea	
Spatial Area (km^2)	12 km^2	
Water Depth Range (m)	Intertidal to 27 metres below sea level (chart datum)	
Existing Data & Information	Arnold, K. (2016). Mounts Bay MCZ 2016 Survey Report. Environment Agency, Bristol, UK. Curtis, L.A. (2014). Mounts Bay rMCZ intertidal rock and sediment verification survey 2013/14. Report ER14-227, prepared by Ecospan Environmental for Natural England. 108pp. Godsell. N., Fraser, M., and Jones, N. (2013). Mounts Bay rMCZ Survey Report. Environment Agency, Bristol, UK Murray, J. and Downie, A. (2014). Mounts Bay rMCZ Post-survey Site Report. Cefas, Lowestoft, UK.	
Current & Proposed Management Measures	N/A	
Features Present (BSH)	**Designated**	**GMA**
A1.1 High energy intertidal rock*	✓	Maintain
A1.2 Moderate energy intertidal rock*	✓	Maintain
A2.1 Intertidal coarse sediment*	✓	Maintain
A2.2 Intertidal sand and muddy sand*	✓	Maintain
A3.1 High energy infralittoral rock	✓	Maintain
A3.2 Moderate energy infralittoral rock	✓	Maintain
A4.1 High energy circalittoral rock	✗	N/A
A4.2 Moderate energy circalittoral rock	✗	N/A
A5.2 Subtidal sand	✓	Maintain
Features Present (Habitat FOCI)		
Seagrass beds	✓	Maintain
Subtidal sands and gravels	✗	N/A
Features Present (Species FOCI)		
Giant goby (*Gobius cobitis)***	✓	Maintain
Stalked Jellyfish (*Haliclystus* spp)**	✓	Maintain
Stalked jellyfish (*Calvadosia campanulata*)**	✓	Maintain
Stalked jellyfish (*Calvadosia cruxmelitensis*)**	✓	Maintain

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

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

[2] http://webarchive.nationalarchives.gov.uk/20141203170558tf_/http://chartingprogress.defra.gov.uk/ [accessed 10/01/2019]

Table 2. Subtidal Broadscale Habitats (BSH) and features of conservation importance (FOCI) identified at Mounts Bay MCZ from the Site Assessment Document (SAD) to this survey (© Natural England and Environment Agency 2022). Designated features indicated with grey shading.

Feature type	Feature Name	Extent according to SAD	Extent according to updated SAD	Presence following 2012 survey	Extent following 2012 survey	Presence following 2016 survey
Broadscale Habitat (BSH)	High energy infralittoral rock	0.16 km^2	0.07 km^2	8 stations	3.69 km^2	Not recorded
	Moderate energy infralittoral rock	0 km^2	0 km^2	2 stations	0.04 km^2	35 stations
	Subtidal sand	10.32 km^2	7.69 km^2	1 station 14 PSA	2.65 km^2	20 PSA
	Subtidal mixed sediments /	0.01 km^2	0.03 km^2	1 station	1.38 km^2	1 PSA
	Subtidal coarse sediment			Not recorded		3 PSA
	Moderate energy circalittoral rock	None	None	None	None	Not recorded
Habitat FOCI	Seagrass beds	0.01 km^2	N/A	None	N/A	2 stations
	Subtidal sands and gravels	10.32 km^2	7.69 km^2	14 PSA	4.03 km^2	24 PSA
Species FOCI	*Gobius cobitis* (Giant goby)*	3 records	N/A	N/A	N/A	N/A
	Haliclystus spp (Stalked jellyfish)*	4 records	N/A	N/A	N/A	N/A
	Calvadosia campanulata (Stalked jellyfish)*	1 record	N/A	N/A	N/A	N/A
	Calvadosia cruxmelitensis (stalked jellyfish)*	1 record	N/A	N/A	N/A	N/A

1.6 Aims and objectives

1.6.1 High-level conservation objectives

High-level site-specific conservation objectives serve as benchmarks against which the efficacy of the General Management Approach (GMA) in achieving the conservation objectives (i.e. maintaining designated features at, or recovering them to, ‘favourable condition’) can be assessed and monitored.

As detailed in the Mounts Bay 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.

It should be noted that ‘maintain’ GMAs may have been applied based on an indirect or proxy assessment, as opposed to being based on empirical monitoring evidence (i.e. direct observations).

1.6.2 Definition of favourable condition

Favourable condition, with respect to a habitat feature[1], 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.

1.6.3 Report aims and objectives

The primary aim of this characterisation report is to explore and describe the attributes of the designated features within Mounts Bay MCZ, to enable future assessment and monitoring of feature condition. 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.

To date, the spatial and temporal variability of faunal communities at this site have not been investigated. This presents a challenge in relation to decisions around the selection of suitable metrics upon which to base the assessment of biological condition. Furthermore, this situation is exacerbated due to the lack of any time-series data upon which the natural temporal variability of any such metrics can be quantified.

The selection of metrics for monitoring habitat condition can be guided by the attributes listed in the site's Supplementary Advice on Conservation Objectives (SACO)[3]. These attributes are considered to be those which best describe the site's ecological integrity and which, if safeguarded, will enable the feature to achieve favourable condition.

At the time of this report's writing, the Mounts Bay MCZ Conservation Advice Package was not published, so only the standard list of attributes for Broadscale Habitats could be evaluated for this report (Table 3).

The broad objectives of this monitoring report are provided below:

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

2) Note observations of any Habitat or Species FOCI not covered by Designation Order as features of the site;

3) Present evidence relating to marine litter (Descriptor 10), to satisfy requirements of the Marine Strategy Framework Directive;

[3]https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0036&SiteName=mounts bay&SiteNameDisplay=Mounts+Bay+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=[accessed 10/01/2019] [accessed 10/01/2019]

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

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

1.6.4 Feature attributes and supporting processes

To achieve report objective 1, this report investigates the biological characteristics of the conservation features designated for protection within the Mounts Bay MCZ through analysis of seabed imagery and grab sample data, collected at the site in targeted surveys conducted between 2012 and 2016. Taxa observed in grab samples and seabed imagery have been used to describe the biological communities present in association with the designated Broadscale Habitats. The current condition of the site has been investigated using a number of diversity metrics and community analyses.

The list of selected feature attributes and supporting processes considered in this report is presented in Table 3, alongside the generated outputs for each.

Where sufficient numbers of observations are present from within and outside the MCZ, comparisons of the communities and diversity metrics have been carried out between the proposed management areas and ‘control’ areas where no management approaches have been proposed. The characterisation of habitats within and outside the MCZ (and the proposed management boundaries), at the time of setting the baseline (T0), ensures that the selected locations representative of unmanaged areas are sufficiently similar to those where a management approach is proposed to act as effective control sites.

2 Methods

2.1 Data sources

Data used to inform this report has been compiled from surveys carried out at the Mounts Bay MCZ in March 2012 and April 2016 by the Environment Agency (EA) (Godsell *et al*., 2013, Arnold, 2016). Locations of video tows and grab samples collected during these surveys are shown in Figure 2.

2.2 Survey design

Twenty stations inside the MCZ boundary were surveyed in March 2012 by the EA as part of the Mounts Bay MCZ verification survey. Due to the absence of a habitat map, to help inform the 2012 survey design, a systematic approach was adopted, with stations positioned 500 m apart, using a triangular lattice arrangement. All twenty stations were surveyed using a drop-down video, from which nine stations identified as subtidal sand were resampled for sediment with a Day grab.

Table 3. Feature attributes and supporting processes addressed to achieve report objective 1, for the Mounts Bay MCZ (© Natural England and Environment Agency 2022).

Feature attributes	Features	Outputs
Extent and distribution	A3.2 Moderate energy infralittoral rock A4.2 Moderate energy circalittoral rock* A5.1 Subtidal coarse sediment** A5.2 Subtidal sand A5.4 Subtidal mixed sediments** A5.5 Subtidal macrophyte dominated sediment** Seagrass beds	Maps of locations of biotopes & substrates sampled & Habitat map
Physical structure	A3.2 Moderate energy infralittoral rock A4.2 Moderate energy circalittoral rock*	Maps of locations of substrates sampled & Habitat map
Sediment composition and distribution	A5.1 Subtidal coarse sediment** A5.2 Subtidal sand A5.4 Subtidal mixed sediments**	Habitat map and PSA derived from seabed sediment samples
Presence and spatial distribution of biological communities **Presence and abundance of key structural and influential species** **Species composition of component communities**	A3.2 Moderate energy infralittoral rock A4.2 Moderate energy circalittoral rock* A5.1 Subtidal coarse sediment** A5.2 Subtidal sand A5.4 Subtidal mixed sediments** A5.5 Subtidal macrophyte dominated sediment**	Biological communities (and derived biotopes) derived from ground truth samples
Non-indigenous species (NIS)	Mounts Bay MCZ	Location of samples where NIS were recorded
Supporting processes:		
Energy and exposure	Mounts Bay MCZ	Hydrological model
Sediment contaminants	Mounts Bay MCZ	Results of analysis of surface sediment scrapes
Water quality parameters	Mounts Bay MCZ	Summary of water column salinity
Additional monitoring		
Marine Litter	Mounts Bay MCZ	Map of location of marine litter sampled and description

*** Only observed outside of site MCZ in 2016**

**** Not a designated feature of the MCZ**

Twenty stations inside the MCZ were surveyed for subtidal sand in 2016, including repeat sampling at five of the nine stations surveyed in 2012 to give a representative overview of temporal change. The stations located inside the MCZ were randomly positioned within areas of ‘A5.2 Subtidal sand’ identified from the 2012 habitat map, in order to sample areas that previously had no groundtruthing information on sediment type. A further twenty stations were positioned in areas to the west and south of the MCZ boundary, considered to be subtidal sand (determined by examination of recent bathymetric charts), as part of the 2016 baseline monitoring survey (T0) and in accordance with the principles of a Before-After-Control-Impact (BACI) survey design. Stations outside of the MCZ boundary were not selected below the 21 m depth contour to ensure comparable depth range with the stations located inside the MCZ. Additional stations inside the site were positioned to sample the patches of ‘A5.1 Subtidal coarse sediment’ (five stations) and ‘A5.4 Subtidal mixed sediments’ (two stations), that were only observed in camera stills in 2012 and illustrated in the updated habitat map for the MCZ (Murray and Downie 2014).

Twenty-one stations inside the MCZ were surveyed as part of the 2016 baseline monitoring survey, using drop-down video to target ‘A3.1 High energy infralittoral rock’, including resampling at eight of the stations originally surveyed in 2012. The stations inside the MCZ were randomly positioned within areas of ‘A3.1 High energy infralittoral rock’ identified from the 2012 updated habitat map. A further nineteen randomly positioned stations were surveyed outside the MCZ, in areas considered to be ‘A3.1 High energy infralittoral rock’ (determined by examining of recent bathymetric charts), in line with the BACI survey design principles as described above. Two additional stations inside the site were selected to target patches of ‘A3.2 Moderate energy infralittoral rock’ that were observed in camera stills in 2012 and illustrated in the updated habitat map for the MCZ (Murray and Downie 2014).

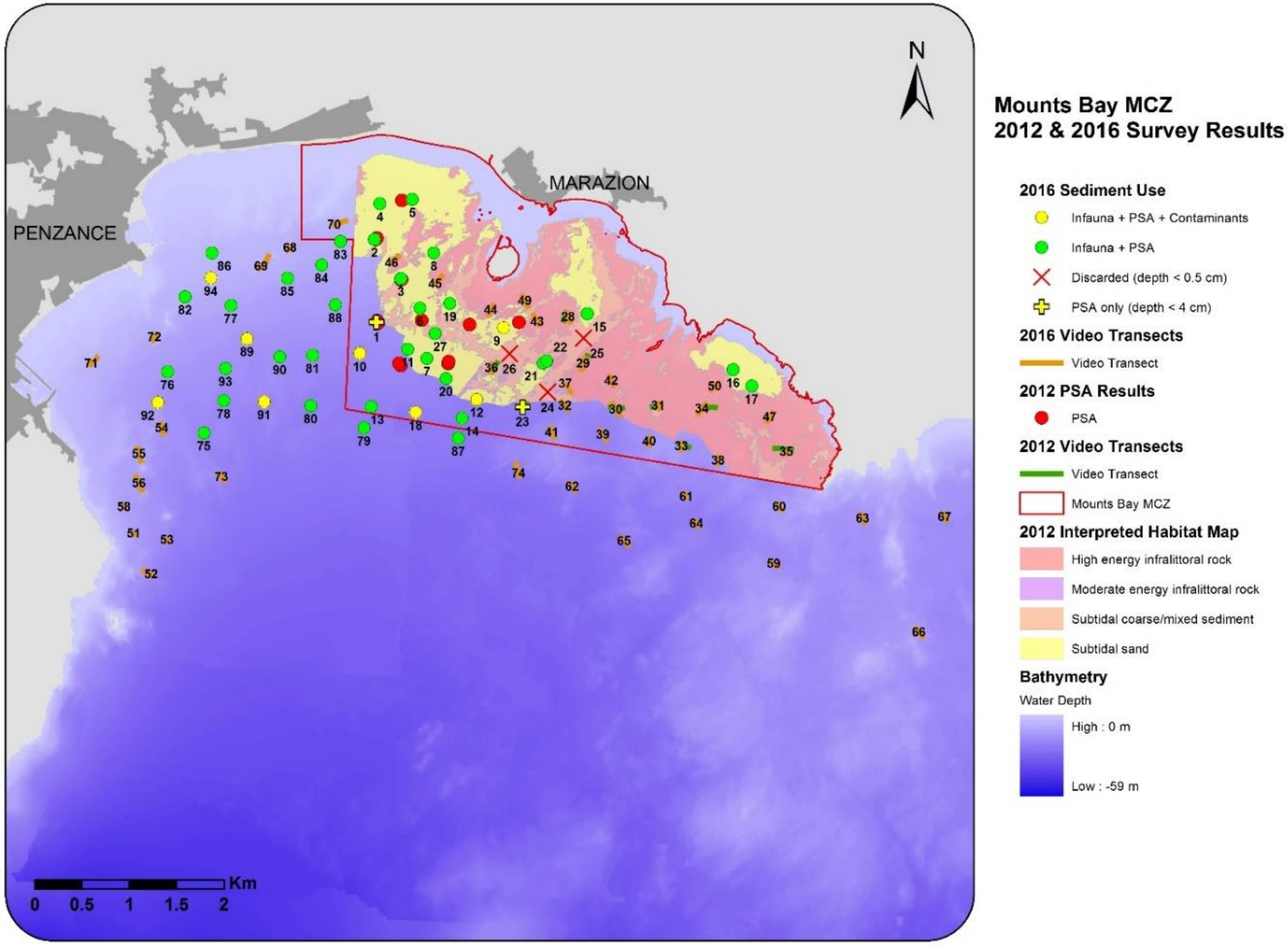


Figure 2. Location of the grab samples and video transects collected during the 2012 and 2016 Mounts Bay MCZ surveys (© Natural England and Environment Agency 2022).

