Thanet Coast Marine Conservation Zone (MCZ) Monitoring Report 2017-18

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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.

Acknowledgements

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

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Executive Summary

Under the UK Marine & Coastal Access Act (2009), the Department for Environment, Food and Rural Affairs (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 Marine Conservation Zones (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 Marine Protected Area (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).

The Statutory Nature Conservation Body (SNCB) responsible for nature conservation inshore between 0 and 12 nm from the coast is Natural England. SNCBs 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 by SNCBs 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, **does not** therefore aim to assess the condition of the designated features or provide advice on management of anthropogenic activities occurring within the site.

This report explores environmental and ecological sample data, primarily acquired from a characterisation survey of the Thanet Coast MCZ in 2017-18 intended to serve as the first point in a monitoring time series. Anthropogenic pressures and their interaction with the data reported on here are considered by SNCBs at a later stage as part of condition assessment and management advice for this site.

This report includes recommendations which inform continual improvement and development of sample acquisition, analysis and data interpretation for future survey and reporting. Site and feature specific indicator metrics are not currently defined for this site. Potential indicators, where identified, will be evaluated and considered for inclusion in recommendations for future reporting.

This characterisation report is informed by data acquired during a dedicated survey carried out at the Thanet Coast Marine Conservation Zone (MCZ) (during 2017-18) and will form part of the ongoing time series data and evidence for this MPA.

The Thanet Coast MCZ is an inshore site located on the north Kent coast within the ‘Southern North 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 Thanet Coast MCZ. This report provides a characterisation of a number of Broadscale Habitats (BSHs) (‘A5.1 Subtidal coarse sediment’, ‘A5.2

Subtidal sand', 'A5.4 Subtidal mixed sediments', 'A3.2 Moderate energy infralittoral rock', 'A4.2 Moderate energy circalittoral rock'), Habitat FOCI (Blue Mussel Beds, Subtidal Chalk, Peat and Clay Exposures, Ross Worm (*Sabellaria spinulosa*) Reefs) and species FOCI (St John's Stalked Jellyfish (*Calvadosia cruxmelitensis*) and Stalked Jellyfish *Haliclystus* spp.) designated within the MCZ.

Historical studies (Davies, 1995, Tittley *et al.*, 1998 and Sheehan *et al.*, 2015) have identified that the Thanet Coast subtidal area is particularly challenging to survey. Data generated from this Type-1[1] densely packed grid survey has formed a general picture of a dynamic subtidal environment subject to moderate/strong wave action and tidal streams. The infralittoral/circalittoral habitat boundary was shallow, likely due to highly turbid waters flowing out of the Thames estuary mixing with chalk particles from the surrounding rock (Tittley *et al*., 1998). The 'A3.2 Moderate energy infralittoral rock' BSH was not identified from the survey data collected. The sediment BSHs present off the more exposed east coast between North Foreland and Ramsgate were predominantly composed of impoverished sand and coarse sediment communities. Along the north coast, more complex mixed and mud biotopes were present indicating more sheltered conditions. The survey has generated evidence to indicate the presence of Blue Mussel Beds, Subtidal Chalk and Ross Worm (*Sabellaria spinulosa*) within the MCZ, however Peat and Clay Exposures were not found. The Stalked Jellyfish species FOCI was not observed due to the sampling techniques employed.

Contaminant levels were generally below OSPAR Background Assessment Concentrations (BAC) in the four samples collected from across the site. However, heavy metal Effects Range-Low (ERL) exceedances were detected in the sample collected at station THNC30, off North Foreland. The ecological status for this sample and one collected from an adjacent station was 'moderate'. Given there is heavy shipping activity in this part of the MCZ (MMO, 2014) this may warrant further investigation.

A number of recommendations for future assessment and monitoring of designated features within the Thanet Coast MCZ are provided.

[1] Type 1 monitoring is defined by Kröger and Johnston, (2016) as sentinel monitoring of long-term trends to measure rate and direction of long-term change.

1 Introduction

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

Under the Marine and Coastal Access Act (2009), the Department for Environment, Food and Rural Affairs (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 characterisation survey of the Thanet Coast MCZ, which will form the initial point in a monitoring time series against which feature condition can be assessed in the future. The specific aims of the report are discussed in more detail in section 1.2.

1.1 Site overview

The Thanet Coast MCZ is an inshore site on the north Kent coast (Figure 1). Thanet Coast MCZ was recommended as a MCZ by the 'Balanced Seas' regional stakeholder group project. It is located in the jurisdictional area of the Kent and Essex Inshore Fisheries and Conservation Authority (KEIFCA) and falls within the wider 'Charting Progress 2' (CP2) area 'Southern North Sea'. The site overlaps the Thanet Coast Special Area of Conservation (SAC) designated to protect Annex I habitat 'Reefs' and the Margate and Long Sands SAC designated for the Annex I 'Sandbanks which are slightly covered by seawater all the time'. In addition two Special Protection Areas (SPAs) overlap the site: Outer Thames Estuary SPA and Thanet Coast and Sandwich Bay SPA (Figure 1). The MCZ is also close to The Swale Estuary MCZ to the west and Dover to Deal MCZ to the south.

The MCZ boundary extends out to a maximum of 4 km from the shoreline, ranging from intertidal to a water depth of approximately 20 metres below sea level (chart

datum). The site was designated[2] due to the presence of a number of sediment habitats and unusual reef features (Table 1). The chalk seabed present within the MCZ boundary forms part of the longest continuous stretch of coastal chalk in the UK (Natural England, 2013). The designation includes Features of Conservation Importance (FOCI) such as Blue Mussel (*Mytilus edulis*) Beds and Ross Worm (*Sabellaria spinulosa*) that form complex intertidal biogenic reef structures. These reefs play an important role within the ecosystem, stabilising mobile sediment and creating niche habitats that support a diverse range of species (Natural England, 2013). It is also one of only two designated MCZs protecting the species of Stalked Jellyfish (*Calvadosia cruxmelitensis*), a UK Biodiversity Action Plan (BAP) Priority species[3].

The KEIFCA (2018) have a byelaw in place that prevents the use of all bottom towed gear within a large area of the MCZ (Figure 1) to protect the regionally important soft chalk reef habitat and associated communities. Potting and netting activities are not restricted. At the time of writing, no evidence of trawling/dredging within the MCZ boundary not covered by the byelaw area has been seen since early 2014 (KEIFCA pers. comm.).

The site overlaps with the Kent North coastal Water Framework Directive (WFD) Water Body, where monthly water quality monitoring is undertaken for temperature, salinity, dissolved oxygen, dissolved inorganic nutrients, phytoplankton community composition and chlorophyll. The site also encompasses 12 microbiological monitoring stations for the Bathing Waters Directive, sampled between May and September (Figure 1).

[2] http://www.legislation.gov.uk/ukmo/2013/24/pdfs/ukmo_20130024_en.pdf [accessed 28/02/2019]

[3] http://jncc.defra.gov.uk/page-5671 [accessed 28/02/2019]

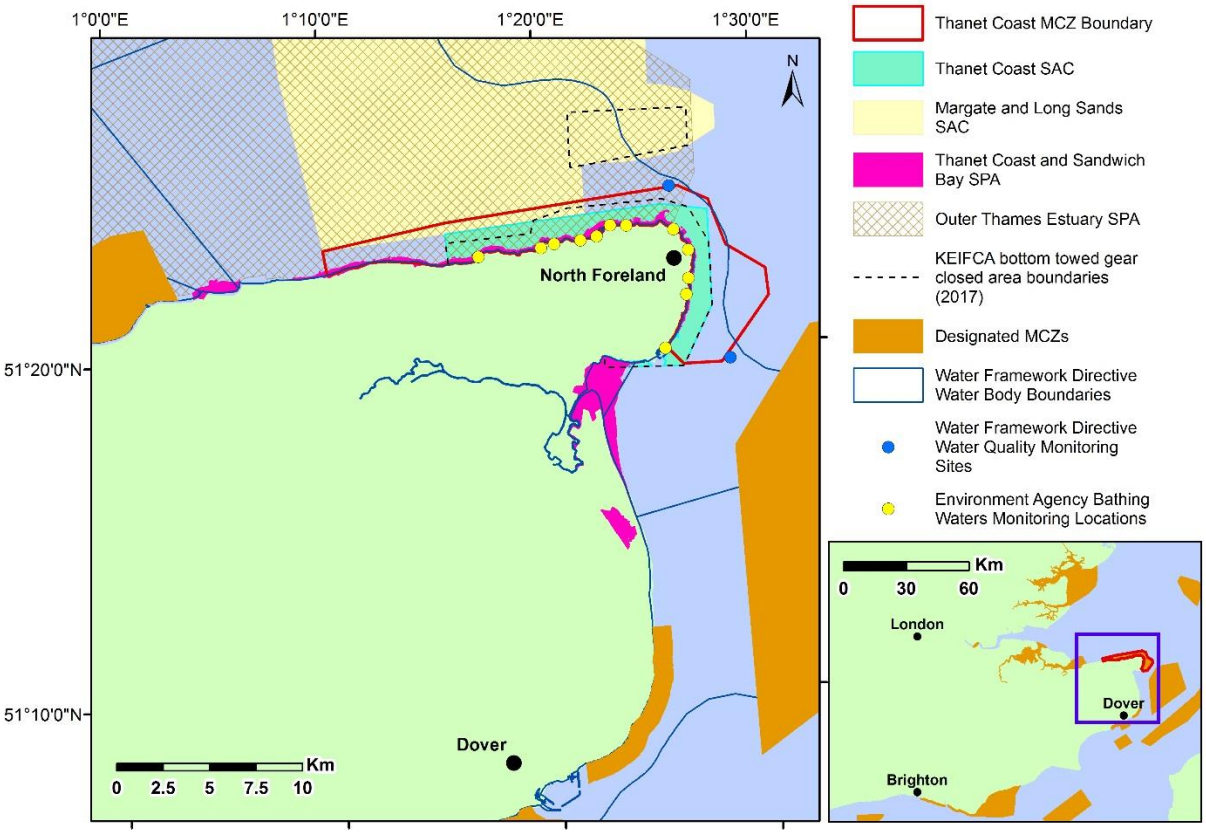


Figure 1. Location of the Thanet Coast MCZ in the context of Marine Protected Areas and management jurisdictions proximal to the site (© Natural England and Environment Agency 2022).

Table 1. Thanet Coast MCZ site overview (© Natural England and Environment Agency 2022).

Charting Progress 2 Region[4]	Southern North Sea
Spatial Area (km²)	62.8 km²
Water Depth Range (m)	0 to 20 m
Broadscale Habitat (BSH) Features Present	**Designated**
A1.2 Moderate energy intertidal rock*	✘
A2.1 Littoral coarse sediment*	✘
A2.2 Intertidal sand and muddy sand*	✘
A2.3 Intertidal mud*	✘
A2.4 Intertidal mixed sediments*	✘
A3.2 Moderate energy infralittoral rock	✓
A4.2 Moderate energy circalittoral rock	✓
A5.1 Subtidal coarse sediment	✓
A5.2 Subtidal sand	✓
A5.3 Subtidal mud	✘
A5.4 Subtidal mixed sediments	✓
Habitat FOCI Present	
Blue Mussel Beds	✓
Subtidal Chalk	✓
Ross Worm (*Sabellaria spinulosa*) Reefs	✓
Peat and Clay Exposures	✓
Species FOCI Present	
St John's Stalked Jellyfish (*Calvadosia cruxmelitensis*)**	✓
Stalked Jellyfish *Haliclystus* spp.	✓

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

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

[4] http://webarchive.nationalarchives.gov.uk/20141203170558tf_/http://chartingprogress.defra.gov.uk/ [accessed 19/02/19]

1.2 Existing data and habitat maps

Acoustic data was available up to 1 nm from the shore to aid survey planning (UK Hydrographic Office HI1340, Ramsgate to Minnis Bay 2011; HI1438, Swale to Minnis Bay 2013). No acoustically-derived habitat map was available, although interpreted habitat maps from existing evidence have been created by NE. No MCZ verification survey was undertaken for this site, but there was a small Drop Camera survey of the Thanet Coast SAC focusing on chalk reef habitats undertaken for NE in 2013 (Sheehan *et al*., 2015) which provided limited evidence of biotope distribution. No existing infauna data was available.

1.2.1 High-level conservation objectives

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

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

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

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

1.2.2 Definition of favourable condition

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

a) Its extent and distribution is stable or increasing;

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

c) Its natural supporting processes are unimpeded.

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

Structure encompasses the physical components of a habitat type and the key and influential species present. Physical structure refers to topography, sediment

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

For species features, favourable condition means that:

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

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

c) Its natural supporting processes are unimpeded.

1.2.3 Report aims and objectives

The primary aim of this characterisation report is to explore and describe the attributes of the designated features within the Thanet Coast 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.

The broad objectives of this characterisation report are provided below:

1) Provide a description of the **extent[5], distribution, structural** and **functional** attributes of the designated features within the site (see Table 2 for more detail), to enable subsequent condition monitoring and assessment;

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

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

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

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

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

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

1.2.4 Reporting sub-objectives (Objective 1)

To achieve report objective 1, a number of reporting sub-objectives will be addressed to provide evidence for Feature Attributes and supporting processes (as defined in Supplementary Advice on Conservation Objectives (SACOs) developed by NE for Thanet Coast MCZ [6]). It was not possible to address all Feature Attributes in the characterisation survey design, given the comprehensive nature of the attribute lists for each feature. The Feature Attributes were therefore rationalised according to SNCB priorities, resulting in a smaller subset.