2.3 Data acquisition and processing

2.3.1 Seabed imagery

All drop-down video data were collected following MESH Recommended Operating Guidelines (Coggan *et al*., 2007). In the 2012 and 2016 EA surveys, video footage and still images were collected using a Seaspyder drop-down 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 survey reports (Godsell *et al*., 2013, Arnold, 2016). Still images of the seabed were captured every 10-15 m over a distance of ~150 m. Additional images were taken in heterogeneous areas of BSH and if particular habitat or species FOCI were observed.

2.3.2 Seabed sediments

Sediment samples for particle size distribution and benthic infauna analyses were collected using a 0.1 m^2 Day Grab as described in the Environment Agency Water Framework Directive (WFD) operational instructions 104_10 (2012) and 009_07 (2014).

The EA WFD sampling methodology required two similar samples; the first was used to obtain a faunal sample (to a minimum depth of 5 cm in sand habitat and 7 cm in mud habitat) and the second to obtain a sub-sample for Particle Size Analysis (PSA).

The faunal sample was sieved over a 1.0 mm mesh. The retained material was photographed on the sieve and preserved in a buffered 4 % formaldehyde solution, for transfer ashore to a specialist laboratory for analysis (APEM). All fauna present in each sample were extracted. 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 North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme (Worsfold *et al*. 2010).

Any litter fragments in the sieved material greater than 1 mm in size were counted by the laboratory and categorised following OSPAR/ICES/IBTS guidance (Annex 4).

A full depth-integrated core of sediment (approx. volume of 500 ml) was taken from the second sample for particle size analysis. Samples were analysed by the National Laboratory Service following the recommended methodology of the 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.

2.4 Data preparation and analysis

2.4.1 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) (Figure 3).

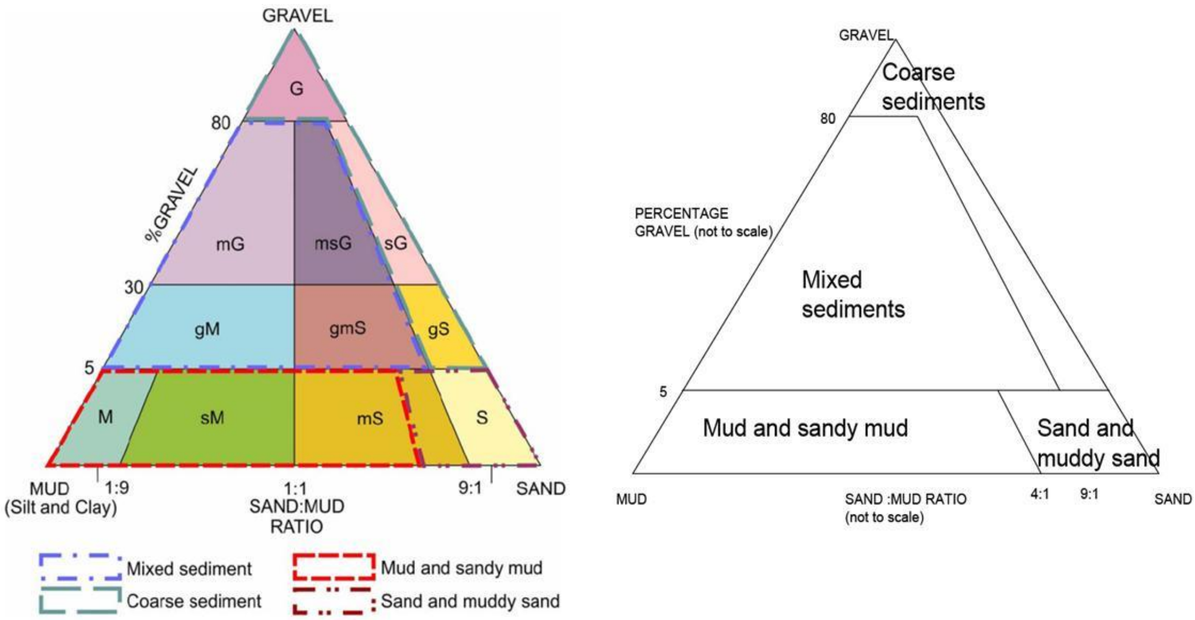


Figure 3. Classification of sediment Broadscale Habitats based on the simplified subdivision of the Folk triangle for UKSeaMap (Long, 2006; Folk, 1954) (© Natural England and Environment Agency 2022).

2.4.2 Biological community data preparation

Infauna data

Benthic macrofauna data sets were checked to ensure consistent nomenclature and identification policies. Any discrepancies identified were resolved using expert judgement following the truncation steps presented in Annex 1. Invalid taxa and fragments of countable taxa were removed from the data set, while the presence of colonial taxa was changed to a numerical value of one. Records were combined where a species was identified correctly both by using its binomial name and by using its binomial name with a qualifier e.g. *Lumbrinereis cingulata* 'aggregate'. Records labelled as 'juvenile' were combined with adults of the same genus/species/family.

Temporal community analysis of the infauna data was undertaken at the genus level in order to remove any potential species identification errors resulting from the infauna samples from the two surveys being analysed by two different contractors.

Drop down video

Both video and still image data were collected during the survey, but only the still images were used for statistical analysis due to the higher resolution of the images. The 2012 and 2016 still image data sets included abundance records for taxa identified in the images. A considerable difference was evident in the taxonomic resolution between the analysis of stills from 2012 and 2016. Consequently, each dataset was truncated separately following the steps presented in Annex 2. In both datasets, 'fish' and 'uncertain identification' at the level of Animalia were removed. All taxa observed were combined to the lowest common taxonomic level. As the 2016 dataset had less taxonomic detail, for the combined dataset, sponges, bryozoans and red and brown algae (other than laminarians, which were conspicuous enough to be identified in both datasets) were simplified to a morphological category. The truncation resulted in 36 taxa recorded in the 2012-2016 dataset, and 39 taxa recorded in the 2016 dataset.

Different modes of recording abundance (percentage cover vs individual counts) prevented the aggregation of observed abundances across the taxa combined in the truncation step. In order to retain some information regarding relative abundance for community analyses, SACFOR scores were converted to a numerical ordinal scale from 1 (rare) to 6 (superabundant). As ordinal scores cannot be added or averaged, the maximum score of the combined taxa was adopted for each truncated entry.

2.4.3 Non-indigenous species

The infaunal and epifaunal species abundance data (generated from the infaunal samples and seabed imagery data respectively) were cross-referenced against a list of 49 non-indigenous target species, which have been selected for assessment of Good Environmental Status in GB waters under MSFD Descriptor 2 (Stebbing *et al.,* 2014; Annex 5). The list includes two categories; species which are already known to be present within the assessment area (present) and species which are not yet thought to be present, but have a perceived risk of introduction and impact (horizon). An additional list of taxa, which were identified as invasive in the 'Non-native marine species in British waters: a review and directory' (Eno *et al*., in 1997) was also used to cross reference against all taxa observed (Annex 5).

2.4.4 Statistical analyses

The truncated infauna abundance and biomass data were imported into PRIMER v6 (Clarke and Gorley, 2006) to enable multivariate analysis and the derivation of various metrics for univariate analyses. Species classification information and a number of relevant factors/indicators were also assigned to the data at this pre-analysis stage. The number of taxa (S), total abundance of enumerable individuals (N), Shannon diversity (Log *e*), species 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).

Non-metric multidimensional scaling (MDS) ordination plots, analysis of similarity between (ANOSIM) and within (SIMPER) groups were produced in PRIMER v6 to explore any temporal and spatial differences in the benthic communities. Spatial differences were examined on a finer scale by undertaking analyses separately on samples collected inside and outside of the MCZ boundary.

Summary statistics, data interpretation/manipulation and non-parametric Mann-Whitney tests were performed on the sample level metrics to test for any significant differences between the spatial and/or temporal groups (Minitab, 2010).

The same analyses were conducted on the epifauna ordinal (SACFOR) abundance data, with the distinction of number of taxa (S) being the only diversity metric derived, and the inclusion of all Broadscale Habitat types.

Each still image was allocated to a Broadscale Habitat type and location (i.e., inside or outside of the MCZ boundary). Some transects crossed the boundary. In these cases, stills within 5 m of the boundary were classified as being inside the site. For each station (transect) abundance was averaged across stills in each BSH type (to account for the effect of habitat association of the species). The mean abundance at each station formed the sample unit for comparison of abundance in each BSH strata located inside and outside the MCZ (Annex 3).

2.4.5 Contaminant sample analyses

Samples were analysed after being homogenised, jaw crushed and sieved to < 63µm (NLS, 2016). Sediment dry weight contaminant concentrations were normalised to 5 % aluminium (for heavy metals) and 2.5 % total organic carbon content (for organics) to take account of the variation between sediment types (OSPAR Commission, 2008; OSPAR Commission 2014) for comparison.

Results were compared against OSPAR background assessment criteria (BAC), considered to be background level thresholds and environmental assessment criteria / effects range low (EAC/ERL), above which concentrations may chronically impact marine fauna, for heavy metals, polycyclic-aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Metal results were also compared against proposed Cefas regional baseline concentrations for the Western Channel area (Mason *et al*., 2011).

3 Results and Interpretation

3.1 Site overview

The Mounts Bay MCZ 2016 baseline monitoring survey incorporated the following Broadscale Habitats; ‘A3.2 Moderate energy infralittoral rock’, ‘A4.2 Moderate energy circalittoral rock’ (Figure 4)**Figure 4. Example images of the rock features present at Mounts Bay MCZ (© Environment Agency and Natural England and Environment Agency 2016).**

, ‘A5.1 Subtidal coarse sediment’, ‘A5.2 Subtidal sand’, ‘A5.4 Subtidal mixed sediments’ and ‘A5.5 Subtidal macrophyte dominated sediment’ (Figure 11).

Table 4 shows the number of samples collected from the Broadscale Habitats to which they were assigned. Seven of the eight re-surveyed camera stations from the 2012 verification survey, previously classified as ‘A3.1 High energy infralittoral rock,’ were assigned as ‘A3.2 Moderate energy infralittoral rock’ BSH, classification based on the additional hydrological information derived from the hydrodynamic model.

Table 4. Number of samples collected in each BSH (© Natural England and Environment Agency 2022).

Broadscale Habitat (BSH)	Grab – PSA & 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	0	0	0	0
A3.2 Moderate energy infralittoral rock	N/A	N/A	N/A	N/A	22	12	118	73
A4.2 Moderate energy circalittoral rock	N/A	N/A	N/A	N/A	0	5	0	40
A5.1 Subtidal coarse sediment	2	-	1	-	1	3	24	33
A5.2 Subtidal sand	19	20	1	-	2	11	5	51
A5.4 Subtidal mixed sediment	1	-	-	-	0	0	1	0
A5.5 Macrophyte-dominated subtidal sediment	-	-	-	-	0	0	0	5

3.2 Subtidal rock BSH: Physical structure and biological communities

The rock feature at the site comprises bedrock overlain by boulders and cobbles (Figure 5). The main biotopes identified at the site include Laminariaceae and red algae on ‘A3.2 Moderate energy infralittoral rock’ (IR.MIR.KR), and ‘A4.2 Moderate energy circalittoral rock’ (CR.MCR) (Figure 6 and Figure 7).

Characterisation of the biotopes using the 2016 seabed imagery data indicated only the ‘A3.2 Moderate energy infralittoral rock’ BSH category was present within the MCZ. All examples of the rock feature observed within the MCZ boundary (118 still images) were classified as ‘A3.2 Moderate energy infralittoral rock’ based on their associated biological community characteristics. Examples of ‘A3.2 Moderate energy infralittoral rock’ were also identified outside the MCZ boundary (73 still images) along with examples of ‘A4.2 Moderate energy circalittoral rock’ (40 stills), which were mostly observed below the 20 m depth contour.

‘A3.2 Moderate energy infralittoral rock’	‘A4.2 Moderate energy circalittoral rock’
	

Figure 4. Example images of the rock features present at Mounts Bay MCZ (© Environment Agency and Natural England and Environment Agency 2016).

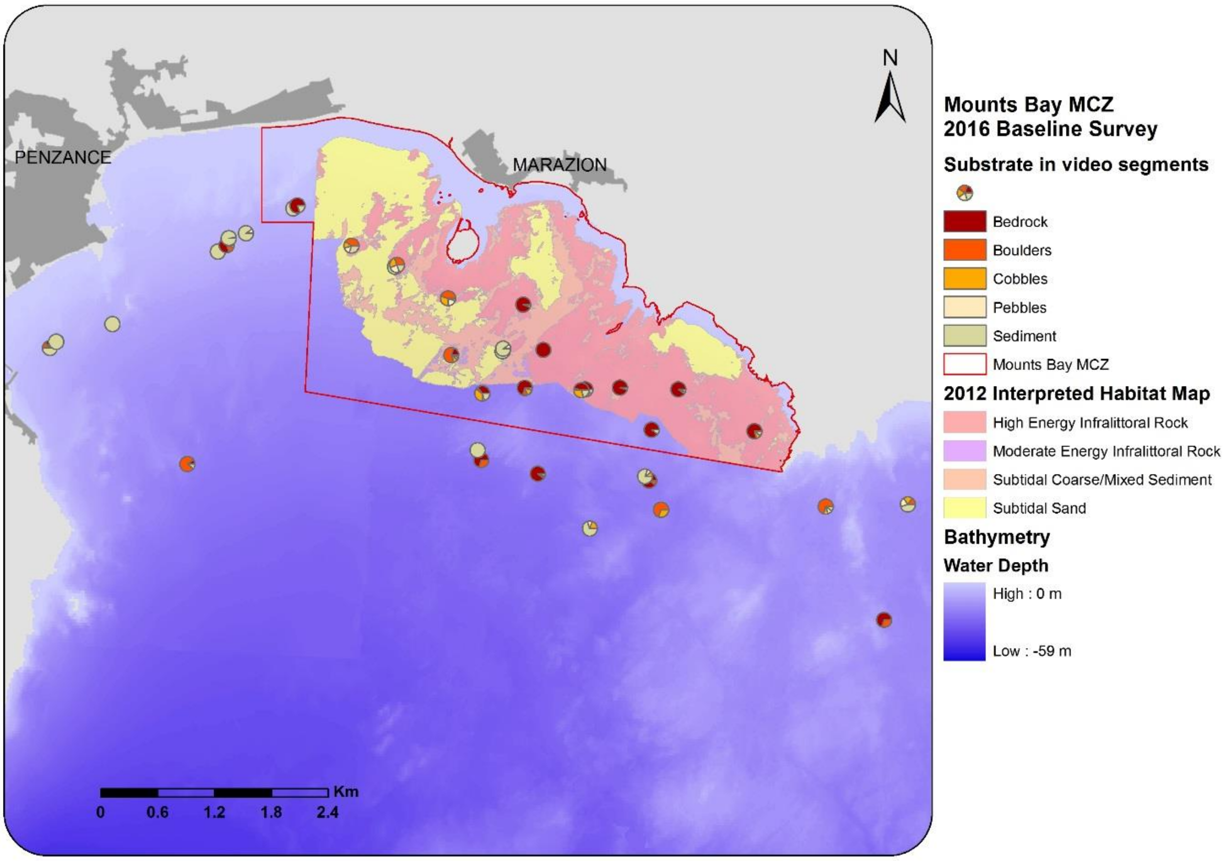


Figure 5. Substrate composition recorded in each video tow segment in 2012 and 2016 (© Natural England and Environment Agency 2022). Due to visibility issues in the surveys, substrate composition was not recorded for every video segment.

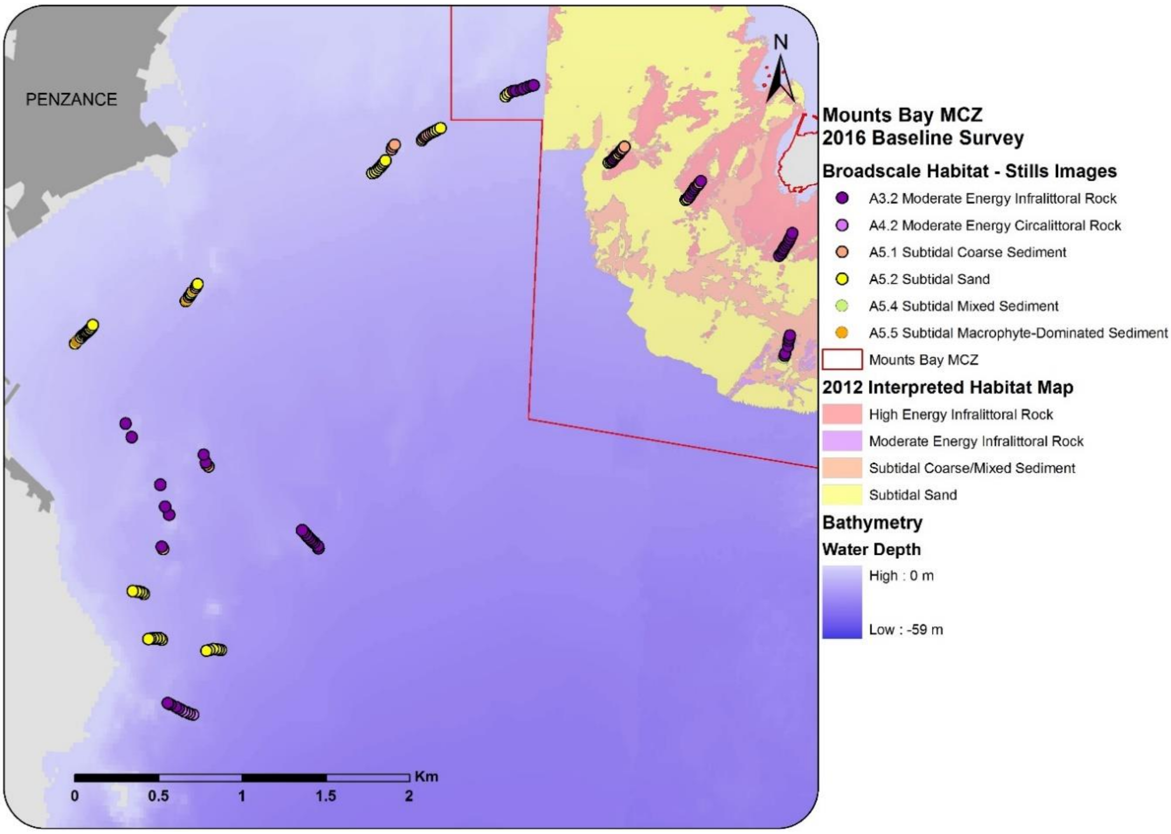


Figure 6. Broadscale Habitat classifications derived from still images of Mounts Bay MCZ and surrounding area – West (© Natural England and Environment Agency 2022).

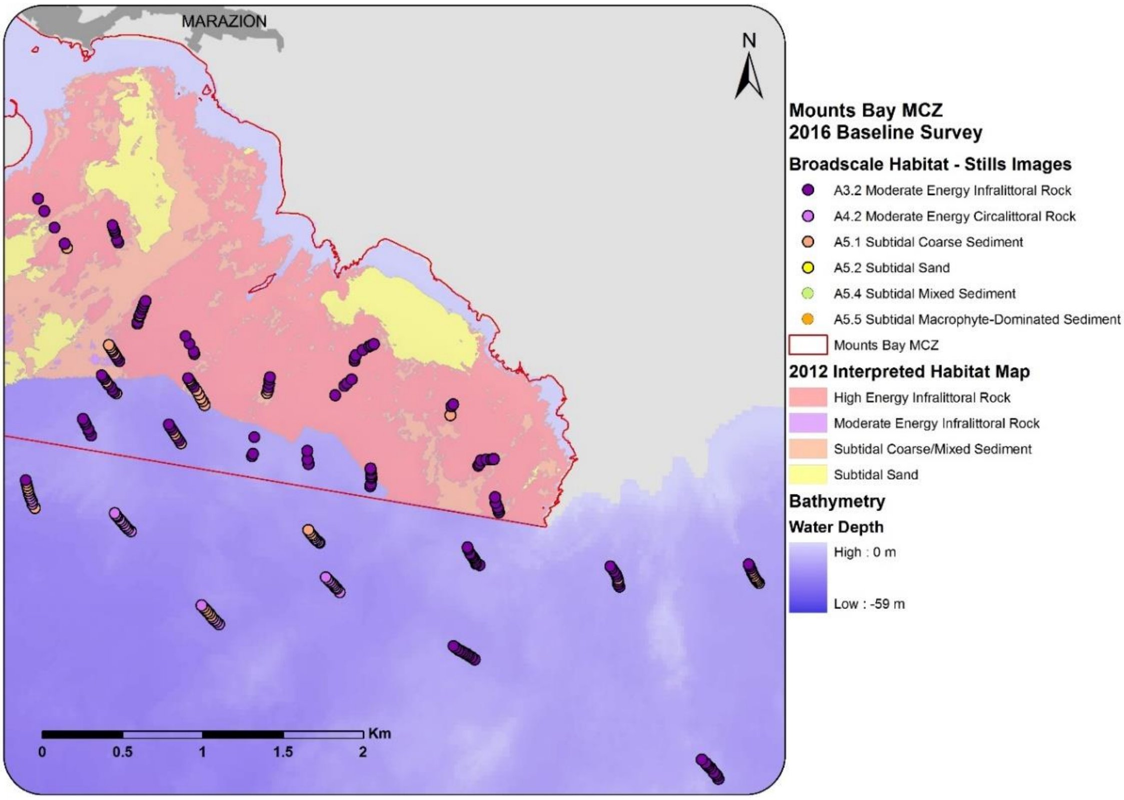


Figure 7. Broadscale Habitat classifications derived from still images of Mounts Bay MCZ and surrounding area – East (© Natural England and Environment Agency 2022).

3.2.1 'A3.2 Moderate energy infralittoral rock'

The 'A3.2 Moderate energy infralittoral rock' feature present in the Mounts Bay MCZ is characterised by frequent occurrence of Rhodophyceae, Laminariaceae, Corallinaceae and orange encrusting sponges. An ANOSIM analysis comparing the epifaunal community composition of infralittoral rock, derived from still images collected during 2016, across examples of the feature located inside and outside of the MCZ, indicated a very small but significant difference (Global R = 0.097, P = < 0.001). These slight differences observed between the feature located inside and outside of the MCZ (**Error! Reference source not found.**) are due to a higher cover o f Laminariaceae and Rhodophyceae inside the MCZ and a higher occurrence of *Marthasterias glacialis* outside the MCZ. There was no significant difference in taxa richness derived from the stills images collected in association with the 'A3.2 Moderate energy infralittoral rock' feature located inside and outside the MCZ, with α = 0.05 (mean ± SE richness inside MCZ = 4.09 ± 0.12 species per still; outside MCZ = 4.58 ± 0.24 species per still, t = -1.82, P = 0.071).

The mean (± SE) percentage cover of Laminariaceae on infralittoral rock inside the MCZ was 16.77 ± 1.58 % (range of 0 – 75 %), and outside the MCZ was 7.41 ± 1.48 % (range of 0 – 60 %). Percentage cover was significantly higher inside the MCZ than outside the site (Mann Whitney W = 13336.0, P < 0.001). Similarly, the mean percentage cover of red seaweeds on infralittoral rock inside the MCZ was 8.76 ± 0.81 % (range of 0 – 50 %) and outside the MCZ was 5.45 ± 0.96 % (range of 0 – 50 %). Again, percentage cover of red algae was significantly higher inside of the MCZ (W = 13156.5, P < 0.002).

Temporal Changes

Eight stations sampled in March 2012 within the MCZ were resampled as part of the April 2016 baseline monitoring survey (with 59 stills acquired in 2012 and 45 stills acquired in 2016). Still images collected at all of these stations in 2016 were characterised as 'A3.2 Moderate energy infralittoral rock', which differs from the 2012 survey where they were classified and recorded as 'A3.1 High energy infralittoral rock' (mostly as the IR.HIR.KFaR.LhypR, *Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock biotope). There was a significant difference in community structure between the infralittoral rock sites sampled in 2012 (classified mostly as 'High energy') and resampled in 2016 (all classified as 'Moderate energy') (ANOSIM Global R = 0.51, P < 0.001). SIMPER analysis indicated that a higher relative abundance of Hydrozoa, brown and red algae in 2012 (and increased relative abundance of *Laminaria* sp. in 2016) contributed to the dissimilarity between the communities across the two years.

Similarly, there was also a significant difference in the observed number of taxa (S) between still images at stations inside the MCZ sampled in both 2012 and 2016 (mean 2012 = 6.27, range 2 – 10, mean 2016 = 3.78, range 2 – 6, W = 4097.5, P < 0.001). It should be noted that two different contractors processed the still images from the

2012 and 2016 surveys, resulting in a reduction of taxonomic resolution across the merged dataset. Consequently, some caution should be applied when interpreting the results of the temporal analysis.

3.2.2 'A4.2 Moderate energy circalittoral rock'

'A4.2 Moderate energy circalittoral rock' was only observed outside of the MCZ boundary (Figure 6 and Figure 7). This was characterised by *Marthasterias glacialis, Holothuria forskali,* and *Echinus esculentus* (Figure 10), with a mean taxa richness of 4.55 ± 0.28 species per still. The increased abundance of these species in the circalittoral rock habitat drove the significant difference in community structure between the infralittoral and circalittoral rock communities observed in the still images (Global R = 0.453, $P < 0.001$, note that the statistical design was not balanced).

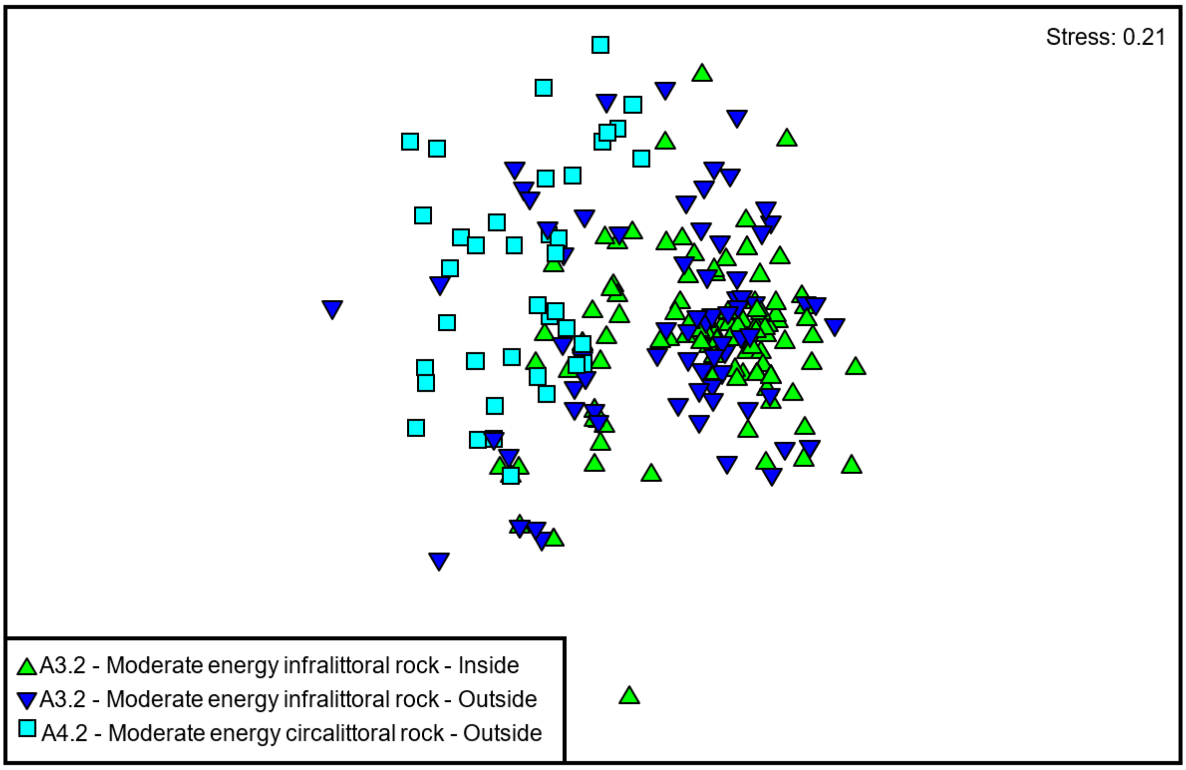


Figure 8. MDS plot illustrating the similarity of infralittoral and circalittoral rock communities identified from still images sampled during the 2016 baseline survey inside and outside of Mounts Bay MCZ (© Natural England and Environment Agency 2022). SACFOR scores were converted to 6 – 1 before conversion to a resemblance matrix using a Bray-Curtis similarity index. No transformation was performed on the data.