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

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

Feature attribute*	Features	Reporting sub-objective	Report section
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 Ross Worm (*Sabellaria spinulosa*) Reefs. Blue Mussel Beds Subtidal Chalk Peat and Clay Exposures	Generate point habitat maps to determine the distribution of BSH and Habitat FOCI within the MCZ.	3.1, 3.3.1 and 3.4
Extent of supporting habitat	Blue Mussel Beds Ross Worm (*Sabellaria spinulosa*) Reefs Peat and Clay Exposures	Discuss evidence of supporting habitat presence for these Features.	3.4, 4.4 and 4.5

6 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0017&SiteName=Thanet&SiteNameDisplay=Thanet+Coast+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= [accessed 28/02/2019]

Feature attribute*	Features	Reporting sub-objective	Report section
	St John's Stalked Jellyfish (*Calvadosia cruxmelitensis*) Stalked Jellyfish *Haliclystus* spp.		
Sediment composition and distribution	A5.1 Subtidal coarse sediment A5.2 Subtidal sand A5.4 Subtidal mixed sediments	PSA derived from seabed sediment samples.	3.3.1
Distribution: Presence and spatial distribution of biological 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 Peat and clay exposures Subtidal chalk	Biological communities and biotopes derived from each BSH.	3.2 and 3.3.2 - 3.3.6
Structure: 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 Peat and Clay Exposures Subtidal Chalk	Statistical techniques used to explore the species composition of component communities, where possible.	3.3.2 and 3.3.3
Structure: species composition of the community	Blue Mussel Beds Ross Worm (*Sabellaria spinulosa*) Reefs	Examine if other commonly associated species are present.	4.4.2 and 4.4.3
Structure: population density	Blue Mussel Beds Ross Worm (*Sabellaria spinulosa*) Reefs	If possible, report on densities present.	3.4.2 and 3.4.3
Structure: age/size frequency	Blue Mussel Beds	Examine Blue Mussel grab data for the presence of adults and juveniles.	3.4.2
Structure: physical structure of rocky substrate	A3.2 Moderate energy infralittoral rock A4.2 Moderate energy circalittoral rock Peat and Clay Exposures Subtidal chalk	Describe the physical structure of the rock habitats and the Habitat FOCI as determined using the grab and video data.	3.2, 3.4.1 and 4.4.1
Structure and Function: Presence and abundance of key structural and influential species	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 Blue Mussel Beds Ross Worm (*Sabellaria spinulosa*) Reefs Peat and Clay Exposures	Discuss potential candidates for key structural and influential species in the Thanet Coast MCZ.	4.9 and 5

Feature attribute*	Features	Reporting sub-objective	Report section
	Subtidal Chalk		

* As defined in Supplementary Advice on Conservation Objectives (SACO) for the Thanet Coast MCZ. https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0017&SiteName=Thanet&SiteNameDisplay=Thanet+Coast+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

2 Methods

2.1 Survey design

The MCZ encompasses a major headland (North Foreland), with The Swale Estuary MCZ to the west and the deeper Outer Thames channel to the north. Consequently, no comparable area of seabed was considered to be within a reasonable distance of the site, and that a Before-After, Control-Impact (BACI) style survey was deemed unsuitable. Instead, a Type-1 densely sampled survey methodology (designed to monitor long-term trends) was chosen to provide as much information as possible on the distribution of Broadscale Habitats (BSHs) across the site. Using available habitat information and outputs from the 2011 and 2013 bathymetric surveys, target sampling stations were plotted using a 750m triangular lattice distributed evenly across the site. For vessel safety and to avoid disturbed areas of seabed, stations were not placed within 500 m of undersea cables at North Foreland and Broadstairs, in the Ramsgate dredged channel or in the spoil ground off Ramsgate Sands.

2.2 Data acquisition and processing

A dedicated characterisation survey was conducted at the Thanet Coast MCZ on board the survey vessels *Humber Guardian* and *Thames Guardian* between the 12th of June 2017 and 13th of January 2018. The data acquired is summarised in Table 3 and shown in Figure 2, for full details of the survey, please see Fraser *et al*. (2018).

Table 3. Summary of samples collected during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

Equipment	Data type	No. of stations	No. of samples
Drop Camera (Freshwater Lens)	HD Video	35	273 (53 of limited value due to very poor visibility)
Mini-Hamon Grab	Biota, PSA and eDNA	88	29
	PSA and eDNA only		34
	eDNA only		25
Day Grab	Contaminants	4	4

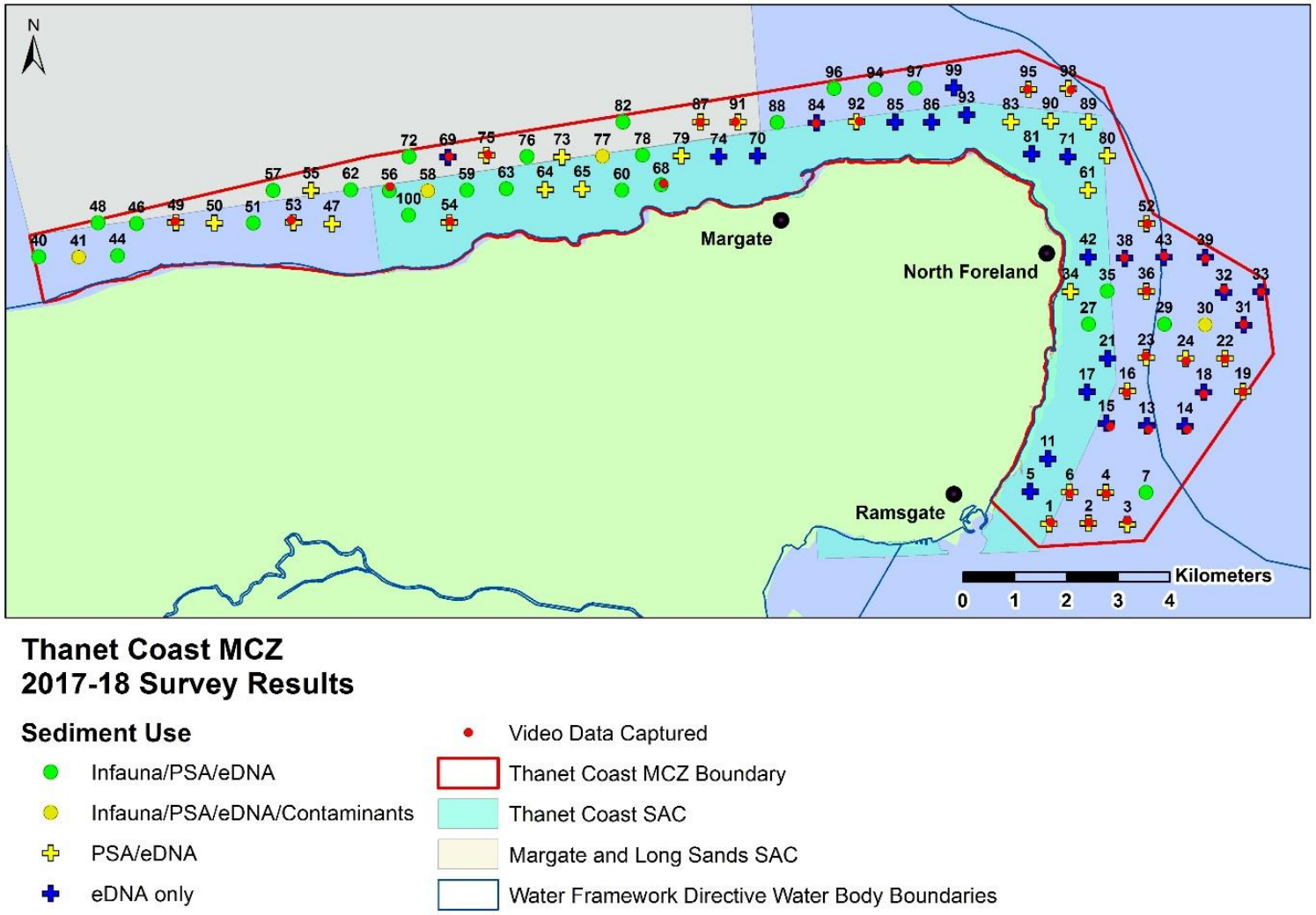


Figure 2. Location of grab samples and Drop Camera data capture for the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

2.2.1 Grab sampling

Seabed sediment samples for particle size distribution and benthic infauna analyses were collected using a 0.1 m^2 Hamon Grab (also known as a 'Mini' Hamon Grab).

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

The faunal fraction was sieved over a 1 mm mesh, photographed, and then fixed in buffered 4% formaldehyde diluted with seawater. Faunal samples were processed by the Institute of Estuarine and Coastal Studies to extract all fauna present in each sample. Fauna were identified to the lowest taxonomic level possible, enumerated and weighed (blotted wet weight) to the nearest 0.0001 g following the recommendations of the NMBAQC scheme (Worsfold *et al*., 2010). The samples was assigned to biotopes according to the JNCC Marine Habitat Classification for Britain and Ireland Version 15.03 (JNCC, 2015).

The contents of each sediment grab were visually inspected for the invasive non-native Carpet sea squirt (*Didemnum vexillum*). If an ascidian was found matching the description of *D. vexillum*, approximately 1 gram of tissue was removed and immersed in a container of 100% ethanol. Samples were transported to Cefas specialists in Weymouth for Polymerase Chain Reaction (PCR) analysis to confirm species identification. In addition, supernatant water samples were collected from each grab sample. Three 50 ml aliquots were taken from each grab and fixed in 100% ethanol. Each water sample was tested for DNA presence of the following moderate, high or unknown impact non-native species: *Eriocheir sinensis*, *Crassostrea gigas*, *Crepidula fornicata*, *Styela clava*, Non-native Didemnidae sp. (*Didemnum vexillum*), *Bugula neritina*, *Hemigrapsus takanoi*, *Hemigrapsus sanguineus*, *Homarus americanus*, and *Caprella mutica* (WFD UK TAG, 2015).

2.2.2 Seabed imagery

Drop Camera (DC) equipment was deployed in accordance with the Mapping European Seabed Habitats (MESH) 'recommended operating guidelines (ROG) for underwater video and photographic imaging techniques' (Coggan *et al*., 2007). The Seastar Survey Ltd. video camera with freshwater lens was deployed from the stern of the survey vessel. Real-time navigation data acquisition and manual position fixing when the gear contacted the seabed was captured via Trimble® HYDRO*pro*™ software and logged by the survey officer. The position fixing offset for the camera was 2 metres beyond the mid-point of the stern gantry to allow for vessel movement

whilst the frame was landed. Video files and digital still images were transmitted via the sea cable to be captured and saved directly to a hard drive in the survey cabin. The video footage was annotated with time and position using a GPS (SIMRAD MX512 DGPS) referenced video overlay (uncorrected position data). Between 30 to 60 seconds of high definition video was recorded during each drop, with five to ten drops completed at each station depending on the visibility and habitat complexity observed. The DC frame depth was controlled via a winch operator receiving instructions from the survey cabin. Video and still images were analysed following an established protocol developed and used by Cefas (Coggan and Howell, 2005; Hitchin *et al*., 2015; Turner *et al*., 2016) for epibiota community analysis.

2.2.3 Additional environmental data

At four stations, a 0.1 m^2 Day Grab was used to retrieve material for contaminant analyses (heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), tributyltin), providing a record of the most recent contaminant levels deposited in the sediment. Surface sediment scrapes were sampled to a maximum depth of 1 cm (avoiding the anoxic layer), following the methodology detailed in the Environment Agency Operational Instruction 10_01 (2016). An Idronaut multi-parameter probe was used to collect near seabed salinity measurements alongside Day Grab deployments for the contaminants sampling.

2.3 Data preparation and analysis

2.3.1 Sediment particle size distribution

Sediment particle size distribution data (0.5 phi (ϕ) 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 BSHs using a modified version of the classification model produced during the MESH project (Long, 2006).

2.3.2 Infaunal data preparation

The benthic macrofauna data set was truncated by following the steps presented in Annex 3. Invalid taxa and fragments of countable taxa were removed from the data set whilst the presence of colonial taxa was changed to an abundance 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.

2.3.3 Non-indigenous species

The infaunal and epifaunal taxon lists generated from the infaunal samples and seabed imagery data were cross-referenced against lists of non-indigenous target

species which have been selected for the assessment of GES in waters of Great Britain under MSFD Descriptor 2 (marine), Ecological Status assessment for WFD Water Bodies (coastal and estuarine), and identified as significant by the Non-Native Species Secretariat of Great Britain. These taxa are listed in Annex 5.

2.3.4 Numerical and statistical analyses

The truncated macrofaunal abundance and biomass data were imported into PRIMER (Plymouth Routines in Multivariate Ecological Research) v.6 (Clarke and Gorley, 2006) to enable multivariate analysis and the derivation of various metrics for univariate analysis. Species classification information and a number of relevant factors/indicators were also assigned to the data at this stage, as follows. The following metrics were derived for each sample using the DIVERSE function within PRIMER v.6: abundance, taxa richness, Shannon-Wiener and Simpson's evenness. These metrics were derived to assess structural differences in the biological communities between designated habitat features and biological community characteristics of comparable features.

For multivariate analysis, a similarity matrix (Bray-Curtis) was generated between the samples. The maximum abundance of an individual taxon within a sample was 629, so abundance values were square-root transformed for the analysis. Non-Metric Multidimensional Scaling (nMDS) ordination, analysis of similarity (ANOSIM) between and dissimilarity[7] within groups were conducted to explore differences in biological community composition between the habitat features. The infaunal quality index (IQI), an assessment of benthic faunal condition, was calculated using the latest version of the WFD UK Technical Advisory Group (TAG) IQI excel workbook (Phillips *et al.,* 2014).

3 Results

3.1 Site overview

The Thanet Coast MCZ subtidal characterisation survey was completed in January 2018, and four of the five designated BSH features, 'A5.1 Subtidal coarse sediment', 'A5.2 Subtidal sand', 'A5.4 Subtidal mixed sediments' and 'A4.2 Moderate energy circalittoral rock' were found to be present (Table 4). Two further non-designated BSHs were identified 'A5.3 Subtidal mud' and 'A4.1 High energy circalittoral rock' through a combination of particle size and video data analyses.

[7] Similarity profile routine (SIMPROF) with associated similarity percentages breakdown (SIMPER).

Table 4. Number of 2017-18 Thanet Coast MCZ samples collected in each Broadscale Habitat (BSH) (© Natural England and Environment Agency 2022). Designated features are shown in bold.

Broadscale Habitat (BSH)	Mini-Hamon Grab – PSA and Infauna	Mini-Hamon Grab – PSA only	Drop Camera - Video
A4.1 High energy circalittoral rock	-	-	46
A4.2 Moderate energy circalittoral rock	**-**	**-**	**4**
A5.1 Subtidal coarse sediment	**5**	**13**	**63**
A5.2 Subtidal sand	**8**	**10**	**108**
A5.3 Subtidal mud	6	-	-
A5.4 Subtidal mixed sediments	**10**	**11**	**38**

All but one of the sediment samples collected from the 'A5.4 Subtidal mixed sediments' and 'A5.3 Subtidal mud' habitats were found along the north Kent coast, between the western boundary of the MCZ and North Foreland (Figure 3). Between North Foreland and Ramsgate, the subtidal sediment present was predominately 'A5.1 Subtidal coarse sediment' and 'A5.2 Subtidal sand'. Indicative sediment BSH assignments from the analysis of the video data have also been included in Figure 3.

Despite the use of the freshwater lens, classifying the rock BSH features present was challenging due to the poor visibility. However, two subtidal rock features were identified from the video data, 'A4.1 High energy circalittoral rock' and 'A4.2 Moderate energy circalittoral rock' (Figure 4), predominantly in the area of the MCZ between North Foreland and Ramsgate, beyond the Thanet Coast SAC boundary.

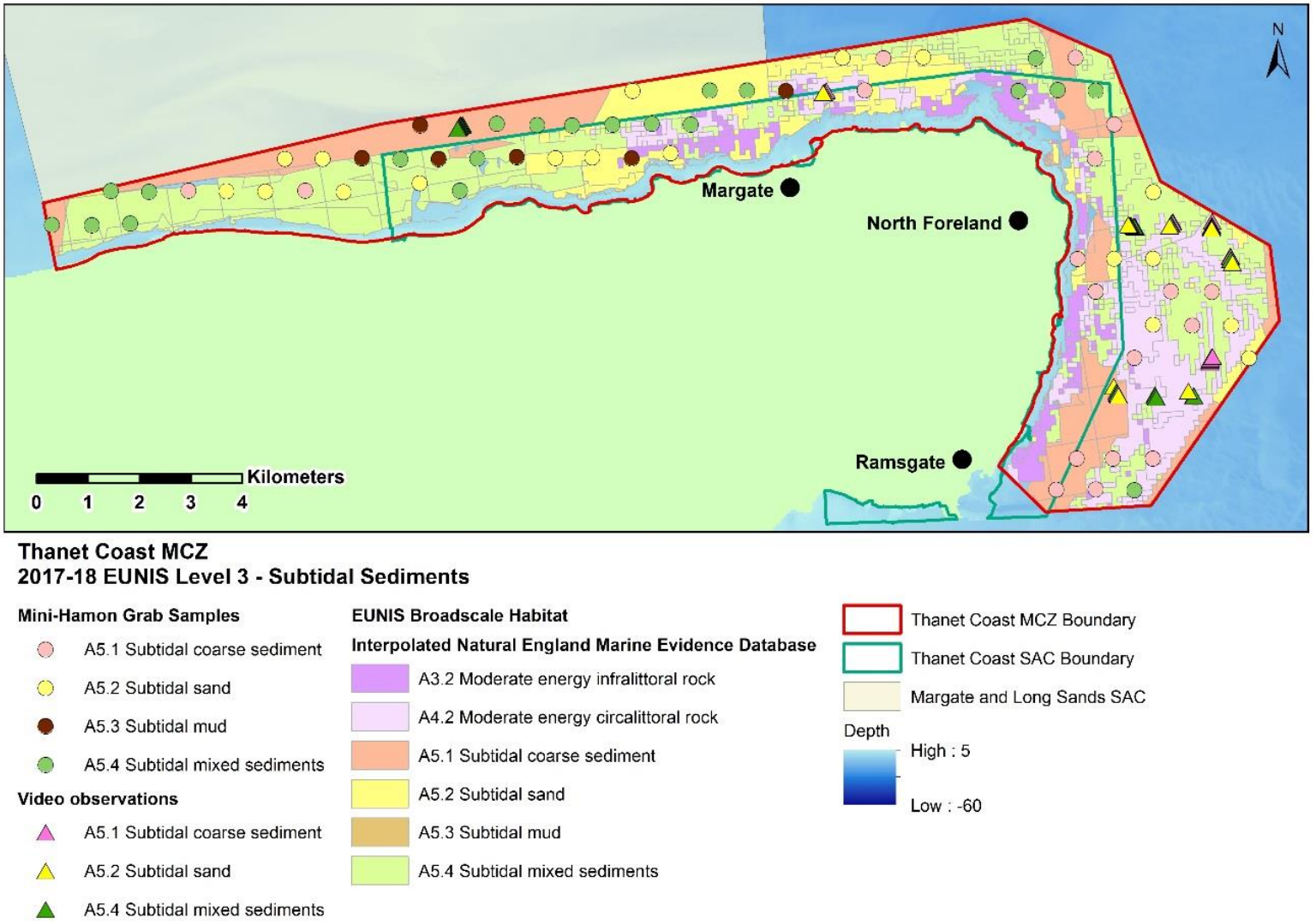


Figure 3. Subtidal sediments identified from the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

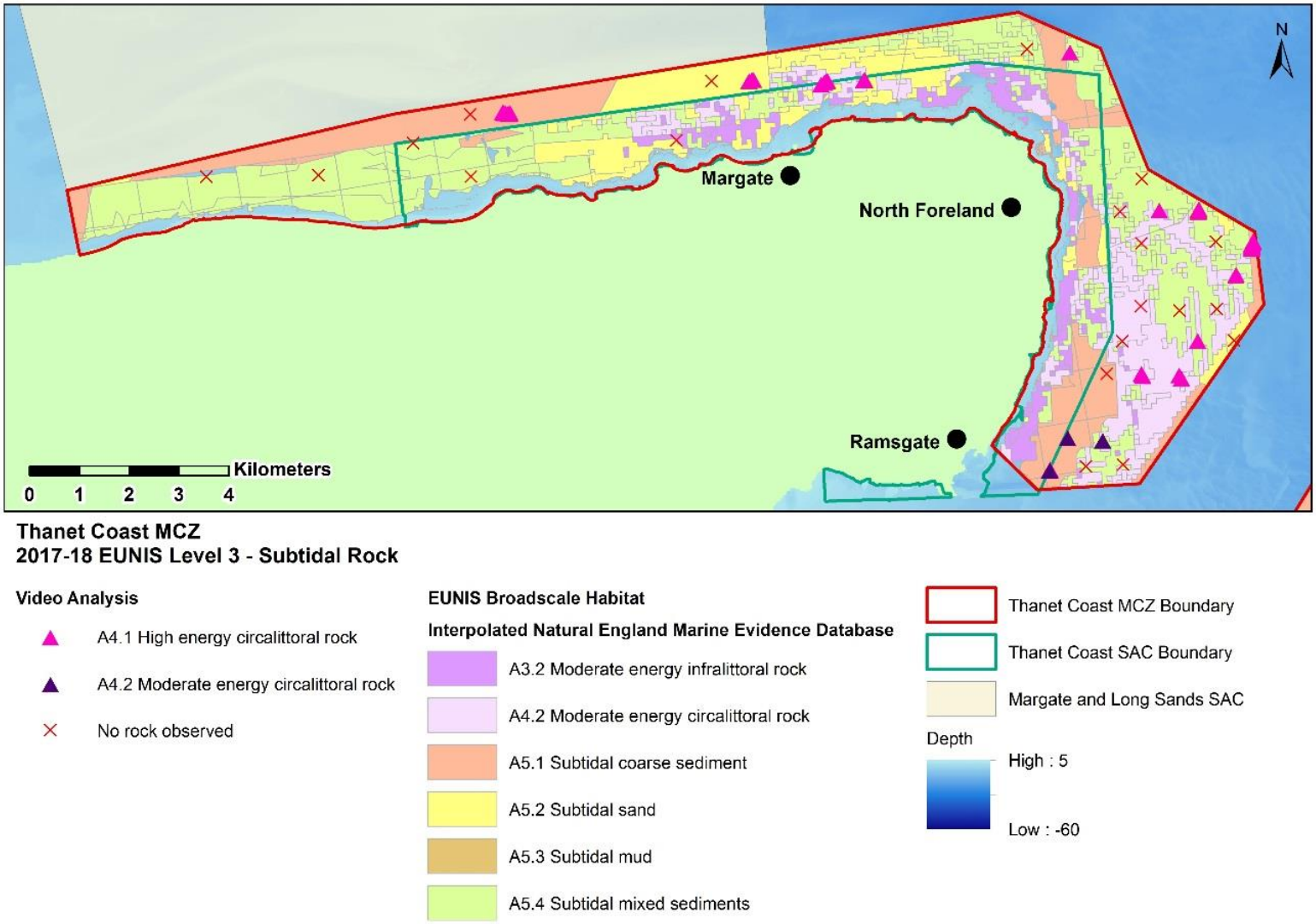


Figure 4. Subtidal rock habitats identified from the 2017-18 Thanet Coast MCZ survey(© Natural England and Environment Agency 2022).

3.2 Subtidal Rock BSH: Physical structure and biological communities

The general nature of the subtidal rock BSH features found within the Thanet Coast MCZ survey area was epifaunal encrusted pebbles and cobbles (some flint and bored chalk) overlaying sublittoral sediment. Twenty-nine taxa were identified from 50 camera drops, captured at a total of 15 stations (Figure 4). Identification to species level proved difficult due to the poor visibility encountered. An epifaunal turf was observed in over half the samples (n = 28) and Serpulidae sp. (tube-building worms) were abundant. Larger sessile animals included hydroids (*Hydrallmania falcata*, *Nemertesia antennina*), bryozoans (Flustridae sp. and *Alcyonidium* sp.), sponges (*Haliclona oculata* and *Halichondria* sp.), anemone species including *Sagartia elegans* and the soft coral *Alcyonium digitatum*. Motile species included starfish (*Asterias rubens*), crabs (*Cancer pagurus*, Inachidae sp.), the urchin species *Psammechinus miliaris* and the whelk (Buccinidae sp.). Very little macroalgae was observed (Rhodophyta sp. < 5 % cover at a single station) despite the shallow water depth which ranged from 7.3 to 14.8 m. In accordance with NMBAQC guidelines (Turner *et al.*, 2016), as the image quality resulting from the high turbidity encountered was <poor for the majority of the videos, statistical analyses of the epibiota data were not deemed appropriate.

3.2.1 'A4.1 High energy circalittoral rock' (not designated)

Twenty-eight of the 29 taxa identified from the video data were present within the 'A4.1 High energy circalittoral rock' BSH. Three biotopes were assigned: CR.HCR 'A4.1 high energy circalittoral rock', CR.HCR.XFa 'A4.13 mixed faunal turf communities' and CR.HCR.XFa.Mol 'A4.138 *Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock' (Figure 5). The presence of these biotopes indicates that the benthic communities in this area are exposed to moderately strong to strong tidal streams (JNCC, 2015).

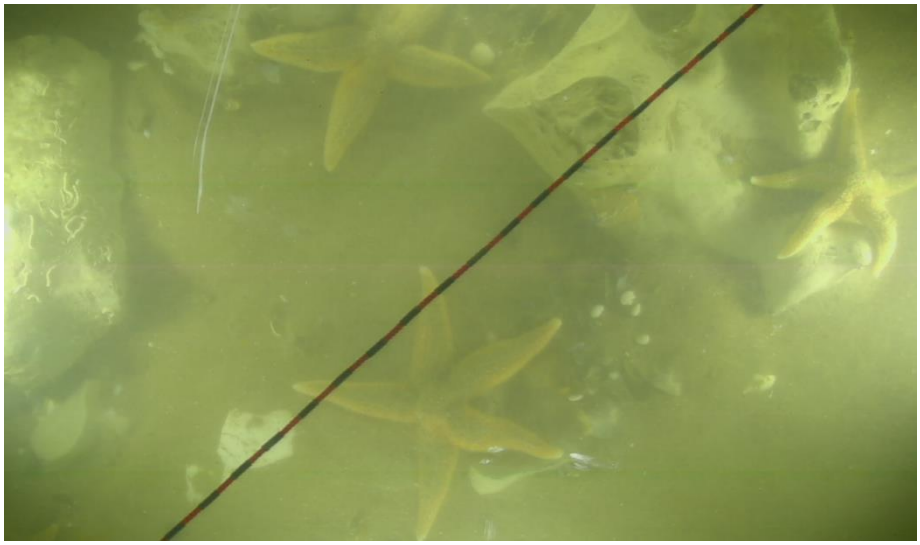
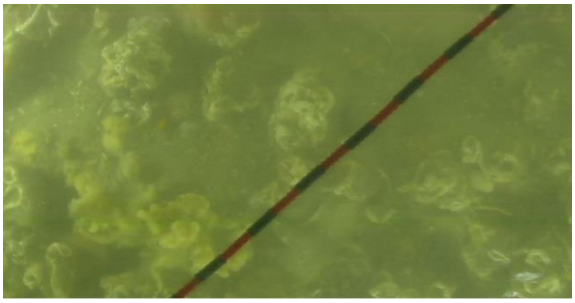
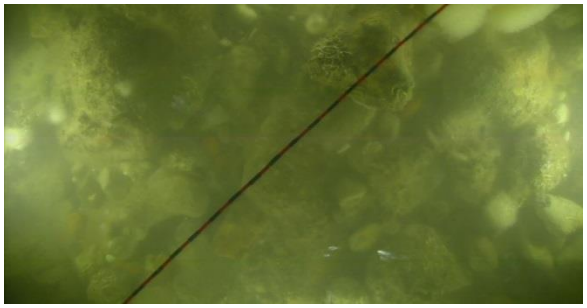
‘A4.1 High energy circalittoral rock’ (CR.HCR)	
	
‘A4.13 mixed faunal turf communities’ (CR.HCR.XFa)	**‘A4.138 Molgula manhattensis with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock’ (CR. HCR. XFa.Mol)**
	

Figure 5. Example images of the ‘A4.1 High energy circalittoral rock’ biotopes (JNCC v15.03) present in the 2017-18 Thanet Coast MCZ. Field of view scale graduations = 12 mm (© Environment Agency and Natural England 2017-18).

3.2.2 ‘A4.2 Moderate energy circalittoral rock’

The ‘A4.2 Moderate energy circalittoral rock’ feature was characterised by a single biotope: CR.MCR.SfR ‘A4.23 Soft rock communities’ (Figure 6). Piddock shells were noted in two of the four samples assigned to this biotope, however due to the poor visibility, it was difficult to ascertain if the specimens were alive.

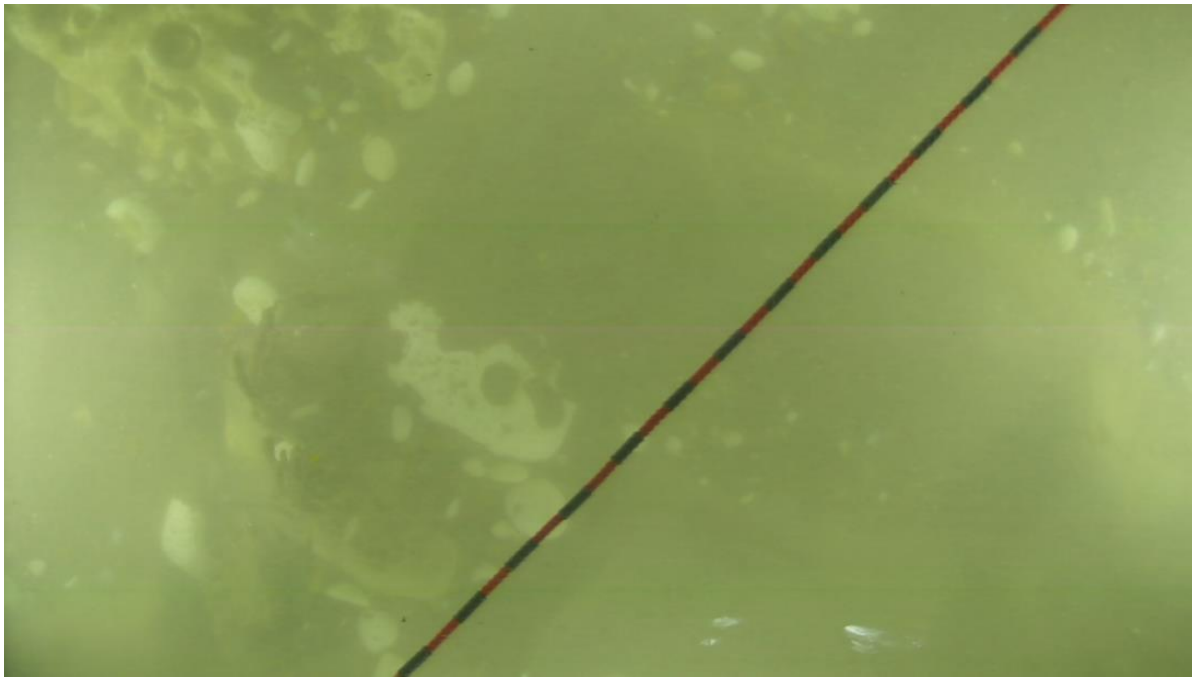
‘ A4.23 Soft rock communities’ (CR.MCR.SfR)


Figure 6. Example image of the ‘A4.2 Moderate energy circalittoral rock’ biotope (JNCC v15.03) present in the 2017-18 Thanet Coast MCZ. Field of view scale graduations = 12 mm (© Environment Agency and Natural England 2017-18).