Kelp and red seaweeds ('Moderate energy infralittoral rock') (IR.MIR.KR)

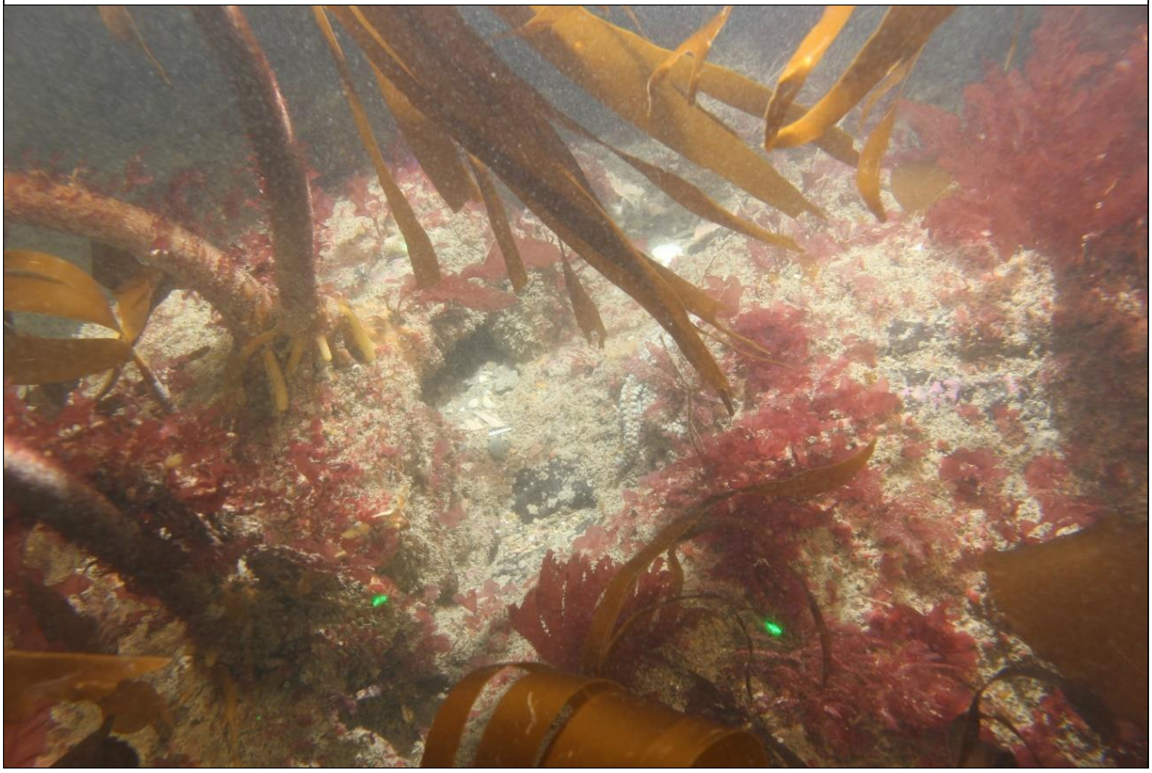


Figure 9. Example images of biotopes observed to be associated with the infralittoral rock feature at Mounts Bay MCZ. © Environment Agency and Natural England 2016

'Moderate energy circalittoral rock' (CR.MCR)

Figure 10. Example images of biotopes observed to be associated with the circalittoral rock feature at Mounts Bay MCZ. © Environment Agency and Natural England 2016.

3.3 Subtidal sediment BSH: Sediment composition and biological communities

Results are presented for the 2016 sediment samples where both particle size distribution and infaunal community analyses were conducted (n = 42). Table 4 shows the number of samples collected from the sediment BSHs that they were assigned. The samples acquired from the 'A5.1 Subtidal coarse sediment' and 'A5.4 Subtidal mixed sediments' features were only to confirm the presence of the features in the site and not part of the BACI study, thus descriptive statistics are presented in the absence of statistical analyses.

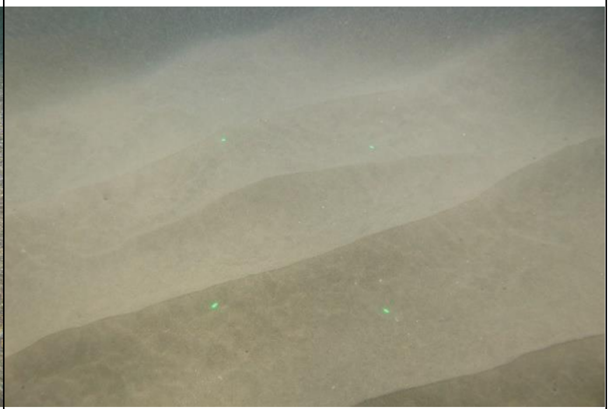
'A5.1 Subtidal coarse sediment'	**'A5.2 Subtidal sand'**
	
'A5.4 Subtidal mixed sediment'	**'A5.5 Subtidal macrophyte dominated sediment' / Seagrass beds**
	

Figure 11. Example images of the sediment features acquired at Mounts Bay MCZ (© Environment Agency and Natural England 2016).

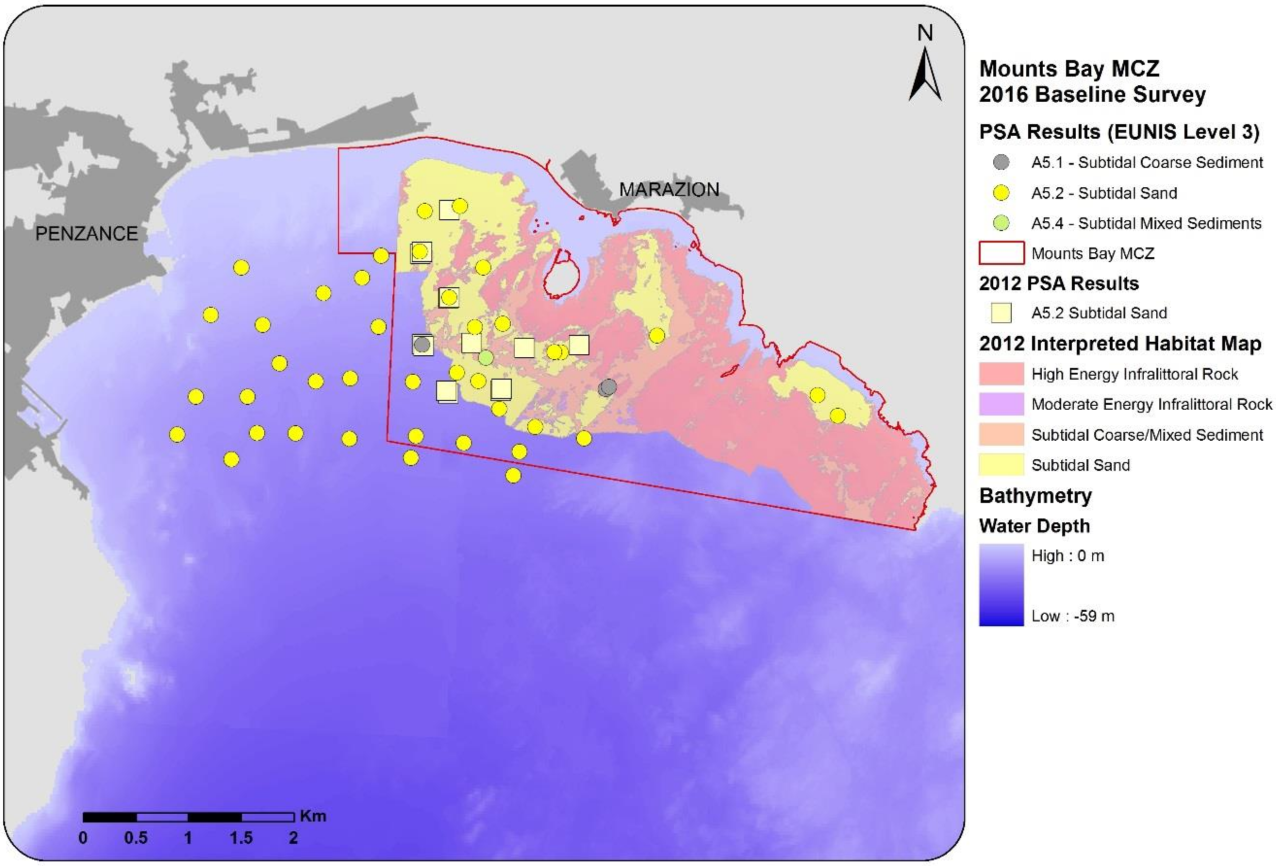


Figure 12. Broadscale Habitat classifications assigned to point samples based on PSA from the 2016 Mounts Bay MCZ baseline survey and the 2012 verification survey (© Natural England and Environment Agency 2022).

The distribution of sediment samples and assigned Broadscale Habitats collected during the Mounts Bay MCZ 2016 baseline survey and the 2012 survey are illustrated in Figure 12. The percentage contribution of gravel, sand and mud in the 2016 samples is illustrated in Figure 13. Each sediment distribution is labelled with its assigned sediment Broadscale Habitat. 'A5.2 Subtidal sand' was dominant both inside and outside of the MCZ (39 of the 42 samples collected). The mud (< 63 µm fraction) content of the sand increased away from the coast, with stations 76 and 78 outside of the MCZ recorded as a 'muddy sand' Folk classification (< 1:9 – 1:4 ratio mud:sand).

Three stations were characterised as 'A5.1 Subtidal coarse sediment' inside the MCZ (MNTB 1, 21 and 22), and one station was characterised as 'A5.4 Subtidal mixed sediments', (MNTB 27) (Figure 12).

In total, 195 taxa were identified inside the MCZ from sediment samples collected in 2016 (50, 151 and 13 taxa from 'A5.1 Subtidal coarse sediment', 'A5.2 Subtidal sand' and 'A5.4 Subtidal mixed sediments' samples respectively). Table 5 shows the mean (± standard error) macrobenthic species abundance, richness, infaunal quality index (IQI) and other univariate indices derived from the Day Grab samples for the three different Broadscale Habitats.

Table 5. Mean (± standard error) macrobenthic species abundance, richness, infaunal quality index (IQI) and other univariate indices of the Day Grab samples for the three different Broadscale Habitats collected inside and outside of the Mounts Bay MCZ (© Natural England and Environment Agency 2022).

		Sample number	Total taxa	Abundance (n sample^{-1})		Taxa Richness (S sample^{-1})		Total Wet Weight Biomass (g)		Shannon H'(log^e)		Hills N1		Simpsons (1-λ')		IQI	
				Mean	±S.E.	Mean	±S.E.	Mean	±S.E.	Mean	±S.E.	Mean	±S.E.	Mean	±S.E.	Mean	±S.E.
A5.1 Subtidal coarse sediment	Inside MCZ	2	50	133.00	10.00	33.50	5.50	1.15	0.32	2.80	0.18	16.79	3.0	0.90	0.01	0.611	0.01
A5.2 Subtidal sand	Inside MCZ	19	92	63.74	9.39	18.95	1.91	1.81	0.47	2.44	0.10	12.38	1.1	0.90	0.01	0.639	0.01
	Outside MCZ	20	129	72.60	9.58	23.65	1.95	2.53	0.60	2.62	0.10	14.90	1.3	0.90	0.01	0.665	0.01
A5.4 Subtidal mixed sediments	Inside MCZ	1	13	28.00	*	13.00	*	0.46	*	2.19	*	8.97	*	0.86	*	0.564	*

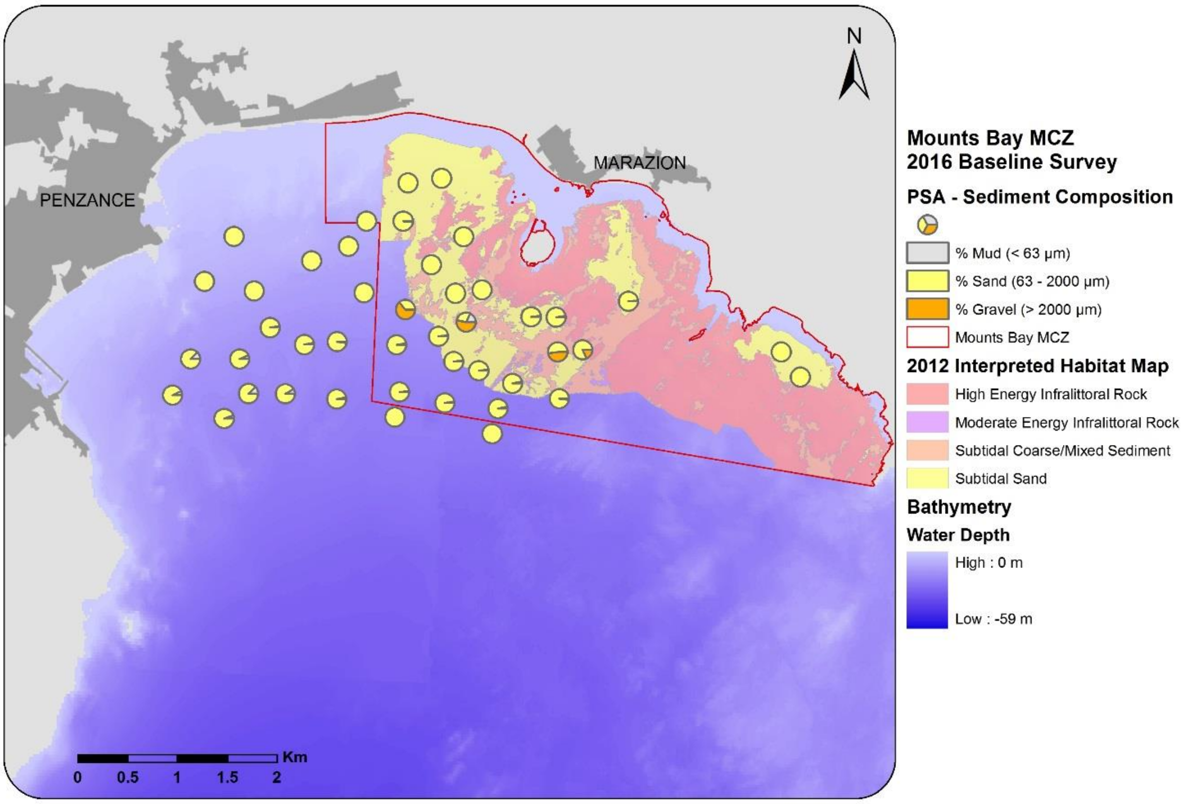


Figure 13. Distribution of sediment fractions at PSA sample locations (© Natural England and Environment Agency 2022).

Nine different sediment biotopes across three Broadscale Habitats were assigned from the grab samples (Figure 14). The most frequently occurring biotope was '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (SS.SSa.IMuSa.FfabMag), which was present in six samples inside the MCZ and three outside. The biotope '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (SS.SSa.CMuSa.AalbNuc) was also frequently observed, mostly outside the MCZ in deeper water, with '*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment' (SS.SMx.CMx.MysThyMx) found mostly inside the MCZ in deeper water (**Error! Reference source not found.**).

The two stations classified as 'A5.1 Subtidal coarse sediment' were characterised by the biotope 'Cumaceans and *Chaetozone setosa* in infralittoral gravelly sand' (cf. SS.SCS.ICS.CumCset), whilst the 'A5.4 Subtidal mixed sediments' station was assigned a biotope typical of coarse sediment with some mud content (*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand', SS.SCS.CCS.Pkef).