3.2.3 Subtidal rock BSH temporal comparison

An underwater video survey for condition assessment of the Thanet Coast SAC was conducted in 2013 (Sheehan *et al*., 2015). The visibility underwater at the time was reported to be ‘fairly bad’. Several of the areas surveyed were sited close to 2017-18 Thanet Coast MCZ stations. Taking differences in survey design, methodology, analytical techniques and visibility in to consideration, in 2013, four circalittoral rock biotopes were identified (Figure 7), all assigned as high energy circalittoral rock. Three of these biotopes were observed again in 2017-18. The moderate energy biotope CR.MCR.SfR was not identified in 2013.

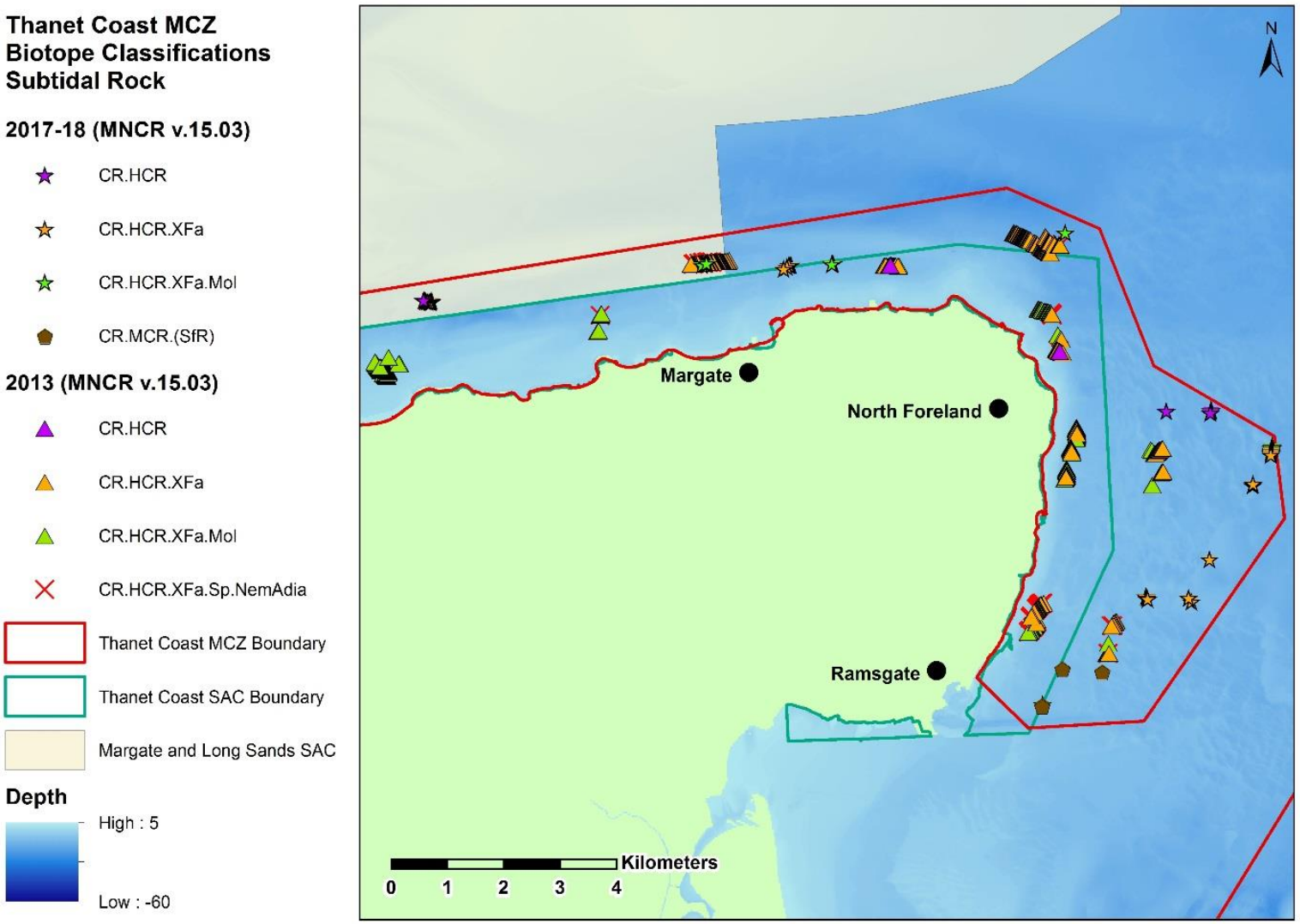


Figure 7. Distribution of subtidal rock biotopes at Thanet Coast MCZ stations sampled in 2013 (Sheehan *et al*., 2015) and in 2017-18 (© Natural England and Environment Agency 2022).

3.3 Subtidal Sediment BSH: Sediment composition and biological communities

3.3.1 Particle size analysis

Particle size analysis was completed on 63 samples collected from the Thanet Coast MCZ and the results confirmed the presence of four subtidal sediment BSHs: ‘A5.1 Subtidal coarse sediment’ (28.6%), ‘A5.2 Subtidal sand’ (28.6%), ‘A5.3 Subtidal mud’ (9.5%) and ‘A5.4 Subtidal mixed sediments’ (33.3%) (Figures 8 and 9).

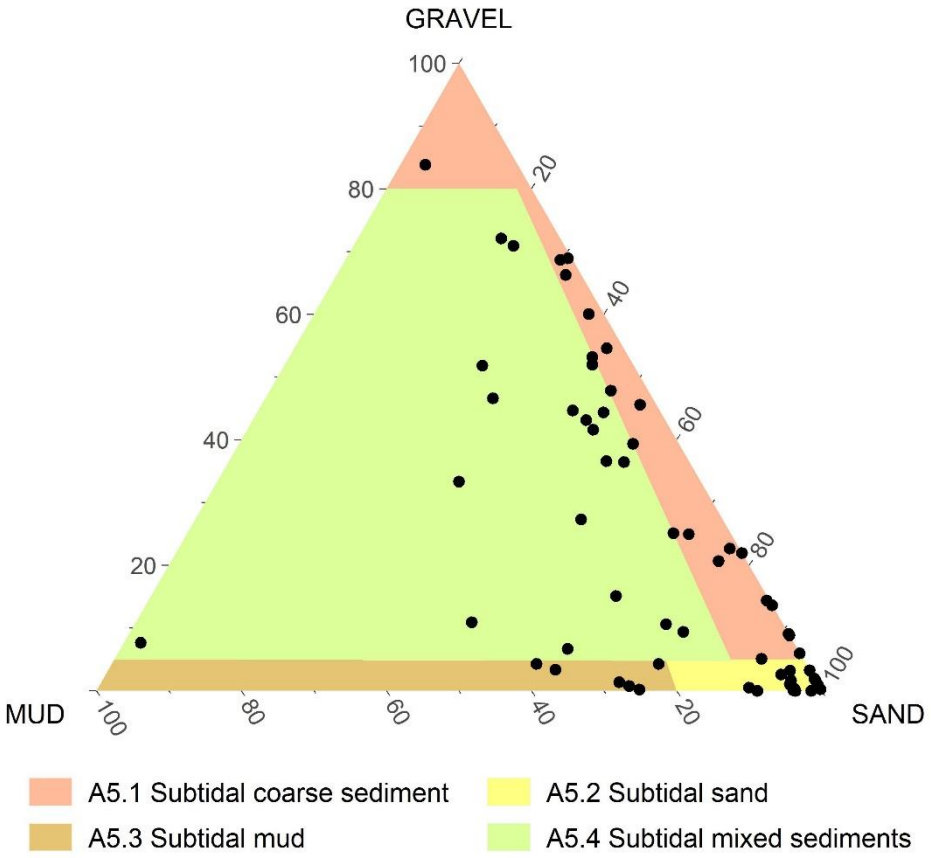


Figure 8. Classification of particle size distribution 0.5 phi (ϕ) information for each 2017-18 Thanet Coast MCZ sample (closed black circles) into one of the sediment Broadscale Habitats (coloured areas) plotted on a true scale subdivision of the Folk triangle into the simplified classification for UKSeaMap (Long, 2006; Folk, 1954) (© Natural England and Environment Agency 2022).

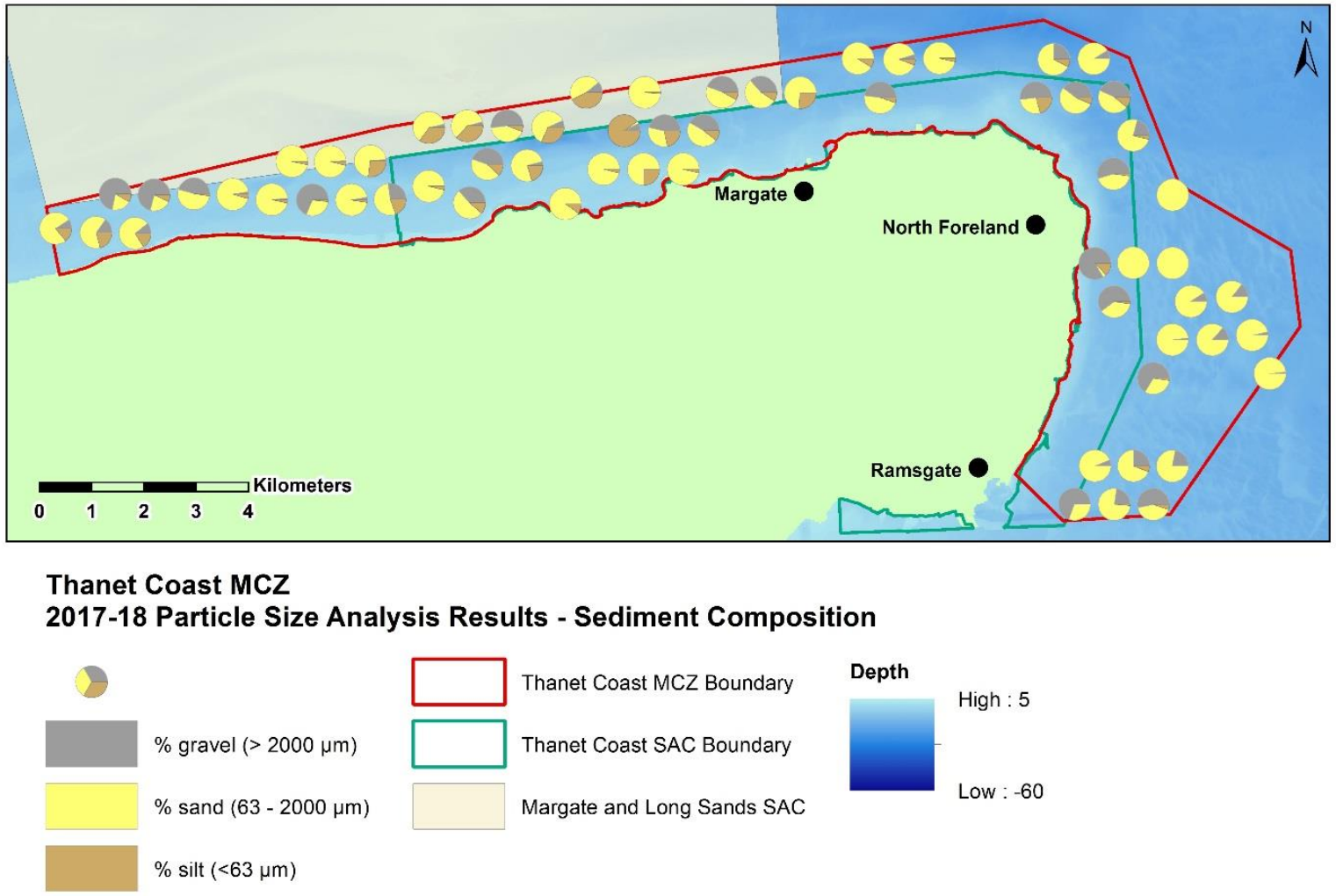


Figure 9. Percentage contributions of gravel, sand and silt in samples collected from the 2017-18 Thanet Coast MCZ (© Natural England and Environment Agency 2022).

3.3.2 Biological communities

In total, 252 taxa were identified in 29 sediment samples collected during the Thanet Coast MCZ survey. Table 6 shows the mean (± standard error) infaunal species abundance, richness, IQI and other univariate indices calculated for the infaunal samples.

Taxon richness showed significant differences between BSHs (Kruskal-Wallis, H = 16.66 df = 3, *P* <0.001), with the number of taxa in mixed sediments being significantly higher than in both sandy and coarse sediments (Dunn's Bonferroni-corrected *post-hoc* comparisons significant at *P <0.003*). Mean biomass also showed significant differences (Kruskal-Wallis, H = 19.27 df = 3, *P* <0.001). Pairwise comparisons subsequently revealed that mean biomass was significantly higher in the mixed and mud samples compared to those collected from the coarse and sand BSHs (Dunn's Bonferroni-corrected *post-hoc* comparisons significant at *P* <0.02). The large standard error associated with the mud BSH mean biomass value was attributed to the presence of 28 adult razor clams (*Ensis leei*).

Overall, there were significant differences in infaunal community composition between the different sediment types (ANOSIM, global R = 0.523, *P* <0.05) except between 'A5.3 Subtidal mud' and 'A5.4 Subtidal mixed sediments' (*P* = 0.116).

Eleven biotopes were identified based on the infauna assemblages present (Figure 10). The Marine Nature Conservation Review (MNCR) v.15.03 classification (JNCC, 2015) was reduced from Level 5 to Level 4 for six samples (THNC27, 56, 58, 59, 77 and 78) as the taxa present when considered with the PSA data could not be definitively assigned to a single biotope. A physical mismatch between PSA results and infauna communities present was identified for a number of samples, these are considered in the following sections.

Overall, the ecological status derived using the IQI for 21% of the samples was 'High', 72% were at 'Good' and 7% at 'Moderate' status (Figure 11). All samples had a low percentage (<10%) of individuals with unassigned AMBI ecological groups (AZTI[8] Marine Biotic Index). This information should be considered when assessing condition.

[8] AZTI is a member of the Basque Research and Technology Alliance https://www.azti.es/en/.

Table 5. Mean (± standard error) macrobenthic species abundance, richness, total biomass, IQI and other univariate indices of the Mini-Hamon Grab samples for the four different Broadscale Habitats (BSHs) collected within the 2017-18 (© Natural England and Environment Agency 2022).Thanet Coast MCZ(sieved to 1 mm). Means that are significantly different share the same letter.

BSH	Sample number	Abundance (*n* sample^{-1})		Taxa Richness (*S* sample^{-1})		Biomass (g)		Shannon H'(log^{e})		Simpsons (1-λ')		Hill's N1		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'	5	31.0	19.0	18.8^{a}	10.4	0.71^{ab}	0.65	2.31	0.41	0.910	0.042	14.54	6.96	0.67	0.04
'A5.2 Subtidal sand'	8	29.3	8.2	12.0b^{c}	2.2	0.35^{cd}	0.14	1.99	0.23	0.848	0.043	8.46	1.44	0.67	0.01
'A5.3 Subtidal mud'	6	171.0	31.9	39.7^{b}	5.4	42.38^{bc}	35.97	2.76	0.20	0.875	0.028	17.18	2.73	0.74	0.01
'A5.4 Subtidal mixed sediments'	10	465.0	77.4	59.2a ^{c}	7.0	11.48^{ad}	2.20	2.75	0.20	0.839	0.046	18.22	3.02	0.74	0.02

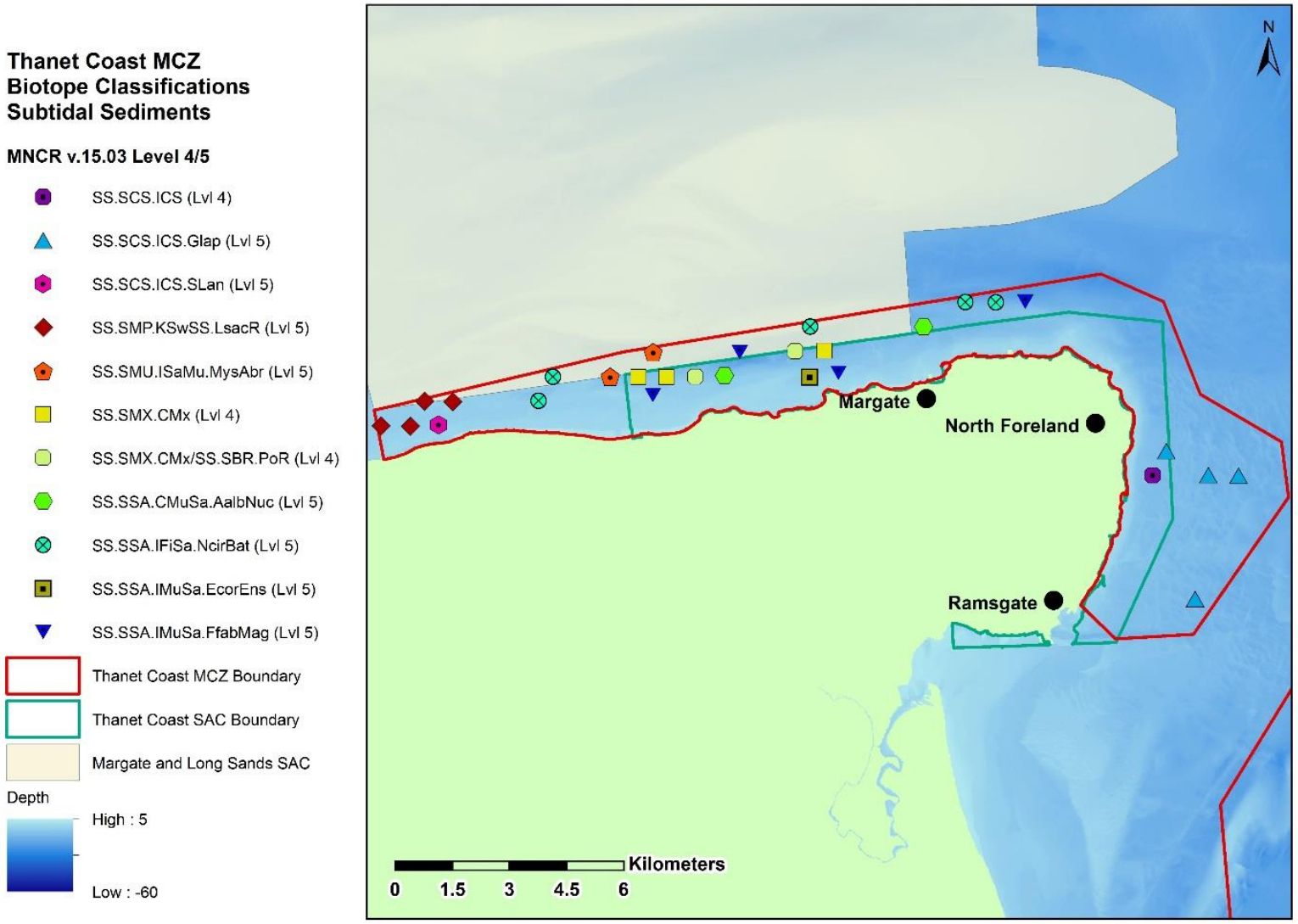


Figure 10. Distribution of subtidal sediment biotopes (JNCC, 2015) within the 2017-18 Thanet Coast MCZ (© Natural England and Environment Agency 2022).

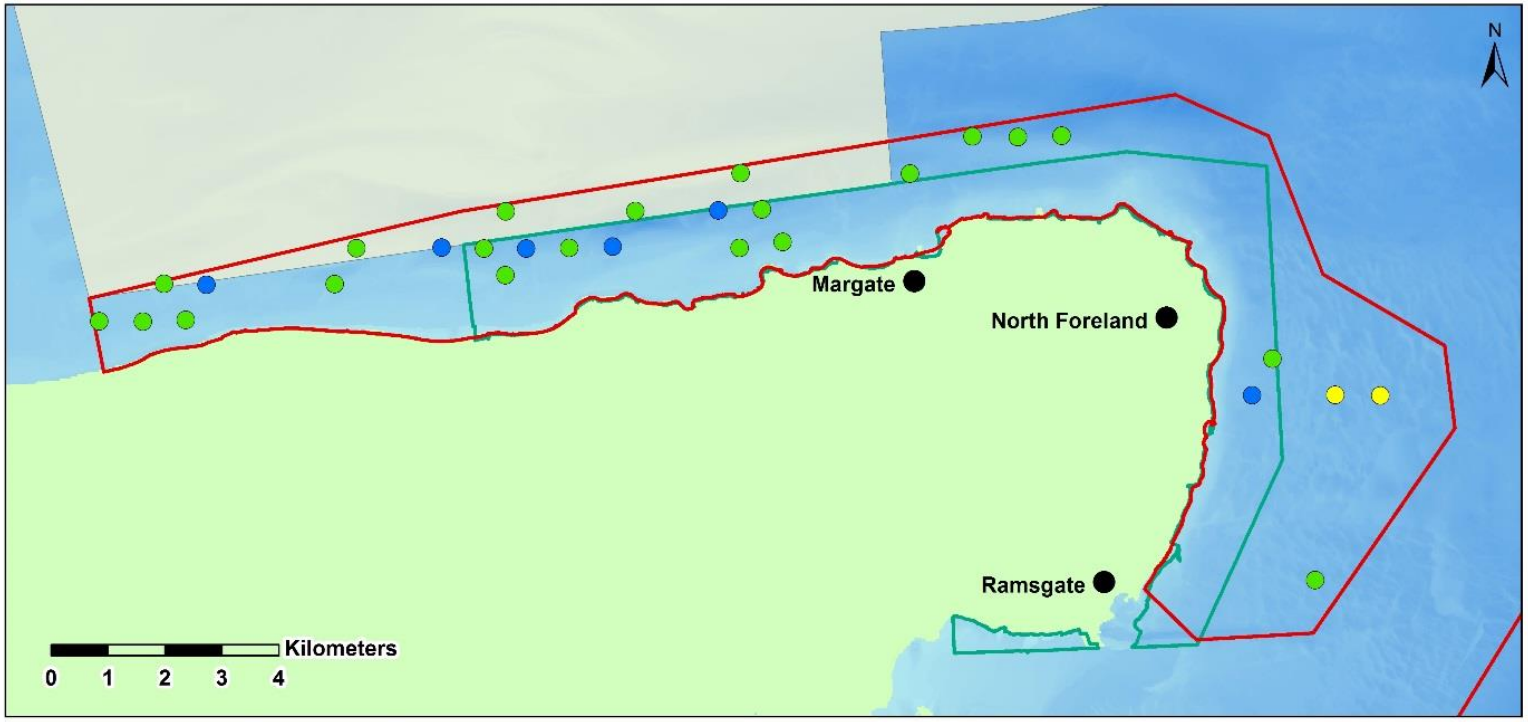


Figure 11. Ecological status of subtidal sediment samples collected from the 2017-18 Thanet Coast MCZ as derived by the Infaunal Quality Index (© Natural England and Environment Agency 2022).

3.3.3 ‘A5.1 Subtidal coarse sediment’

There was low within-group similarity (12%) in community composition for the five samples assigned to ‘A5.1 Subtidal coarse sediment’ BSH, as evidenced by the spread of points in the MDS plot and SIMPROF groupings (Figure 12, Table 6). The percentage of gravel in the PSA samples ranged from 5% (THNC94) to 60% (THNC27). The three greatest contributors to similarity were the polychaete *Glycera lapidum*, ribbonworms (Nemertea *sp*.) and the bivalve *Goodallia triangularis*.

Three biotopes were identified within the ‘A5.1 Subtidal coarse sediment’ habitat (Figure 13), all indicative of an area subject to frequent physical disturbance attributed to strong wave action and/or tidal stream (JNCC, 2015). Samples assigned to ‘*Glycera lapidum* in impoverished infralittoral mobile gravel and sand’ (SS.SCS.ICS.Glap, A5.135) and ‘Infralittoral coarse sediment’ (SS.SCS.ICS, A5.13) were all collected between Ramsgate and North Foreland. A single sample (THNC94) collected between Margate and North Foreland was assigned to the ‘*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand’ (SS.SSA.IFiSa.NcirBat, A5.233) biotope. The PSA results revealed 5% gravel in this sample.

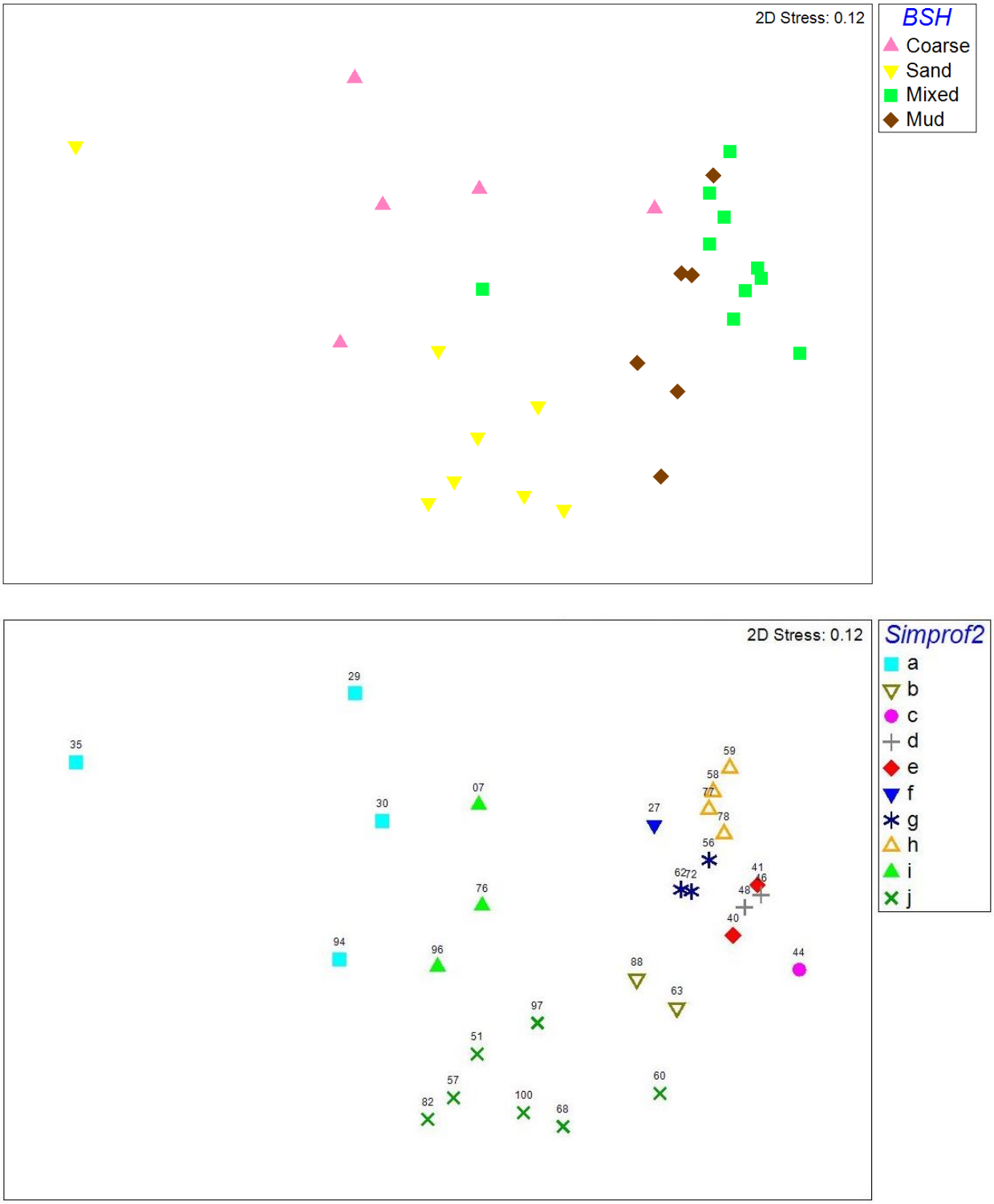


Figure 12. Non-metric Multidimensional Scaling (nMDS) plot of infaunal communities sampled in the 2017-18 Thanet Coast MCZ survey, grouped by assigned sediment Broadscale Habitats (top), and groupings of stations with significantly different community structure, derived from SIMPROF analysis (bottom) (© Natural England and Environment Agency 2022).

Table 6. The top three species that characterise each grouping defined by SIMPROF analysis, assessed using SIMPER analysis on untransformed abundance data from the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022). SIMPROF-defined groupings (c, f) composed of one sample are not listed.

Group 'a' (Coarse n = 3, Sand = 1)	
Species	**% Contribution to characterisation**
Glycera lapidum	24.85
Nemertea	23.47
Ophelia borealis	22.78
Group 'b' (Mud n = 2)	
Species	**% Contribution to characterisation**
Nucula nitidosa	52.17
Lovenella clausa	4.35
Sertularia distans	4.35
Group 'd' (Mixed n = 2)	
Species	**% Contribution to characterisation**
Molgula	23.86
Actiniaria	15.06
Ammothella longipes	10.80
Group 'e' (Mixed n = 2)	
Species	**% Contribution to characterisation**
Clymenella torquata	14.44
Achelia echinata	14.07
Actiniaria	11.85
Group 'g' (Mixed n = 1, Mud n = 2)	
Species	**% Contribution to characterisation**
Actiniaria	32.67
Anoplodactylus petiolatus	10.04
Notomastus	9.23
Group 'h' (Mixed n = 3, Mud n = 1)	
Species	**% Contribution to characterisation**
Spirobranchus lamarcki	40.21
Actiniaria	27.90
Mediomastus fragilis	6.96
Group 'i' (Mixed n = 1, Sand n = 1, Coarse = 1)	
Species	**% Contribution to characterisation**
Electra monostachys	33.33
Electra pilosa	33.33
Glycera tridactyla	11.56
Group 'j' (Sand n = 6, Mud n = 1)	
Species	**% Contribution to characterisation**
Magelona johnstoni	19.53
Bathyporeia elegans	15.34
Ensis	15.27

‘A5.1 Subtidal coarse sediment’
Infralittoral coarse sediment (SS.SCS.ICS) – THNC27 
***Glycera lapidum* in impoverished infralittoral mobile gravel and sand (SS.SCS.ICS.Glap) – THNC29** 
***Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSA.IFiSa.NcirBat) – THNC94** 

Figure 13. Example images of Mini-Hamon Grab samples associated with the ‘A5.1 Subtidal coarse sediment’ feature collected during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

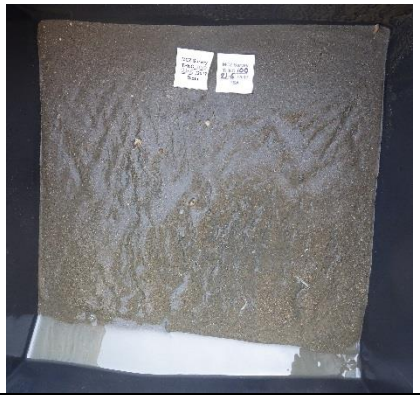
3.3.4 ‘A5.2 Subtidal sand’

The mean percentages of mud, sand and gravel content in the eight ‘A5.2 Subtidal sand’ samples were 4 %, 96 % and 0.4 % respectively. Mean within-group similarity for the BSH was again low (17%) with the greatest contributors being the amphipod species *Bathyporeia elegans*, and the polychaete worms *Magelona johnstoni* and *Nephtys cirrosa*. Mean taxa richness and biomass was the lowest of all four BSHs found within the site, supported by the associated univariate indices (Table 6).