For 14 of the samples collected (including 8 inside the MCZ), the JNCC 15.03 (or EUNIS) Level 5) BSH of the biotope derived from the community data differed from the EUNIS Level 3 BSH derived from the associated PSA sample (e.g. 'A5.4 Subtidal mixed sediments' biotope present in 'A5.2 Subtidal sand' BSH).

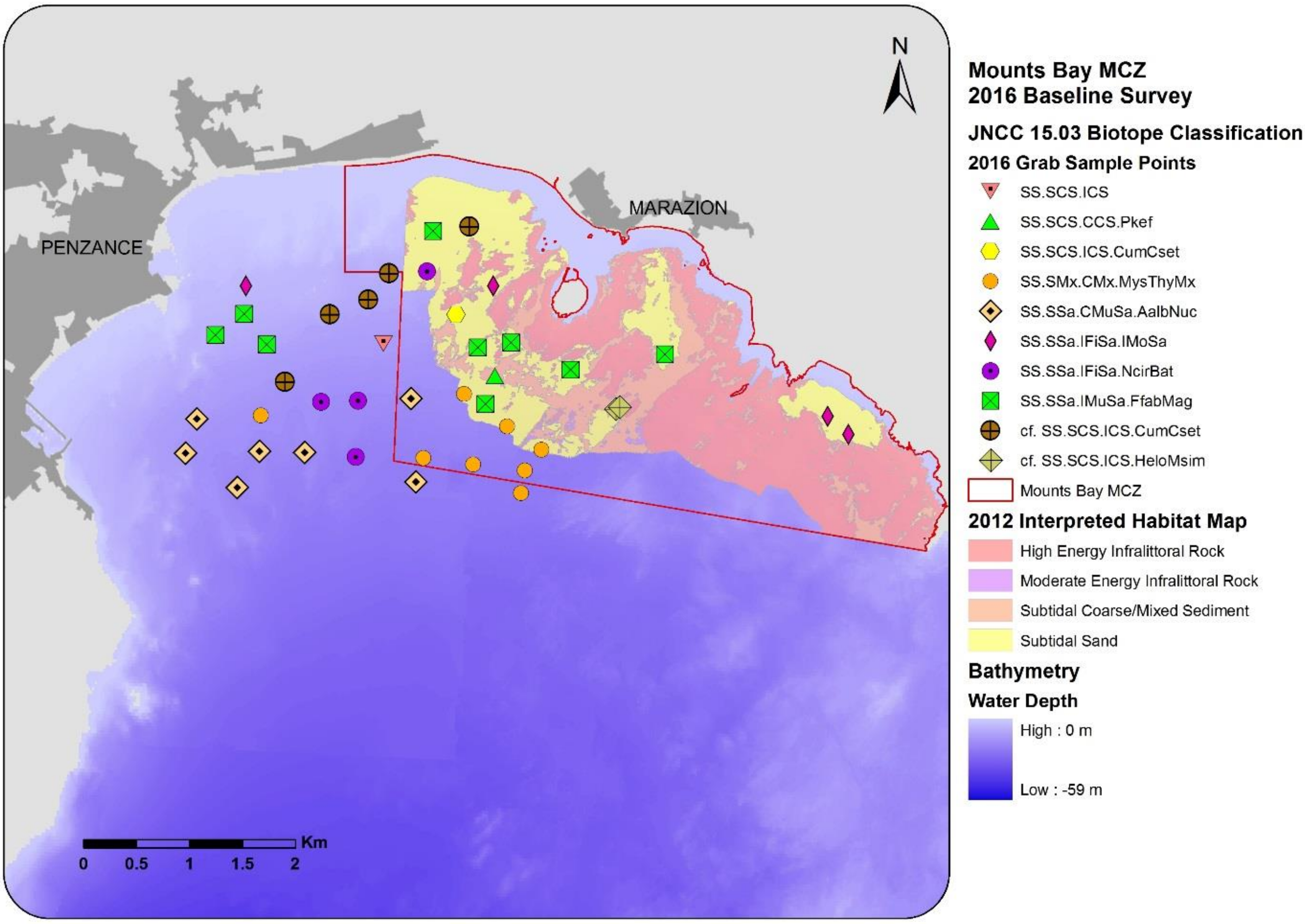


Figure 14. JNCC 15.03 Biotope Classification assigned to each grab sample location at Mounts Bay MCZ (© Natural England and Environment Agency 2022).

3.3.1 ‘A5.1 Subtidal coarse sediment’

There were too few benthic infauna grab samples collected from the ‘A5.1 Subtidal coarse sediment’ BSH to allow a robust statistical analysis to be carried out (i.e., 2 samples within the site boundary). Eighteen percent (50/284) of the taxa recorded in the 2016 survey were present in the ‘A5.1 Subtidal coarse sediment’ samples.

Several taxa were present in moderate abundances (> five individuals) in the two coarse and one mixed sediment samples that were not present in ‘A5.2 Subtidal sand’. These include Nematoda, the polychaetes *Pisione remota, Glycera lapidum* and *Polygordius sp.,* the brittlestar *Amphipholis squamata* and lancelet *Branchiostoma lanceolatum*.

'Infralittoral coarse sediment' (SS.SCS.ICS)	*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand (SS.SCS.ICS.HeloMsim)
	

Figure 15. Example images of JNCC 15.03 sediment biotopes observed to be associated with the coarse sediment feature at Mounts Bay MCZ (© Environment Agency and Natural England 2022).

From the stills analysis, the epifauna observed in association with the 'A5.1 Subtidal coarse sediment' feature included bryozoans, coralline algae, *Spirobranchus* worms and occasional observations of red algae (Figure 15).

3.3.2 'A5.2 Subtidal sand'

Thirty two percent (92/284) of all taxa present in 2016 were represented in 'A5.2 Subtidal sand' within the site boundary and 45 % (129/284) outside. Taxa richness ranged from 5 – 34 taxa sample^{-1} inside the MCZ and 7 – 37 taxa sample^{-1} outside the MCZ. The most frequently occurring taxa in 'A5.2 Subtidal sand' inside the MCZ were juvenile Amphiuridae brittlestars and the polychaete *Chaetozone christiei* (present in 13 out of 20 samples), and the bivalves *Phaxas pellucidus* and *Tellina fabula* (present in 12 out of 20 samples).

'*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (SS.SSa.IMuSa.FfabMag)	'*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (SS.SSa.IFiSa.NcirBat)
	

Figure 16. Example images of JNCC 15.03 sediment biotopes observed to be associated with the Subtidal sand feature at Mounts Bay MCZ (© Environment Agency and Natural England 2016).

Wet weight biomass for infaunal species recorded in 'A5.2 Subtidal sand' inside and outside of the MCZ ranged from 0.01 to 7.38 g sample^{-1} and was dominated by echinoderms. Fifty eight percent of the total wet weight biomass inside the MCZ was apportioned to the brittlestar *Acrocnida brachiata* (19.9 g), followed by 6.8 % for the brittlestar *Amphiura filiformis* and 5.2 % for the sand star *Astropecten irregularis*. Biomass was higher outside of the MCZ, with the largest values occurring closest to Newlyn harbour. Biomass was also greater in samples further offshore within the MCZ (Figure 17).

There was no significant difference in taxa richness (T = -1.72, p = 0.093), abundance (T = -0.66, p = 0.513), Shannon index (T = -1.34, p = 0.189), or wet weight biomass (T = -0.94, p = 0.352) between' A5.2 Subtidal sand' samples collected inside and outside the MCZ. The Infaunal Quality Index (IQI, an assessment of benthic faunal condition), was significantly higher for samples outside the MCZ than those inside (T = -2.36, p = 0.024) (Figure 18). All samples achieved a moderate or good Ecological Status boundary in WFD classifications (Moderate = 0.44 -0.64; Good = 0.64 – 0.75; High = > 0.75) (Table 5). The 'A5.2 Subtidal sand' feature inside the MCZ had a mean IQI score of 0.64 which is at the upper limit of the 'Moderate' Ecological Status boundary, however outside the MCZ; the score for sand was slightly higher at 0.67, at the lower limit of the 'Good' Ecological status boundary.

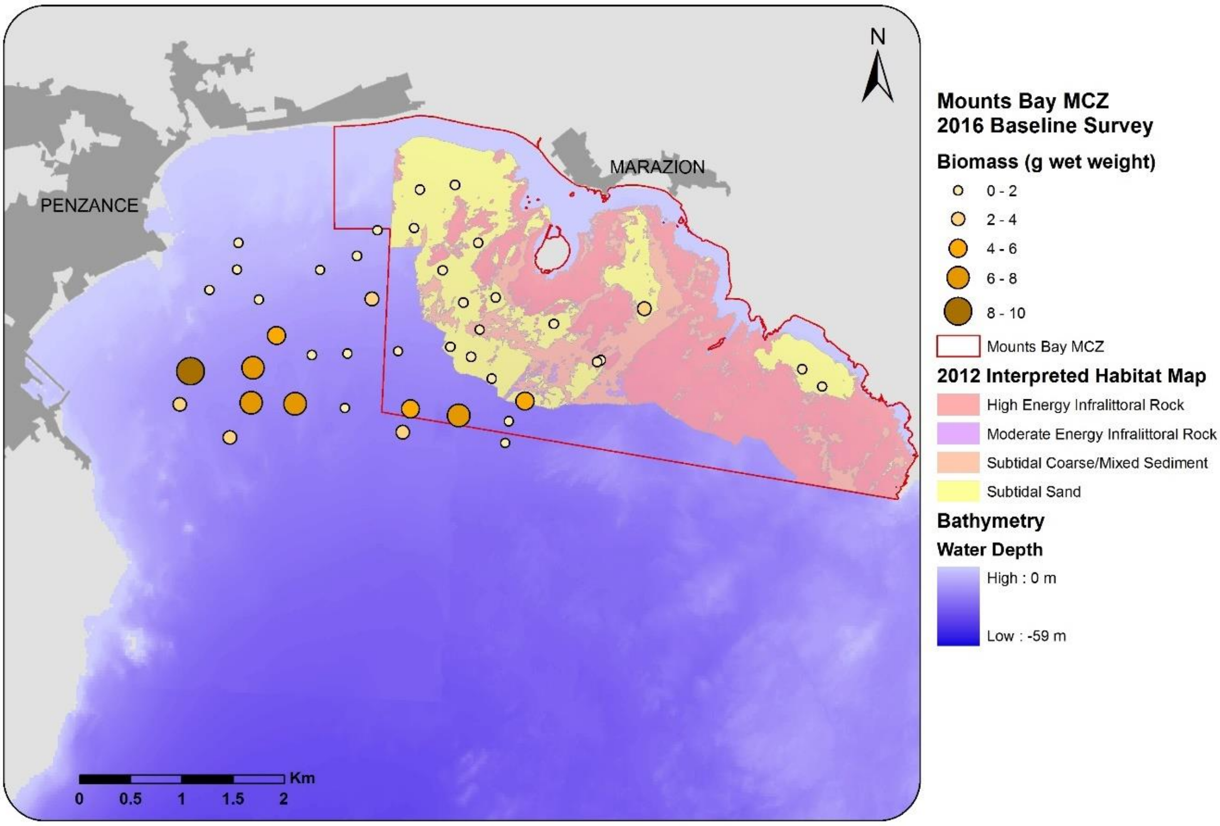


Figure 17. Wet weight biomass (g) infauna samples collected during the 2016 baseline survey (© Natural England and Environment Agency 2022).

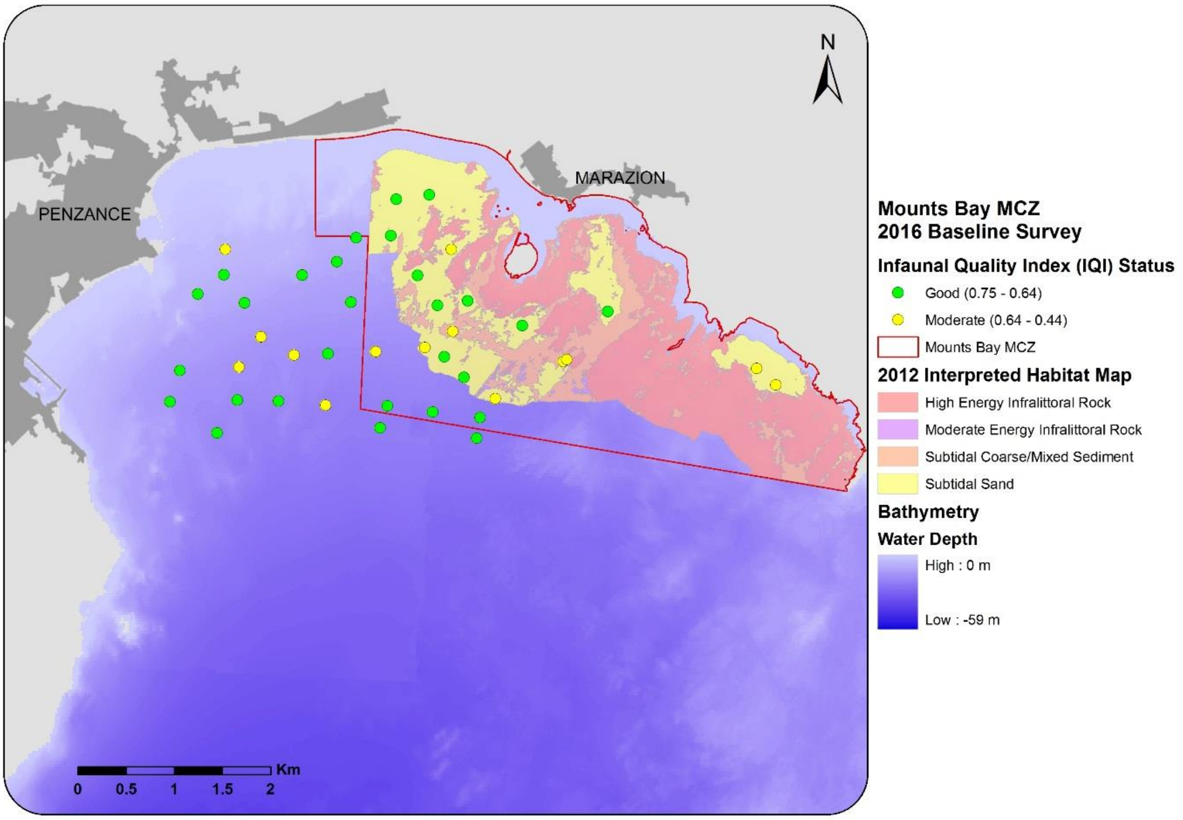


Figure 18. Infaunal quality index status of infauna samples collected during Mounts Bay MCZ baseline survey in 2016 (© Natural England and Environment Agency 2022).

There was no significant difference between infaunal community composition of 'A5.2 Subtidal sand' samples collected inside and outside the MCZ (ANOSIM Global R = 0.056, p = 0.067, Figure 19). Higher abundances of *Nucula nitidosa* and *Chaetozone gibber* were observed outside the MCZ, whereas higher abundances of Amphiuridae were observed inside the MCZ.