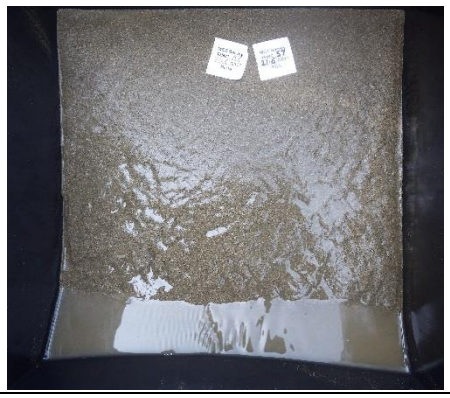
The biotope ‘*Glycera lapidum* in impoverished infralittoral mobile gravel and sand’ (SS.SCS.ICS.Glap, A5.135) (Figure 14) was assigned to one sample (THNC35), as evidenced by the MDS plot (Figure 12) where it appears as a solitary point spaced apart from the main grouping. The SS.SCS.ICS.Glap biotope was also present in the ‘A5.1 Subtidal coarse sediment’ BSH as was ‘*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand’ (SS.SSA.IFiSa.NcirBat, A5.233). Sandeels (Ammodytidae spp.) can be observed in association with this biotope, attracted by the actively swimming amphipods (JNCC, 2015) and a single *Ammodytes* sp. specimen was found in sample THNC57 during the survey. Three samples were collected along the north Kent coast from a third biotope, ‘*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’ (SS.SSA.IMuSa.FfabMag, A5.242). The presence of this biotope is indicative of a more stable physical environment (JNCC, 2015).

'A5.2 Subtidal sand'

***Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand (SS.SSA.IMuSa.FfabMag) – THNC100**



***Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSA.IFiSa.NcirBat) – THNC57**



***Glycera lapidum* in impoverished infralittoral mobile gravel and sand (SS.SCS.ICS.Glap) – THNC35**

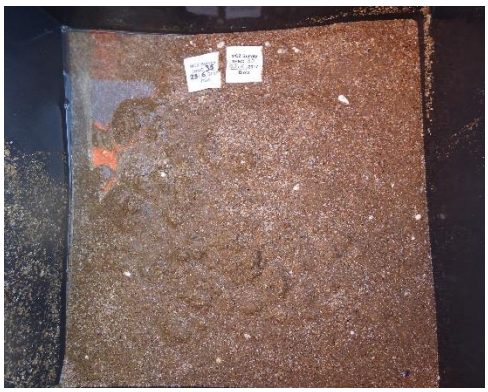


Figure 14. Example images of Mini-Hamon Grab samples associated with the 'A5.2 Subtidal sand' feature collected during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

3.3.5 ‘A5.3 Subtidal mud’ (not designated)

The percentage of mud found in each sample ranged from 20% to 37% and gravel from 0.2% to 4%. Four biotopes (one mud, one mixed and two sand) revealed distinct faunal community heterogeneity within the ‘A5.3 Subtidal mud’ BSH (Figure 15). This is supported by low mean similarity amongst the six samples (20%), with five taxa Actiniaria spp. (anemones), *Nucula nitidosa* (bivalve), *Notomastus* sp. (bristleworm), *Anoplodactylus petiolatus* (sea spider) and *Kurtiella bidentata* (bivalve) contributing 50% to the overall within-group similarity for this BSH. All the ‘A5.3 Subtidal mud’ samples were collected from an area of the MCZ along the north Kent coast between where the western boundary of the Thanet Coast SAC is situated and Margate (Figure 3).

'A5.3 Subtidal mud'

***Mysella bidentata* and *Abra* spp. in infralittoral sandy mud (SS.SMu.ISaMu.MysAbr) – THNC72**


Circalittoral mixed sediment (SS.SMX.CMx) – THNC58


***Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand (SS.SSA.IMuSa.EcorEns) – THNC60**


***Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSA.CMuSa.AalbNuc) – THNC63**


Figure 15. Example images of Mini-Hamon Grab samples associated with the 'A5.3 Subtidal mud' feature collected during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

3.3.6 ‘A5.4 Subtidal mixed sediments’

The ‘A5.4 Subtidal mixed sediments’ BSH was more diverse (taxa rich) and abundant (no. of individuals) than the other three subtidal sediment features (Table 6). As seen for the other three BSHs, mean similarity amongst the ten samples was low (22%) with the five greatest contributors being Actiniaria spp. (anemones), *Spirobranchus lamarcki* (tube-building worm), *Mediomastus fragilis* (polychaete worm), *Lanice conchilega* (Sand mason worm) and *Achelia echinata* (sea spider). Mean percentages for mud, sand and gravel fractions were 24%, 45% and 31% respectively but there was large variation within the group (mud 7% - 90%, sand 2% - 76%, gravel 7% - 71%) (Figure 16). The majority of samples were assigned to mixed sediment biotopes, with the exception of THNC76 which was classified as belonging to the sand biotope SS.SSA.IMuSa.FfabMag (A5.242). This sample was also spatially distinct from the main mixed sediment grouping in the MDS plot (Figure 12). Samples THNC59 and 77 were jointly assigned to ‘Circalittoral mixed sediment’ (SS.SMX.CMx, A5.44) and ’Polychaete worm reefs (on sublittoral sediment)’ (SS.SBR.PoR, A5.61) due to the presence of *Sabellaria spinulosa* individuals. The number of worms (n <100), however were insufficient to definitively assign the samples to the SS.SBR.PoR biotope. The two biotopes, ‘*Laminaria saccharina* and red seaweeds on infralittoral sediments’ (SS.SMP.KSwSS.LsacR, A5.521) and ‘Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand’ (SS.SCS.ICS.SLan, A5.137) were found in a small area at the western end of the MCZ near Herne Bay.

‘A5.4 Subtidal mixed sediments’	
Circalittoral mixed sediment (SS.SMX.CMx) – THNC78	
	
***Laminaria saccharina* and red seaweeds on infralittoral sediments (SS.SMP.KSwSS.LsacR) – THNC46**	
	
Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (SS.SCS.ICS.SLan) – THNC44	
	
***Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand (SS.SSA.IMuSa.FfabMag) – THNC76**	
	

Figure 16. Example images of Mini-Hamon Grab samples associated with the ‘A5.4 Subtidal mixed sediments’ feature collected during the 2017-18 Thanet Coast MCZ survey (© Environment Agency and Natural England 2017-18).

3.4 Habitat FOCI

Evidence indicating the presence of three designated Habitat FOCI, Subtidal Chalk, Blue Mussel Beds and Ross Worm (*Sabellaria spinulosa*) Reefs, was collected during the survey (Figures 17 to 19). The Peat and Clay Exposures feature was not observed.

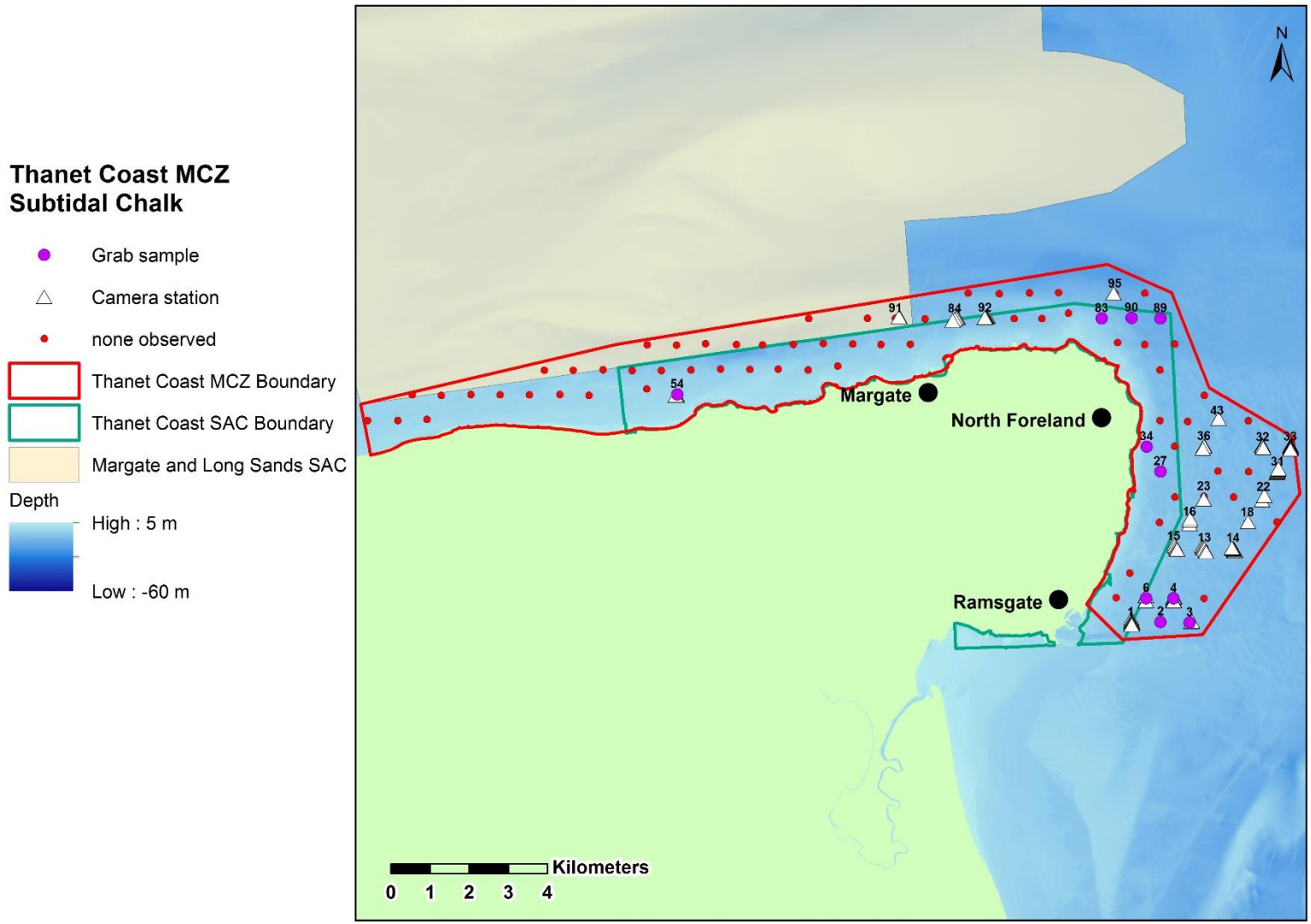


Figure 17. Subtidal chalk observations recorded during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022). A 0.1 m^2 Mini-Hamon Grab and Drop Camera with freshwater lens was used for sample collection.

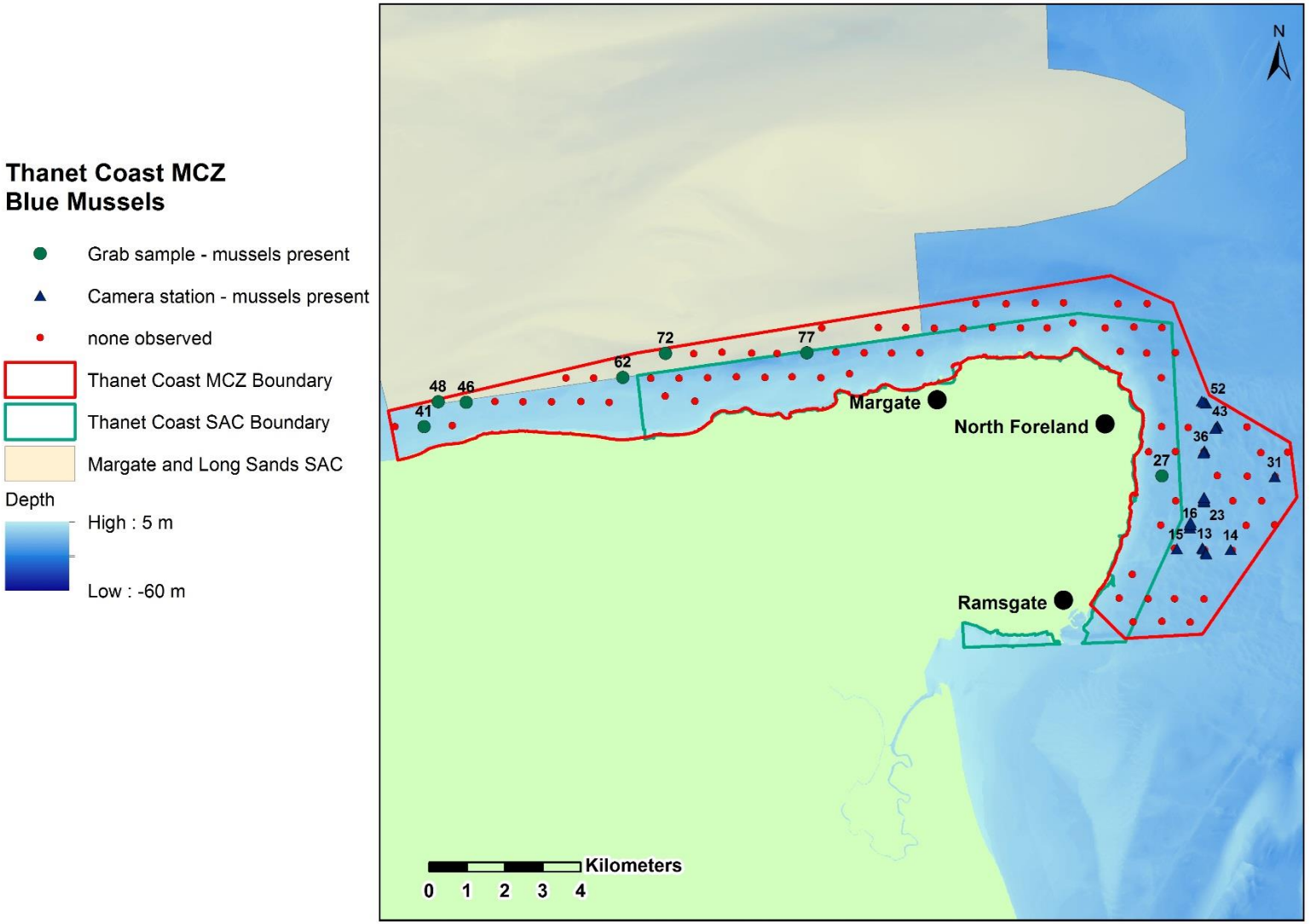


Figure 18. Blue mussel (*Mytilus edulis*) observations recorded during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022). A 0.1 m^2 Mini-Hamon Grab and Drop Camera with freshwater lens was used for sample collection.