Epifauna observed from the stills analysis of Subtidal sand, include seagrass (*Zostera* sp.), green algae (Chlorophyta), sea urchins (*Echinocardium* sp.), and the sea mouse (*Aphrodita aculeata*) outside the boundary. No epifauna was observed in any of the stills within the MCZ boundary (Figure 11).

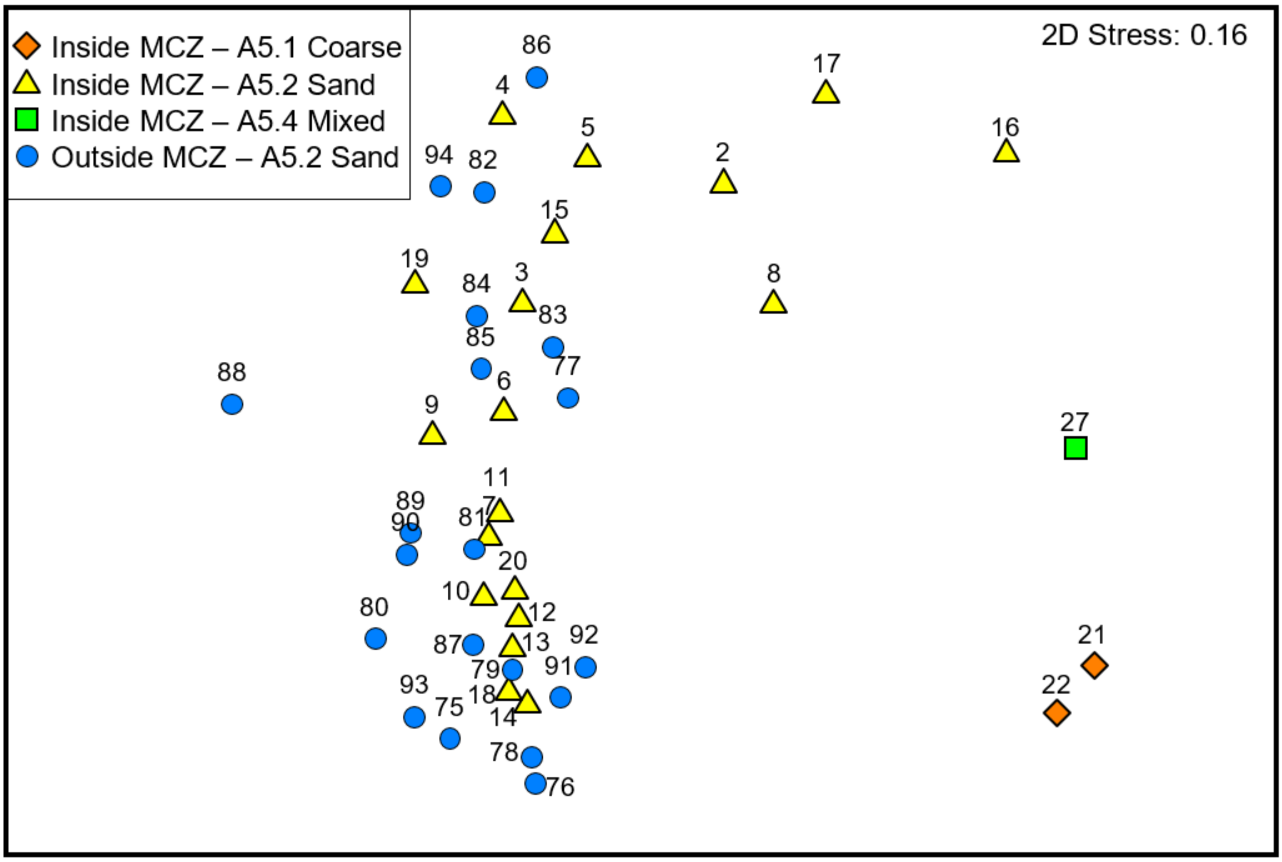


Figure 19. Multidimensional scaling plot of infauna community composition (based on square root transformation of taxa abundance; samples were compared using a Bray-Curtis similarity index) of samples collected during the 2016 Mounts Bay MCZ baseline survey (© Natural England and Environment Agency 2022).

Temporal Changes

There was a significant difference in community structure (at the genus level) between the ‘A5.2 Subtidal sand’ samples collected in 2016 and those collected in the 2012 verification survey (comparing only samples collected in the same area of the Mounts Bay MCZ across both years; 12 samples from 2016 and 14 samples from 2012) (ANOSIM global R = 0.43, $p < 0.001$). Taxa richness (analysed at Genus level) was also significantly higher in the 2012 samples than the 2016 samples (2012 mean = 24.50 ± 0.2; 2016 mean = 17.08 ± 1.8 genera sample^{-1}; T = 2.51, $p = 0.02$). Increased abundances of the bivalves *Fabulina* and *Thyasira,* Ophiuroidea and the polychaetes *Chaetozone* and *Magelona* in the 2012 samples, and the bivalves *Phaxus* and *Kurtiella* in the 2016 samples contributed to the observed significant dissimilarity between the two sampling years.

3.3.3 ‘A5.4 Subtidal mixed sediments’

Only one sample classified as ‘A5.4 Subtidal mixed sediments’ was collected in the 2016 survey (MNTB 27). Thirteen taxa were present in the sample. The polychaete *Protodorvillea kefersteini* and *Pista mediterranea* had the highest abundance (10 and 3 individuals respectively).

‘Infralittoral mixed sediment’ (SS.SMx.IMx)	*‘Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand’ (SS.SCS.CCS.Pkef)
	

Figure 20. Example images of JNCC 15.03 biotopes observed to be associated with the ‘A5.4 Subtidal mixed sediments’ feature at Mounts Bay MCZ (© Environment Agency and Natural England 2016)

Only 5 % of infaunal taxa encountered in the grab samples collected in the 2016 survey were represented in the sample collected from within this BSH.

From the still image analyses, only 1 still image was assigned to the ‘A5.4 Subtidal mixed sediments’ Broadscale Habitat. The epifaunal communities observed in association with the ‘A5.4 Subtidal mixed sediments’ BSH contained foliose red algae (Rhodophyceae), *Spirobranchus* worms, and encrusting sponge (**Error! Reference source not found.**).

3.4 Habitat Features of Conservation Importance (FOCI)

3.4.1 Seagrass beds

Zostera marina plants were observed in 12 still images (stations 71 and 72) assigned to ‘A5.2 Subtidal sand’ and ‘A5.5 Subtidal Macrophyte Dominated’ BSHs near to the entrance of Penzance harbour, outside of the MCZ boundary (Figure 6). Seagrass was only dense enough (> 5 % cover) to be classified as ‘A5.5 Subtidal Macrophyte Dominated Sediment - Seagrass Beds’ in five of the still images (Figure 11).

3.5 Species Features of Conservation Importance (FOCI)

No observations of the Giant Goby (*Gobius cobitis*) or any of the three different species of Stalked Jellyfish (*Haliclystus spp, Calvadosia campanulata and Calvadosia cruxmelitensis*) were made during the grab or video survey. The surveys reported here were not designed to specifically monitor (or identify the presence of) species FOCI. Additionally, these species are generally found in the intertidal / shallow subtidal and therefore unlikely to be picked up by this survey. As such, this should not be interpreted as an absence of these species FOCI from the site.

One juvenile Arctic quahog (*Arctica islandica*) was identified at station MNTB 01 in the 2012 verification survey. None were present in the sediment samples collected during the 2016 survey.

3.6 Non-indigenous (NIS) & Rare and scarce species

There were no non-indigenous species identified from the infauna samples or in the still images.

All taxa identified in grab samples collected in 2016 were searched against a list of rare species and scarce species identified by Sanderson (1996). There were no rare species identified from the infauna samples or in the still images.

3.7 Supporting processes

3.7.1 Water quality parameters

Near seabed water column salinity was recorded at the stations where contaminants were sampled. It ranged from 35.10 to 35.27.

3.7.2 Sediment quality parameters

Surface sediment scrapes were taken at eight grab stations, providing a record of the most recent contaminant levels deposited in the sediment.

Levels of arsenic, chromium and copper exceeded the OSPAR Effects Range Low (ERL) at all eight stations. Levels above the OSPAR ERL are considered to have a chronic impact on macrofauna. Levels of arsenic were also elevated above the proposed Western Channel regional baseline threshold (34 mg kg^{-1}) at all eight stations (mean (± S.D.) of 140.3 ± 81.9 mg kg^{-1}). There was no correlation between the IQI and arsenic concentrations. Station MNTB 91 outside of the designated boundary, had elevated levels of PAHs above the OSPAR Background Assessment Criteria (BAC), but these were below the OSPAR Environmental Assessment Criteria (EAC) at which they would be considered to have a chronic impact on macrofauna.

3.7.4 Hydrodynamics: energy and exposure

Mounts Bay MCZ faces south west but is sheltered from the prevailing westerly winds by the Lands End peninsular. It has mainly weak tidal currents (< 0.5 ms^{-1}) flowing on a west-east axis (Figure 21). The hydrodynamic model of the Mounts Bay MCZ illustrates the sheltered nature of the eastern half of the bay, with the maximum current velocity (characterised as moderate energy currents of 0.5 – 1.5 ms^{-1}) only occurring in a limited area, in association with shallower rock features around St Michael's Mount. No high energy environment was indicated to be present within the site by the results of the model.

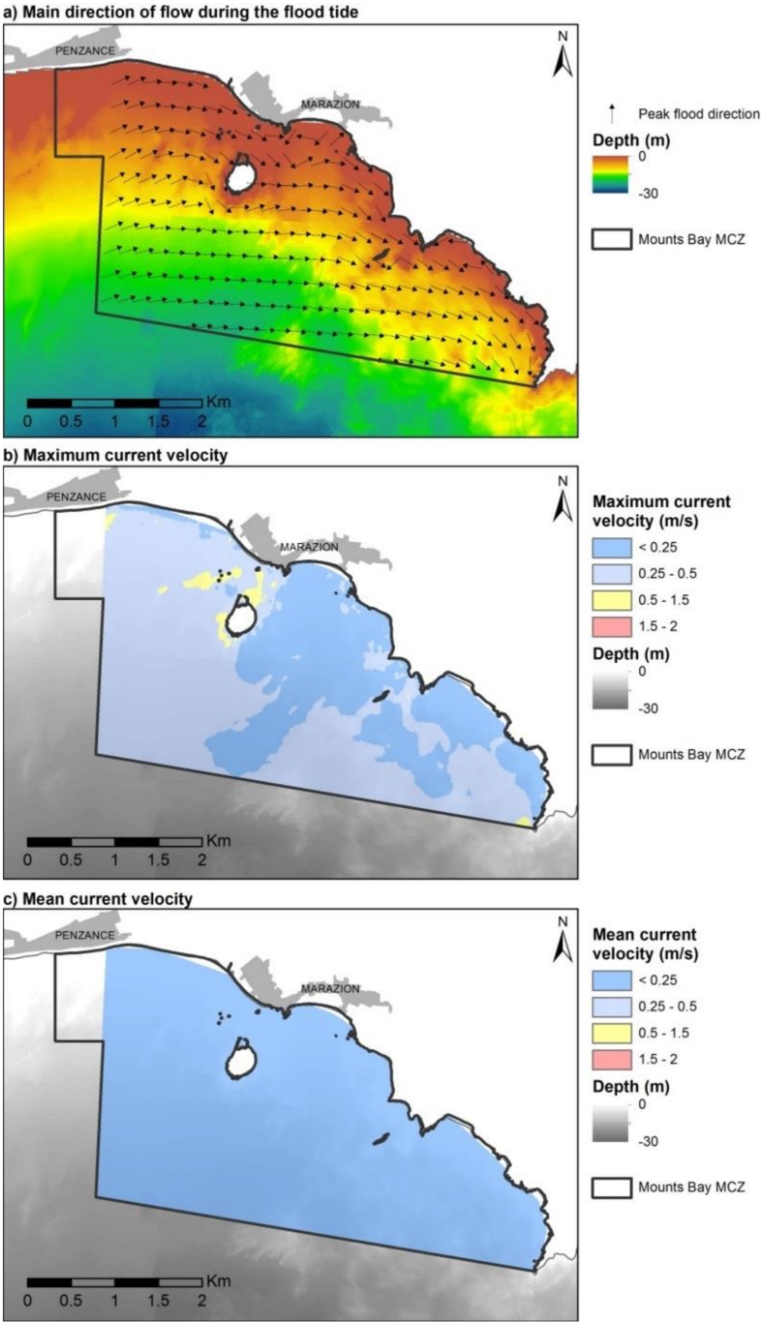


Figure 21. Physical environment at Mounts Bay Marine Conservation Zone (© Natural England and Environment Agency 2022). The maps show depth and current conditions: (a) main direction of tidal flow during the flood phase, (b) maximum and (c) mean current velocity over a spring-neap tidal cycle.

3.8 Additional monitoring requirements

3.8.1 Marine litter

Plastic fragments larger than 1 mm found in infauna samples were recorded. Plastic was present in 19 of the 42 grab stations, with a median of two fragments per sample (Figure 22). The largest number of fragments (12) was recorded at station MNTB 76, in close proximity to Newlyn harbour. One incidence of litter (a small red plastic ball / float) present on the seabed was observed in the seabed imagery at station MNTB 53 (1 still image). No other categories of litter were observed.