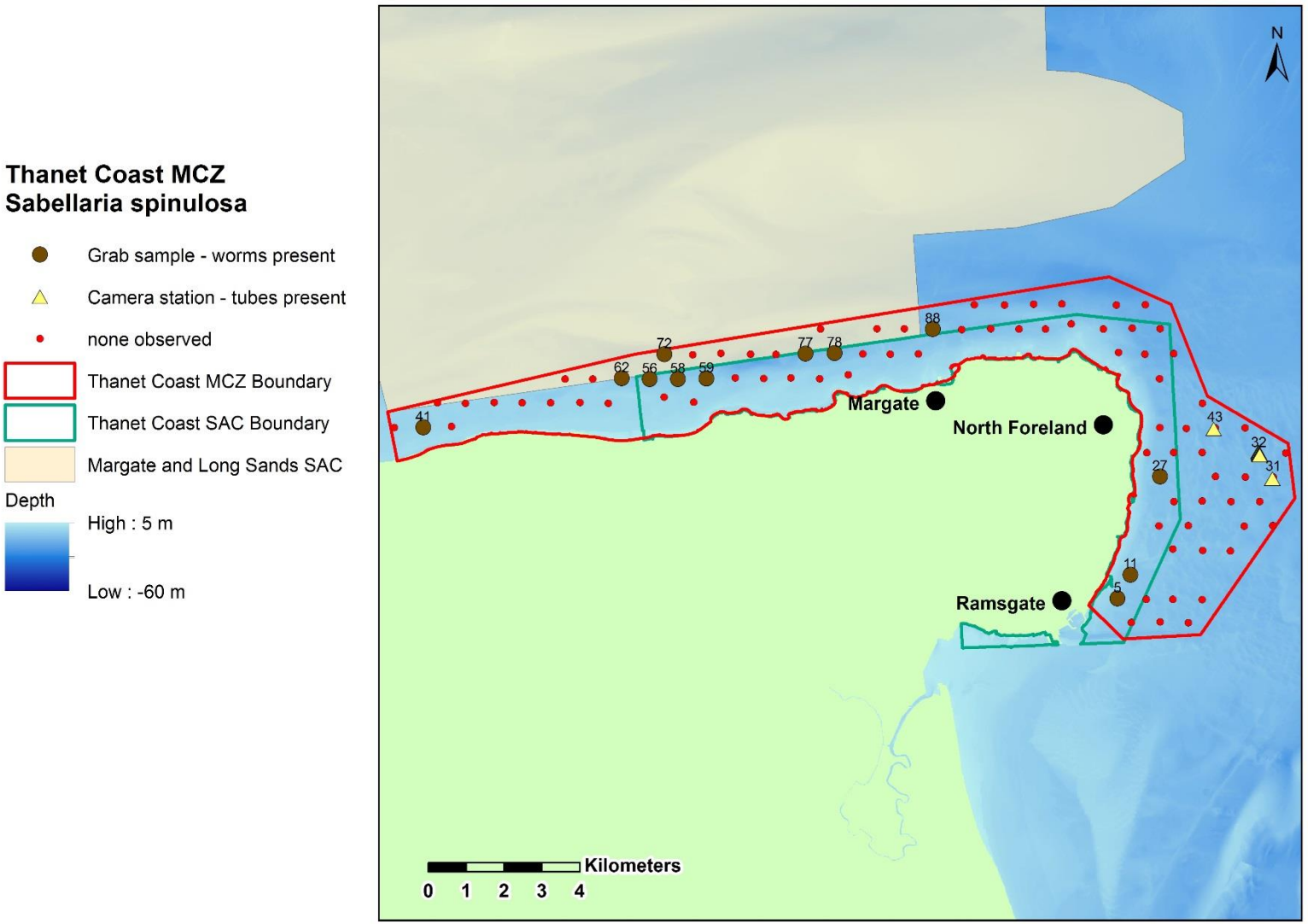


Figure 19. Ross Worm (*Sabellaria spinulosa*) observations recorded during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022). A 0.1 m^2 Mini-Hamon Grab and Drop Camera with freshwater lens was used for sample collection.

3.4.1 Subtidal chalk

Despite the moderate to extremely poor visibility, habitat indicative of the Subtidal Chalk FOCI was identified from video data captured at 21 stations (Figure 17). The chalk was described as predominantly bored cobbles and pebbles with underlying finer sediments. Very few chalk boulder and bedrock observations were recorded. At three stations (THNC01, 04 and 06) individual specimens belonging to the Pholadidae (piddock) family were observed in the video footage. The biotope 'Soft rock communities (CR.MCR.SfR, A4.23)' was assigned to all these stations and other sessile species (*Flustra foliacea* and *Alcyonium digitatum*), typically associated with this habitat (JNCC, 2015) were also identified.

Chalk was also observed at ten stations during the grab sampling phase of the survey (Figure 17), predominantly in the form of bored pebbles and cobbles. One live piddock (*Barnea parva*) was identified in the fauna sample collected from station THNC27 (Figure 20), located inshore just to the south of North Foreland. PSA assigned the sample to the BSH 'A5.1 Subtidal coarse sediment'.

Figure 20. Soft bored chalk cobbles and pebbles collected using a 0.1 m^2 Mini-Hamon Grab during the 2017-18 Thanet Coast MCZ survey (© Environment Agency and Natural England 2017-18).

3.4.2 Blue Mussel Beds

Blue Mussel (*Mytilus edulis*) individuals were found in seven infauna samples collected from stations spread across three BSHs ('A5.1 Subtidal coarse sediment', 'A5.3 Subtidal mud' and 'A5.4 Subtidal mixed sediments') within the MCZ (Figure 18). The maximum number found in a single mud sample (Figure 21) was 11, and all the mussels found were juveniles except for a single adult mussel. Live mussels were also observed in video footage captured at nine stations (Figure 22). Percentage cover in the videos (Field of View (FOV) 0.145 m^2) was estimated to range from 2.5% up to 70%.

THNC72

Figure 21. 'A5.3 Subtidal mud' 0.1 m^2 Mini-Hamon Grab sample containing Blue Mussels (*Mytilus edulis*) collected during the 2017-18 Thanet Coast MCZ survey. © Environment Agency and Natural England 2017-18

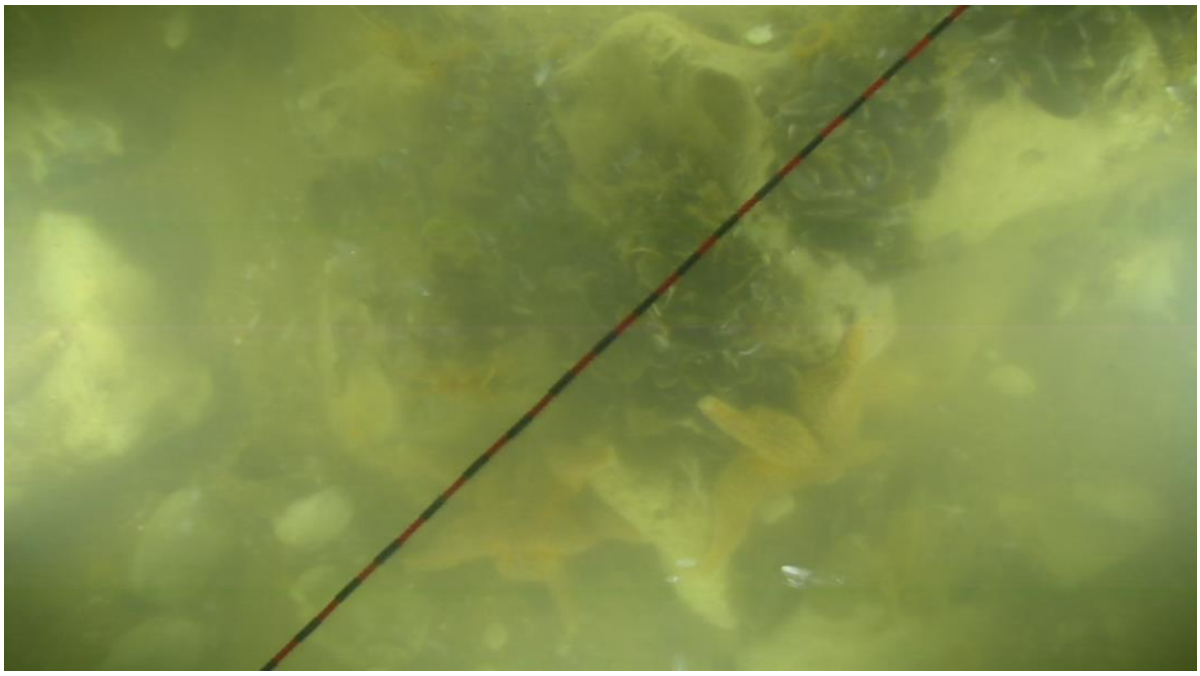


Figure 22. Blue Mussels attached to a chalk boulder being grazed by *Asterias rubens* in the 2017-18 Thanet Coast MCZ (station THNC16). Field of view scale graduations = 12 mm (© Environment Agency and Natural England 2017-18).

3.4.3 Ross worm (*Sabellaria spinulosa*) Reefs

Sabellaria spinulosa worms were identified at 12 stations in Mini-Hamon Grab samples assigned to 'A5.1 Subtidal coarse sediment', 'A5.3 Subtidal mud' and 'A5.4 Subtidal mixed sediments' (Figure 19). The maximum abundance in one grab sample was 40 worms, recorded at station THNC59 and assigned to the 'Circalittoral mixed sediment' (SS.SMX.CMx, A5.44)/'Polychaete worm reefs (on sublittoral sediment)'

(SS.SBR.PoR, A5.61) MNCR Level 4 biotopes (JNCC, 2015). The largest aggregations of tubes were recovered at stations THNC05 and 11 (Figure 23) during multiple and subsequently discarded Grab attempts. The tube aggregations were sent to the specialist laboratory for confirmation of species presence only, as they were not considered viable samples. *Sabellaria* sp. tubes with a percentage cover ranging from 2.5% to 15% (FOV 0.145 m^2) was also recorded at stations THNC31, 32 and 43 during the analysis of the DC data (Figure 19), however visibility for these images ranged from 'poor' to 'extremely poor', preventing a definitive identification.

Sabellaria spinulosa

THNC05

THNC11

Figure 23. Images of *Sabellaria spinulosa* tube aggregations present in Mini-Hamon Grab samples collected during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022).

3.4.4 Peat and Clay Exposures

Peat and clay exposures were not observed during the survey, however, this should not be interpreted as the feature is absent from the site.

3.5 Species FOCI

The survey reported here was not designed to specifically monitor (or identify the presence of) the designated the Stalked Jellyfish species FOCI, (*Calvadosia cruxmelitensis* and *Haliclystus* spp). As such, this should not be interpreted as an absence of these species from the site.

3.6 Non-indigenous species

All taxa identified in Mini-Hamon Grab samples collected in 2017-18 were cross-referenced with the list of non-indigenous species (NIS) compiled in Eno *et al*. (1997), the 49 non-indigenous target species which have been selected for assessment of GES in UK waters under MSFD D2 (Stebbing *et al*., 2014; Annex 5) and the WFD Technical Advisory Group impact list (WFD UK TAG, 2015). Six of the seven NIS found

appeared in these lists: a North Pacific sea spider species *Ammothea hilgendorfi*, an ostracod (*Eusarsiella zostericola*) commonly associated with imported oysters, the barnacle *Austrominius modestus*, the American razor clam species *Ensis leei,* the non-native Didemnidae sea squirt and the well-established slipper limpet *Crepidula fornicata*. One other NIS was found, the northwest Pacific Manila clam (*Ruditapes phillippinarum*).

Non-indigenous taxa were found in just over a third of the infauna samples (Figure 24), with the highest number of individuals (n = 29) recorded in a single grab at station THNC60. The majority were *Ensis leei* (n = 28) along with a single *Eusarsiella zostericola* specimen.

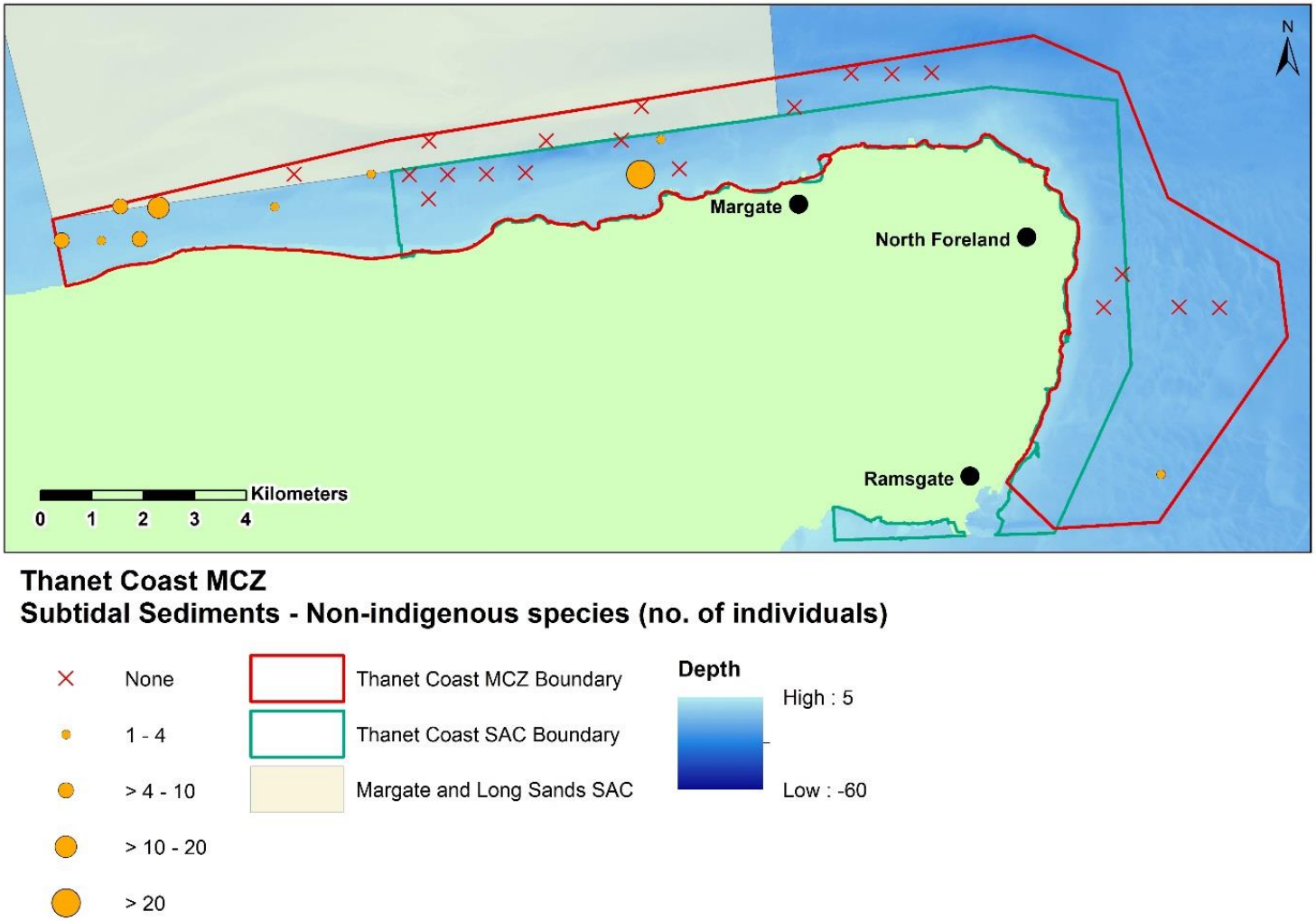


Figure 24. Non-indigenous species (no. of individuals) found in the 2017-18 Thanet Coast MCZ 0.1 m^2 Mini-Hamon Grab infauna samples (© Natural England and Environment Agency 2022).