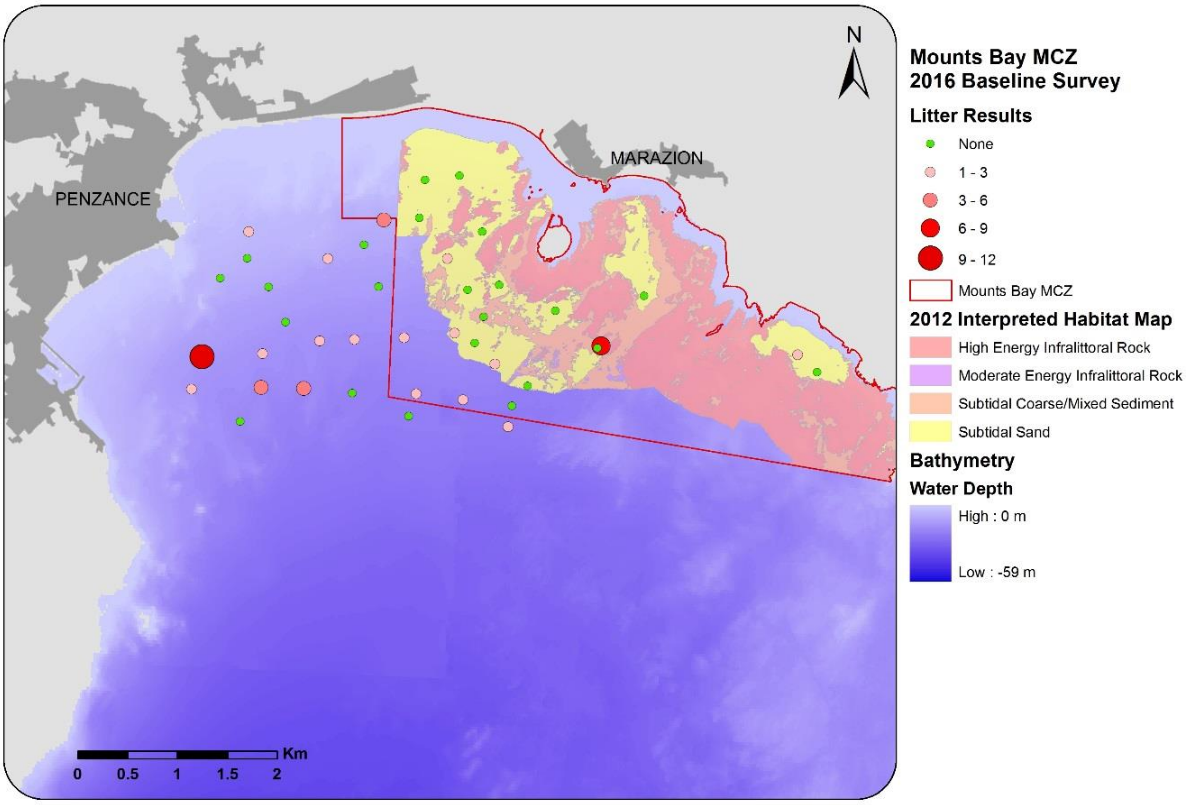


Figure 22. Distribution of plastic fragments greater than 1 mm across Mounts Bay MCZ in 2016 (© Natural England and Environment Agency 2022).

4 Discussion

This discussion presents evidence for the initial temporal monitoring element (T0) of the Before-After, Control-Impact design drop-down video and grab survey conducted at the Mounts Bay MCZ. This informs future assessment and monitoring of designated features within the MCZ, as required to achieve the report objectives stated in Section 1.6.3.

4.1 Subtidal rock Broadscale Habitats

The biological communities colonising the infralittoral and circalittoral rock Broadscale Habitat features of Mounts Bay MCZ are considered to be representative of those typically expected to be found in association with moderately exposed habitats from the south-west coast of England (Moore *et al*. 1999).

4.1.1 Extent and distribution

Distribution: presence and spatial distribution of biological communities

'A3.1 High energy infralittoral rock' was recorded as the predominant rock habitat feature in the 2012 verification survey, but was not observed in the 2016 baseline survey, when all rock within the site was assigned a 'A3.2 Moderate energy infralittoral rock' habitat classification. 'A4.2 Moderate energy circalittoral rock' was only observed outside of the MCZ boundary.

The classification of still images as 'moderate energy' BSH in the 2016 baseline survey compared to 'high energy' in the 2012 verification survey followed the JNCC 15.03 habitat classification definitions (Connor *et al*., 2004). The predominant biotopes across both years were *Laminaria* sp. and red seaweed dominated communities (in 2012, IR.HIR.KFaR.LhypR, *Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock was the predominant biotope observed; whilst in 2016, the predominant biotope observed was IR.MIR.KR, Kelp and red seaweeds i.e., in association with moderate energy infralittoral rock). Many species identified during the survey are found in both high and moderate energy categories (e.g. *Alcyonium digitatum, Caryophyllia smithii, Spirobranchus* sp), and the biotope classification for infralittoral rock can be considered to artificially divide communities along an energy level gradient. There are several possible explanations for the observed differences in communities between the two survey periods and these are summarised below:

- **Camera Set-up** – The camera systems were set up slightly differently between the 2012 and 2016 surveys. The Cefas camera in 2012 was positioned facing straight down onto the seabed, whereas the SeaSpyder camera in 2016 provided an oblique field of view. NE Atlantic Marine Biological Analytical Quality Control Scheme (NMBAQCS) guidelines state that the oblique angle of view on the camera improves the ability to identify species and give a better indication of seabed habitat type, while the perpendicular angle of view best enables quantitative analysis of still images (Hitchin *et al*., 2015). As such, the difference in the field of view between the two camera set ups may have altered the interpretation of the images captured. For example, *Laminaria sp.* are key species in defining infralittoral rock biotopes and may be more frequently observed using an oblique camera, with a greater field of view, than a camera facing straight down.

- **Visibility** – Visibility in the shallower waters within Mounts Bay was greater in 2012 than in 2016. Improved visibility might have allowed the identification of red seaweeds and *Laminaria* to species level in 2012, thereby possibly aiding in the differentiation between high and moderate energy biotopes, e.g. speciating between *L. hyperborea* present in high and moderate energy environments), *L. digitata* (present in moderate and low energy environments) and *L. ochroleuca* (increasingly abundant along the coast of SW England). Increased visibility would have also facilitated the identification of more cryptic epifaunal species, which could explain why significantly more taxa were observed in 2012 than in 2016.

- **Geography and biotope definitions** – The physical environment in and around Mounts Bay is not considered to be a high-energy ecosystem. The hydrodynamic model produced for Mounts Bay (Figure 21) indicated that most of the site is subjected to weak (< 0.5 ms^{-1}) tidal current velocities, with some moderate (0.5 – 1.5 ms^{-1}) currents present around St Michael's Mount when the tide is at maximum velocity. Previous modelling for UKSeaMap (McBreen *et al*., 2010) also predicted Mounts Bay to be exposed to moderate kinetic energy due to waves (0.21 – 1.2 N m^{-2}) and low peak seabed kinetic energy due to tidal currents (< 0.5 m s^{-1}, < 0.13 N m^{-2}). Therefore, Mounts Bay would not be expected to have high-energy infralittoral communities, as supported by the results of this survey. Instead, it may support species that straddle the infralittoral energy category boundaries (which demonstrate a significant overlap in biotopes), leading to differing interpretations between the two survey years.

- **Seasonality** – The 2012 verification drop-down camera survey was undertaken between the 15th and 21st March and the 2016 baseline drop-down camera survey between the 9th and 12th April. The change in algal density could be due to increased period of algal growth during the month separation between the two survey years.

4.1.2 Structure and function: Biological communities

Species composition of component communities.

A subtle difference was observed in community composition between sampled locations inside and outside the MCZ for the 'A3.2 Moderate energy infralittoral rock' BSH feature. This indicated that the selected control sites may be appropriate for the BACI experimental design implemented at this site. The small differences observed could be due to differing pressures within and outside the MCZ, with the sites outside the boundary being closer to both Newlyn and Penzance harbour, thereby potentially exposing them to greater anthropogenic pressures. Depth variation between sites located inside and outside the MCZ boundary, along with differing levels of wave exposure, may also affect community composition. The stations outside the MCZ, in the westerly extent of Mounts Bay, may also be slightly more sheltered from the prevalent south westerly winds and swells.

In the absence of a habitat map being available at the planning stage for the 2016 survey, which covered areas outside the MCZ, several video tows were located on sediment habitats and rock habitats that were observed to be representative of circalittoral features. This resulted in an unbalanced design for the BACI aspect of the survey which focused on the moderate energy infralittoral rock feature. For future survey planning, it would be beneficial to carry out additional acoustic surveys encompassing the wider survey area (e.g., including those regions outside of the MCZ boundary) in order to provide a more spatially comprehensive habitat map. This would enable the placement of additional video tows to target the rock BSH if required for a more comprehensive baseline assessment.

4.2 Subtidal sediment Broadscale Habitats

The biological communities associated with sediment BSH features within this MCZ are considered to be representative of those typically found along semi-exposed bays located along the south-west coast of England (Moore *et al*. 1999). The structural composition of the biological communities characterising the sediment features in the Mounts Bay MCZ and their current status/condition suggests they are in a favourable condition but should continue to be monitored as some signs of deterioration were present as the IQI results straddled the WFD good/moderate ecological status boundary (the mean IQI score for subtidal sand was 0.64).

4.2.1 Extent and distribution

'A5.2 Subtidal sand', which is the only designated BSH for subtidal sediments, was observed in the 2016 baseline survey both within and outside the MCZ boundary. All Subtidal sand samples collected in 2016 aligned with the interpreted habitat map from the 2012 verification survey, including the patches of 'A5.2 Subtidal sand' where PSA samples had not been previously collected. This suggests that the sediments within Mounts Bay are relatively stable in their distribution, with patches of 'A5.1 Subtidal coarse sediment' and 'A5.4 Subtidal mixed sediments' interspersed across the site. A further acoustic survey would be required to provide updated extent values for the BSHs – this was not considered feasible for this survey, which aimed to provide more information on the communities inside and outside the MCZ boundary.

Distribution: presence and spatial distribution of biological communities

Nine biotopes were observed during the survey, with the majority occurring both within and outside of the MCZ boundary (Figure 14). Biotopes had not been characterised for the 2012 verification survey, so it was not possible to assess whether a temporal change in biotope presence/distribution had occurred.

The biotope SS.SSa.IFiSa.NcirBat (*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand) was observed at three stations located outside the MCZ and one station located inside the MCZ, and is considered to be indicative of sediments exposed to physical disturbance through wave action. This biotope is not as faunally diverse as FfabMag (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand), which was also observed during this survey at nine stations. This biotope, which is characterised by the magelonid polychaete *Magelona mirabilis,* is considered to be typically associated with sheltered, low energy conditions thereby resulting in a more diverse and stable community composition (Connor *et al*., 2004). The opportunistic polychaete *Chaetozone christiei*, was relatively abundant and featured in 62% of the samples. This species was observed to be abundant in samples that contained high levels of heavy metal contamination. The biotope SS.SCS.ICS.CumCset (Cumaceans and *Chaetozone setosa* in infralittoral gravelly sand) assigned to some of these samples has been assessed to be relatively insensitive to metal contamination and is therefore classified as 'Not sensitive' to chemical pressures (Tillin, 2016).

The mismatches observed between the biotope and Broadscale Habitat categorisations indicate that the biotope defined by community structure gradate across the 5 % gravel content boundary that separates the EUNIS Level 3 Broadscale Habitats 'A5.2 Subtidal sand' and 'A5.1 Subtidal coarse sediment' / 'A5.4 Subtidal mixed sediments'.

4.2.2 Structure and function: Biological communities

Assessment of sampling sufficiency

There were an almost equal number of 'A5.2 Subtidal sand' samples collected inside and outside the MCZ, resulting in a relatively balanced survey design for assessing this feature (Table 4). *A priori* statistical power analysis was used to determine a cost-effective monitoring survey following guidelines by Marubini (2014). This identified that 18 samples were required to detect a 10 % change in the AMBI (AZTI Marine Biotic Index, a component metric of the IQI and indicator of species tolerance to pollution and nutrient amongst others; Phillips *et al*. 2014) at 90 % power or 14 samples to detect a 20 % change in the Shannon index at 80 % power. *A posteriori* power analysis of the 2016 data showed that this was achieved for the Shannon index but not for the AMBI. The 19 Subtidal sand samples collected inside the MCZ could detect a 20 % change in the Shannon index at 92.4 % power, and a 10 % change in the AMBI index at 82.1 % power, which is higher than the recommended 80 % power suggested by Marubini (2014). However, further sampling would be required to detect a 20 % change in taxa richness at 80 % power – the 2016 survey could only detect such a change at 27.6 % power. Future surveys could collect more samples in order to increase the power to detect change further.

Species composition of component communities

Samples classified as 'A5.2 Subtidal sand' and located outside of the MCZ boundary had slightly higher taxa richness compared to those associated with 'A5.2 Subtidal sand' located inside the boundary, although statistical analyses indicated the difference was not significant (Figure 19). High within-Broadscale Habitat variability was observed at this site, which is likely to contribute to the relatively high variability in infaunal communities associated with a given EUNIS Level 3 sediment classification. The depth variation between stations and differences in prevailing conditions will also potentially have an effect on faunal community composition, along with the influence of anthropogenic pressures arising from Newlyn and Penzance harbours. The 'Good' ecological status recorded outside the MCZ derived from the IQI, in comparison with 'Moderate' ecological status observed inside, may have also been influenced by the same factors.

Results from the analyses of still image data indicated a much higher number of epifaunal taxa at stations located outside the MCZ, with no epifauna observed in any of the stills acquired in association with the 'A5.2 Subtidal sand' feature located within the MCZ boundary. Epifauna indicators such as *Echinocardium cordatum* (burrows) could be associated with the higher mud content of the sand outside of the site boundary (Figure 13).

Structure: presence and abundance of key structural and influential species

Guidance is still being developed by Natural England on the definitions of species that fall within this category. Species observed during this study that could be considered under this attribute (based on their abundances, biomass and ecology) include:

- The bivalves *Abra alba* and *Nucula nitidosa* that were present in high numbers (43 % and 52 % of the samples respectively), in subtidal sand and coarse sediment, and are rapid-recruiting species that can quickly colonise after disturbances. *Nucula nitidosa* may also assist in the incorporation of organic material into the ecosystem (Davis and Wilson, 1985).
- The tellin, *Fabulina fabula,* was present in 63 % of the 'A5.2 Subtidal sand' samples inside the MCZ collected in 2016, and in 100 % of the 'A5.2 Subtidal sand' samples collected in 2012. Unlike *N. nitidosa*, *F. fabula* is considered to be a slower growing species but is also hypothesised to be a key species in translocating particulate organic carbon (detritus and phytoplankton) into the sediment through suspension feeding (Kamp and Witte, 2005).

4.3 Habitat Features of Conservation Importance (FOCI)

Seagrass beds were only observed outside of the MCZ, overlapping with the 'A5.2 Subtidal sand' BSH. This survey was not designed to specifically monitor the condition of the seagrass habitat FOCI but does present evidence of a relatively locally restricted distribution of the seagrass outside of the MCZ boundary.

Future surveys should consider three approaches to build on existing evidence (Curtis, 2014) and provide more appropriate information to assess the condition of seagrass inside the MCZ: 1) investigate the community composition of the seagrass beds; 2) assess the functional role of the seagrass and their ability to support a high diversity of associated fauna; and 3) establish the trend in distribution and spatial extent of the feature.

4.4 Species Features of Conservation Importance (FOCI)

No observations were made of the species FOCI designated for protection with this site. However, as the surveys reported here were not designed to specifically monitor the designated species FOCI, this should not be interpreted as an absence from the site. As detailed earlier, these species are generally found in the intertidal / shallow subtidal and are therefore unlikely to be observed during a survey of the subtidal areas of the site.

4.5 Non-indigenous species (NIS)

4.5.1 BSH and Habitat FOCI; Stucture: Non-native species and pathogens

No non-indigenous infauna were observed in the samples acquired during the 2016 survey or in those collected during the 2012 subtidal verification survey at the Mounts Bay MCZ (Murray & Downie, 2014). Similarly, no non-indigenous infauna were observed in samples collected during the 2014 intertidal survey (Curtis, 2014) or during the Runnelstone (Lands End) MCZ verification survey in 2012, to the west of Mounts Bay (Evans & Colenutt, 2015). However, East of Mounts Bay and at Lizard Point, three non-native species (slipper limpet *Crepidula fornicata*, polychaete *Goniadella gracilis* and barnacle *Hesperibalanus fallax*) were observed in infaunal samples collected during the 2015 baseline monitoring survey at the Manacles MCZ (Downie *et al*., in prep).

4.6 Supporting processes

4.6.1 Sediment BSH; Supporting processes: Sediment contaminants

Concentrations of arsenic, chromium and copper measured at a subset of stations exceeded the OSPAR Effects Range Low (ERL) and for arsenic exceeded the regional baseline threshold (Mason *et al*., 2011) at all eight stations. Lead, which was elevated above OSPAR background assessment criteria at all the stations sampled, is considered to be a substance for priority action by OSPAR (OSPAR, 2014).

Historical mining of polymetallic ores around Cornwall, extracted over a period of nearly 3000 years (Pirrie *et al*., 2002), have led to the widespread contamination in rivers, estuaries and coastal areas. Copper and tin ores formed the majority of the mined metals, however lead, zinc, iron and arsenic were also extracted (Dines, 1956), with Cornwall becoming the world's major producer of arsenic in the period from 1860 to 1900 (Thornton *et al*., 1986).

Mine waters were discharged directly into river courses and/or into the sea via adits or drainage tunnels (Johnston *et al*., 2008). There are currently no active mine discharge points from any of the rivers that flow into Mounts Bay, which suggests that the current concentrations are a result of remobilisation of relic contaminants through wave action, or being transported from other contaminated rivers, such as the Hayle and Red River around the north of Lands End.

As the levels of arsenic, chromium, copper and lead have exceeded both OSPAR ERLs and regional baseline thresholds, future monitoring in and around the MCZ should aim to understand their source and impact on the site and its features, along with identifying trends in concentrations.

5 Recommendations for future monitoring

5.1 Operational and survey strategy recommendations

- The collection of acoustic bathymetry and backscatter data in the south west of the site and outside of the site boundary would allow the extent of the designated features to be more accurately mapped. It would also lead to a more effective targeted sampling of designated Broadscale Habitats for the BACI study stations located outside of the MCZ.
- The element of the BACI survey design which focused on the infralittoral rock feature was imbalanced, due to a combination of visibility issues and circalittoral rock being surveyed at some stations outside of the MCZ. Future surveys should ensure a balanced design by collecting the same number of samples in association with representatives of a given feature located inside and outside of the site.
- Due to the difficulties in differentiating between the energy levels which influence the infralittoral rock feature, 'High' and 'Moderate' energy infralittoral rock features should be reported and monitored as a single 'infralittoral rock' category in the future.
- Future monitoring should be scheduled around the same time of year to minimise the effects of seasonal variability on the data and evidence collection.
- Camera equipment and processing methodologies should be standardised as far as possible to allow for more robust comparisons to be carried out between the datasets generated.
- For investigations into the designated species FOCI for this site, 'Giant Goby (*Gobius cobitis*) and the stalked jellyfish species (*Haliclystus spp, Calvadosia campanulata and Calvadosia cruxmelitensis*), it is recommended that more appropriate approaches to survey are explored (e.g., divers with appropriate training and experience in taxonomy). Similarly, the full extent of the 'Seagrass beds' habitat FOCI is not accessible for survey using a vessel, therefore diver, snorkelling or intertidal surveys would be more suitable methods for assessing its full spatial extent and density.
- Contaminant and litter samples should be resampled at the same stations in future monitoring surveys to identify trends in densities / concentrations.

5.2 Analysis and interpretation recommendations

- Classification of infauna communities into one of the four sediment BSH is not necessarily ecologically relevant. Biological communities do not align with the same physical thresholds used in the classification of sediment BSHs. Further studies are required to improve our understanding of the observed variability (spatial and temporal) in biological assemblages found in association with given sediment BSH features.

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Annex 1. Infauna data truncation protocol.

A number of decisions applied during the data truncation process are described here, with the intention that by following such decisions, a greater degree of consistency in truncation exercises across different studies may be achieved.

Raw taxon-by-sample matrices can often contain entries that include the same taxa recorded differently, erroneously or differentiated according to unorthodox, subjective criteria, for example:

Each row should represent a legitimate taxon to be used in analytical software packages as a unit for the calculation of diversity indices and of similarity amongst groups of samples. 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. The truncation exercise aims to identify and neutralise such entries to reduce the risk of them supporting an artificial pattern in the assemblage.

It is often the case that to overcome uncertainty 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.

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 (i.e., species level information is forfeited).

In this way, the entries identified only to genus are not assigned to a level that is unsupported by the evidence, and the resulting single entry is representative of both original entries, albeit with a little less information, but a loss that will not affect the pattern in the assemblage as a whole.

Additionally, 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 how to avoid the issues discussed above while retaining valuable information within the multivariate data set. The term 'juvenile' is often used to refer to individuals which do not exhibit the morphological features to resolve them to species level. In this case, these records were removed from the analysis rather than lowering the taxonomic resolution of other species level identifications. When a species level identification was labelled 'juvenile' the record was combined with the associated species level identification, when present or the 'juvenile' label removed.

Annex 2. Epifauna data truncation protocol applied to seabed imagery data.

Still image data were derived from two surveys of Mounts Bay MCZ, conducted in 2012 and 2016. For each survey, epifauna and macroalgae were identified to the highest possible taxonomic resolution, which was generally higher in 2012 than 2016. To make the data comparable for analysis, taxa were merged to the highest common resolution across the two surveys. The 2012 data were not analysed separately at a higher resolution, as the 2012 survey was conducted only within MCZ boundaries, which precludes an inside vs outside MCZ comparison, and the lower-resolution 2016 data is necessary to carry out a temporal analysis. Any community analysis of epifaunal and macroalgal data from 2012 only would therefore be of little additional value when applied to monitoring.

The steps undertaken during truncation, and the justification for each step, are described below for 2012 and 2016.

Truncation steps to prepare 2012 still image data for temporal community analysis (© Natural England and Environment Agency 2022).

Recorded taxon	Assigned taxon	Justification
Axinella dissimilis	Axinellidae	To produce comparable data
Terpios gelatinosa	Suberitidae	To produce comparable data
Hemimycale columella	Hymedesmidae	To produce comparable data
Kirchenpaueria spp.	Hydrozoa	To produce comparable data
Virgulariidae	Anthozoa	To produce comparable data
Aiptasia mutabilis	Actinaria	To produce comparable data
Lanice conchilega	Removed	Not epifauna
CRUSTACEA	Removed	Insufficient taxonomic resolution
DECAPODA	Removed	Insufficient taxonomic resolution
Pandalidae	Removed	Not epifauna
Gibbula spp.	Trochidae	To produce comparable data
BRYOZOA	Faunal Turf	To produce comparable data
Membranipora membranacea	Bryozoa (epiphytic)	To produce comparable data
Palmaria palmata	RHODOPHYCEAE	To produce comparable data
Lomentaira spp.	RHODOPHYCEAE	To produce comparable data
Rhodymenia pseudopalmata	RHODOPHYCEAE	To produce comparable data
Heterosiphonia plumosa	RHODOPHYCEAE	To produce comparable data
Delesseria sanguinea	RHODOPHYCEAE	To produce comparable data
Drachiella spectabilis	RHODOPHYCEAE	To produce comparable data
Carpomitra costata	PHAEOPHYCEAE	To produce comparable data
Laminaria hyperborea	Laminaria spp.	To produce comparable data
Laminaria saccharina	Laminaria spp.	To produce comparable data
Burrows	Removed	Not epifauna

Truncation steps to prepare 2016 still image data for temporal community analysis (© Natural England and Environment Agency 2022).

Recorded taxon	Assigned taxon	Justification
Suberites	Suberitidae	To produce comparable data
Porifera A	Porifera	To produce comparable data
Porifera B	Porifera	To produce comparable data
Nemertesia ramosa	*Nemertesia*	To produce comparable data
Sertularia	Hydrozoa	To produce comparable data
Anemonia viridis	Actinaria	To produce comparable data
Caryophyllia (caryophyllia) smithii	*Caryophyllia smithii*	To produce comparable data
Polychaeta (burrows)	Removed	Not epifauna
Spirobranchus spp.	Serpulidae	To produce comparable data
Ensis (burrows)	Removed	Not epifauna
BRYOZOA	Bryozoa (epiphytic)	To produce comparable data
Henricia	ASTEROIDEA	To produce comparable data
Ophiura albida	OPHIUROIDEA	To produce comparable data
Echinocardium cordatum (burrows)	Removed	Not epifauna
Pisces	Removed	Not epifauna
Unidentifed faunal turf	Faunal turf	To produce comparable data

Annex 3. Rationale for using counts of individuals and taxa from still images in condition monitoring.

The spatial sampling design for still images is units collected in linear replicates, in the form of camera tows, at N stations. The individual tows are expected to be a representative, effectively random, sample of each habitat type present at the site. Count data of individuals of set taxa and the total number of taxa exist for each image. Examples of taxa with individual counts are species FOCI (such as the pink sea fan, *Eunicella verrucosa*, at The Manacles MCZ) and specific taxa selected as indicators of habitat condition (such as sponge morphs).

For specific taxa, distributions are not likely to be even. Presence and abundance are habitat dependent for most taxa. The habitat dependent distribution dictates that the probability of presence (or high or low abundance), are not equal across, or where habitat changes during tow, within tows. A more equal sample can be obtained by sub-setting the stills within a station as several small stations for those habitats.

Observations along transects are not independent of each other. In particular, stills from the same station are likely to be more similar than stills from different stations. There might also be spatial correlation within a station – for example, stills next to each other might be more similar than ones further apart. Hence, we are assuming that the randomisation is done for the station locations. In order that our overall mean is not weighted by the number of stills per station, we calculate the mean of counts in individual still images within a habitat type within a tow to arrive at a station mean. We then use these station means in a stratified mean to estimate our overall mean for each stratum (habitat, location, time). Formally, we define this stratified estimator as:

$$\bar{y}_{st} = \sum_{j=1}^{S} \bar{y}_j$$

Where $\bar{y}_j$ is the mean of the replicates for the j^{th} stations and the summation is over the S stations within the stratum. We can calculate, for example, 95% confidence intervals for $\bar{y}_{st}$ from the fact that

$$\mathrm{var}(\bar{y}_{st}) = \sum_{j=1}^{S} \sigma_j^{\,2} / n_j$$

Where $\sigma_j^{\,2}$ is the variance of observations at the j^{th} station and n_j is the number of replicates at the j^{th} station.

Using the mean of station means avoids the need for equal numbers of stills from each station.

In view of continued time series monitoring (i.e. regular repeat surveys), the use of the stratified estimator does not require the same locations to be repeated. Where the assumptions of the analysis are met, i.e. the stations are a representative or random sample of their stratum (e.g. habitat A in region X at time T). This is desirable where sampling is done using a towed camera system, which can never exactly replicate sampling location and may in some cases (e.g. where tidal flow dictates the direction of tow) sample entirely different features on different occasions, whilst nominally repeating a station. In fact, a fully stratified random design will give a better estimate over time of the whole region of interest than fixed stations, which assess change only at those stations.

The recommended procedure is:

1) Define strata – in this case Broadscale Habitats (or where required, more detailed habitat types, e.g. for species FOCI), and if a comparison between specific areas is desired, location.

2) Assign representative random sampling locations to strata.

3) Calculate mean counts for each stratum at each station (post-image-analysis stratification where required).

4) Calculate mean per stratum.

Annex 4. Marine litter

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

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

Related size categories
A: ≤ 5*5 cm = 25 cm²
B: ≤ 10*10 cm = 100 cm²
C: ≤ 20*20 cm = 400 cm²
D: ≤ 50*50 cm = 2500 cm²
E: ≤ 100*100 cm = 10000 cm²
F: ≥ 100*100 cm = 10000 cm²

Annex 5. Non-indigenous species (NIS).

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), and additional non-indigenous species that are listed in the NNSIP (GB Non-native species Secretariat, 2017).

Species name	List	Species name	List	Species name	List
Acartia (Acanthacartia) tonsa	Present	*Alexandrium catenella*	Horizon	*Ammothea hilgendorfi*	NNSIP
Amphibalanus amphitrite	Present	*Amphibalanus reticulatus*	Horizon	*Arcuatula senhousia*	NNSIP
Asterocarpa humilis	Present	*Asterias amurensis*	Horizon	*Austrominius modestus*	NNSIP
Bonnemaisonia hamifera	Present	*Caulerpa racemosa*	Horizon	*Aulacomya ater*	NNSIP
Caprella mutica	Present	*Caulerpa taxifolia*	Horizon	*Clavopsella navis*	NNSIP
Crassostrea angulata	Present	*Celtodoryx ciocalyptoides*	Horizon	*Clymenella torquata*	NNSIP
Crassostrea gigas	Present	*Chama sp.*	Horizon	*Eusarsiella zostericola*	NNSIP
Crepidula fornicata	Present	*Dendostrea frons*	Horizon	*Goniadella gracilis*	NNSIP
Diadumene lineata	Present	*Gracilaria vermiculophylla*	Horizon	*Gonionemus vertens*	NNSIP
Didemnum vexillum	Present	*Hemigrapsus penicillatus*	Horizon	*Grandidierella japonica*	NNSIP
Dyspanopeus sayi	Present	*Hemigrapsus sanguineus*	Horizon	*Marenzelleria viridis*	NNSIP
Ensis directus	Present	*Hemigrapsus takanoi*	Horizon	*Mercenaria mercenaria*	NNSIP
Eriocheir sinensis	Present	*Megabalanus coccopoma*	Horizon	*Monocorophium sextonae*	NNSIP
Ficopomatus enigmaticus	Present	*Megabalanus zebra*	Horizon	*Mya arenaria*	NNSIP
Grateloupia doryphora	Present	*Mizuhopecten yessoensis*	Horizon	*Mytilopsis leucophaeta*	NNSIP
Grateloupia turuturu	Present	*Mnemiopsis leidyi*	Horizon	*Neodexiospira brasiliensis*	NNSIP
Hesperibalanus fallax	Present	*Ocenebra inornata*	Horizon	*Petricolaria pholadiformis*	NNSIP
Heterosigma akashiwo	Present	*Paralithodes camtschaticus*	Horizon	*Pileolaria berkeleyana*	NNSIP
Homarus americanus	Present	*Polysiphonia subtilissima*	Horizon	*Potamopyrgus antipodarum*	NNSIP
Rapana venosa	Present	*Pseudochattonella verruculosa*	Horizon	*Rhithropanopeus harrisii*	NNSIP
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				

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