3.6.1 Didemnidae

Material belonging to the Family Didemnidae was recorded in four infauna Mini-Hamon Grab samples (THNC40, 41, 46 and 48). All four samples were assigned to the same mixed sediment biotope '*Laminaria saccharina* and red seaweeds on infralittoral sediments' (SS.SMP.KSwSS.SlatR, A5.521), collected from a small area close to the western boundary of the MCZ. Subsequent DNA analysis of a tissue sample collected during the survey confirmed the presence of the invasive species *Didemnum vexillum* at station THNC48 (Figure 25). No other samples (water and tissue) generated a definitively positive result.

Figure 25. Image of the invasive non-indigenous species *Didemnum vexillum* taken during the 2017-18 Thanet Coast MCZ survey (© Environment Agency and Natural England 2017-18).

3.7 Supporting processes

Day Grab surface sediment scrapes were collected at four stations within the Thanet Coast MCZ; the analysis data providing a record of the most recent contaminant levels deposited in the sediment. Heavy metal contaminants were normalised to 5% aluminium and organic contaminants normalised to 2.5% carbon prior to comparing with OSPAR thresholds. Chromium levels exceeded the OSPAR Effects Range-Low (ERL) threshold at all four stations, however, the current ERL value is the same as the BAC. Levels of lead and zinc were also above the ERL at station THNC30, off North Foreland and Mercury at THNC41 near the western boundary of the site. Contaminant levels above the ERL may have adverse ecological effects. The only organic

contaminant to exceed the ERL threshold was the Polyaromatic Hydrocarbon (PAH) Benzo(ghi)perylene in samples collected from two stations (THNC58 and THNC77), both situated to the west of Margate. However, these exceedances should be treated with caution as the multiplication factors used for normalisation were large due to the samples containing little organic carbon. Tabulated contaminants results can be found in Annex 6.

Near seabed water column salinity was recorded alongside the sediment samples using a conductivity probe and ranged from 33.1 to 34.9, with a mean (± S.E.) of 33.9 ± 0.4.

3.8 Marine litter

Litter fragments larger than 1 mm found amongst the infauna in the Mini-Hamon Grab samples were counted and categorised according to the Guidance on Monitoring of Marine Litter in European Seas seafloor list for the North East Atlantic and Baltic (MSFD GES, 2013). Litter was present in 21 out of 29 samples (Figure 26), with 98.4 % of the fragments found split amongst five categories of plastic (Table 7). The largest number of fragments (38 plastic) was recorded at station THNC44, in Herne Bay at the western end of the site.

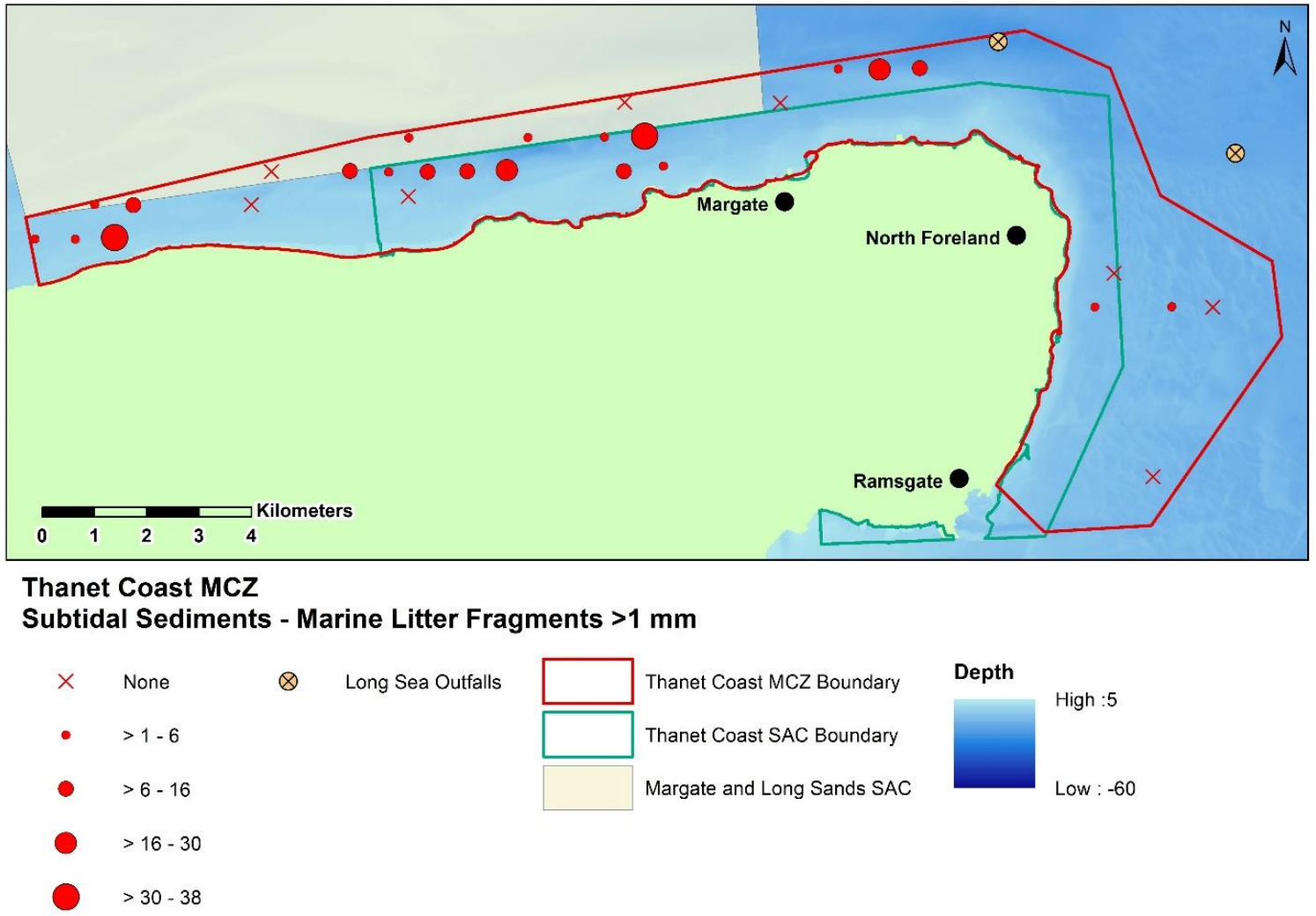


Figure 26. Marine litter fragments found in the 2017-18 Thanet Coast MCZ 0.1 m^2 Mini-Hamon Grab infauna samples (© Natural England and Environment Agency 2022).

Table 7. Marine litter fragments > 1mm found in the 2017-18 Thanet Coast MCZ 0.1 m^2 Mini-Hamon Grab infauna samples (© Natural England and Environment Agency 2022).

Anthropogenic litter category*	Number of infauna samples	Total number of fragments
Metals B.	1	1
Plastic A2. Sheet	3	7
Plastic A5. Fishing line (monofilament)	4	5
Plastic A7. Synthetic rope	9	29
Plastic A13. Sanitary towel/tampon	3	4
Plastic A14. Other	20	188

* Seafloor list for the North East Atlantic and Baltic (MSFD GES, 2013).

4 Discussion

This characterisation report provides the initial characterisation of designated features within the Thanet Coast MCZ from a grab and video sampling survey conducted within the site. This discussion presents evidence for future assessment and monitoring of designated features of the Thanet Coast MCZ, as required to achieve the report objectives stated in section 1.2.3.

Any statements or interim conclusions on feature condition or ecological status provided in this report are underpinned by the evidence collected, collated and analysed herein. Formal assessment of the condition status of designated features is carried out for this MCZ by NE using all available data, including the information presented in this report.

4.1 Benthic and environmental overview

No verification survey was undertaken at this site, so the results presented in this report are discussed with reference to historical SAC surveys (Davies, 1995, Tittley *et al*., 1998 and Sheehan *et al*., 2015) and the original Selection Assessment Document (SAD) (Balanced Seas, 2011). BSH feature extent is described within the limits of the data presented in this report, as further detailed mapping of the habitats was not undertaken.

4.2 Subtidal rock BSH

Time constraints resulting from unfavourable weather limited the DC survey to 35 stations. To make the best use of the time available, the part of the MCZ seaward of the SAC boundary was prioritised due to the lack of historical information from this area. Despite using the freshwater lens, the highly turbid conditions underwater meant that almost 20% of samples collected were of too poor quality for use in any further assessment. All 50 videos captured in the subtidal rock BSH were graded poor or less than poor quality. In accordance with NMBAQC guidelines (Turner *et al.*, 2016) no statistical analyses of the quantitative data were conducted. Similar challenges were reported in past SAC surveys (Davies *et al*., 1995 and Sheehan *et al*., 2015).

4.2.1 Extent and distribution

Subtidal rock was identified in video footage captured across the MCZ (Figure 4). The majority of videos collected (46 out of 50) were assigned to the **undesignated** ‘A4.1 High energy circalittoral rock’ BSH feature. Sheehan *et al*. (2015) also only identified the presence of ‘A4.1 High energy circalittoral rock’ (CR.HCR) biotopes during the Plymouth University Research Institute towed video survey in July 2013. The designated ‘A4.2 Moderate energy circalittoral rock’ BSH feature was identified at just three stations (four video samples) located off Ramsgate Harbour. Despite some subjectivity associated with assigning an energy regime (Parry, 2019), further

consideration should be given to the subtidal rock features (designated and undesignated) present in this MCZ for future monitoring.

4.2.2 Distribution and Structure: Biological communities

This section discusses evidence related to the Feature Attributes: i) Presence and spatial distribution of biological communities and ii) Species composition of component communities.

It is important to note that the freshwater lens camera system was not designed to be towed across the seabed, therefore biotopes have been assigned on discrete point data (small FOV) providing limited information on extent.

As in 2013 (Sheehan *et al*., 2015), very little macroalgae and no infralittoral rock biotopes were identified from the survey data, which suggests that even at the shallowest station (7.3 m) the high turbidity prevents the penetration of sufficient light to support photic communities. Indeed Tittley *et al.* (1998) identified the transition from infralittoral to circalittoral habitat as between two and three metres. However, the video survey reported here was carried out on the 18th of January 2018 and therefore will not provide a comprehensive record of any macroalgal species present due to seasonal dieback.

4.3 Subtidal sediment BSH

No verification data was gathered prior to designation. A Type-1 grid survey was designed to ensure stations were spaced as efficiently as possible to obtain the most comprehensive information on the distribution of BSHs across the whole MCZ given the sample effort. Historical acoustic, diving and towed video surveys (Davies, 1995, Tittley *et al.*, 1998 and Sheehan *et al.*, 2015) had focused on the Thanet Coast SAC and not included a sediment grabbing element.

4.3.1 Extent and distribution

The SAD (Balanced Seas, 2011) identified the presence of ‘A5.1 Subtidal coarse sediment’, ‘A5.2 Subtidal sand’ and ‘A5.4 Subtidal mixed sediments’ within the Thanet Coast MCZ. PSA results from the Thanet Coast MCZ survey confirmed that these three designated BSHs are still present and identified a fourth undesignated feature ‘A5.3 Subtidal mud’.

The sediment interspersed with circalittoral rock off the east coast was found to be predominantly a combination of coarse and sand BSHs instead of mixed sediments as presented in the SAD (Balanced Seas, 2011). Along the north coast there was more agreement between the findings of this survey and the SAD with ‘A5.4 Subtidal mixed sediments’ present along the whole stretch.

4.3.2 Distribution and Structure: Biological communities

As before, this section discusses evidence related to the Feature Attributes: i) Presence and spatial distribution of biological communities and ii) Species composition of component communities.

Coarse sediment samples (n = 4) assigned to the biotope '*Glycera lapidum* in impoverished infralittoral mobile gravel and sand' (SS.SCS.ICS.Glap, A5.135) were all collected off the east coast between Ramsgate and North Foreland (Figure 10). JNCC (2015) suggest that the SS.SCS.ICS.Glap is not a true biotope but rather a transitional community which only under more settled conditions would develop in to a more complex assemblage. Only four stations (out of 28) in this area yielded viable infauna samples which bolsters evidence that these are pockets of sediment overlaying and collecting between the circalittoral rock as supported by video imagery captured.

The MNCR v.15.03 classification (JNCC, 2015) was reduced from Level 5 to Level 4 for six infauna samples, as the taxa present when considered with the PSA data could not be definitively assigned to a single biotope. This largely affected the 'A5.4 Subtidal mixed sediments' BSH on the north coast (stations THNC56, 59, 77 and 78) where the community present was indicative of a transition area. The biotopes considered were: '*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment' (SS.SMX.CMx.MysThyMx, A5.443), '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (SS.SMX.CMx.FluHyd, A5.444) and '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (SS.SBR.PoR.SspiMx, A5.611). Coupled with this, PSA and community mismatches were observed in samples collected from all four sediment BSHs (Figures 13 to 16). For example, two biotopes '*Glycera lapidum* in impoverished infralittoral mobile gravel and sand' (SS.SCS.ICS.Glap, A5.135) and '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (SS.SSA.IFiSa.NcirBat, A5.233) were assigned to samples collected from both coarse and sand BSHs. This suggests that the sand and gravel present in these areas is continuously shifting. These difficulties with assigning biotopes indicate that the subtidal sediment environment within the Thanet Coast MCZ is highly dynamic, which will prove challenging for future monitoring strategies.

Two hundred and forty-nine *Lanice conchilega* (Sand mason worms) individuals were found in the sample collected from station THNC44 at the western end of the MCZ. It has been suggested that the presence of *L. conchilega* in high numbers provides stability to the sediment allowing a more complex community to develop and could be defined as an epibiotic biotope overlaying other infaunal biotopes such as SS.SSA.IFiSa.NcirBat, SS.SSA.IMuSa.FfabMag and SS.SSA.CMuSa.AalbNuc (JNCC, 2015).

At station THNC69 dense brittlestar beds were observed across the whole video transect (Figure 27). Grab sampling was attempted at this location, however an insufficient quantity of sediment was retrieved for PSA. Visual analysis of the video

footage indicated the possible presence of the brittlestar biotope '*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment' (SS.SMx.CMx.OphMx, A5.445), however definitive assignment would require supporting BSH information.

The lowest IQI scores (Moderate) were for two samples (THNC29 and THNC30) collected between Ramsgate and North Foreland (Figure 11) where the Marine Management Organisation (MMO) has reported up to 500 vessel transits per week (MMO, 2014). Whilst this indicates a correlation between pressure and ecological condition, there is insufficient data to state this with high confidence. Future surveys could undertake further sampling to investigate if there is a correlation between areas of intense shipping and the IQI.

Brittlestar bed – THNC69

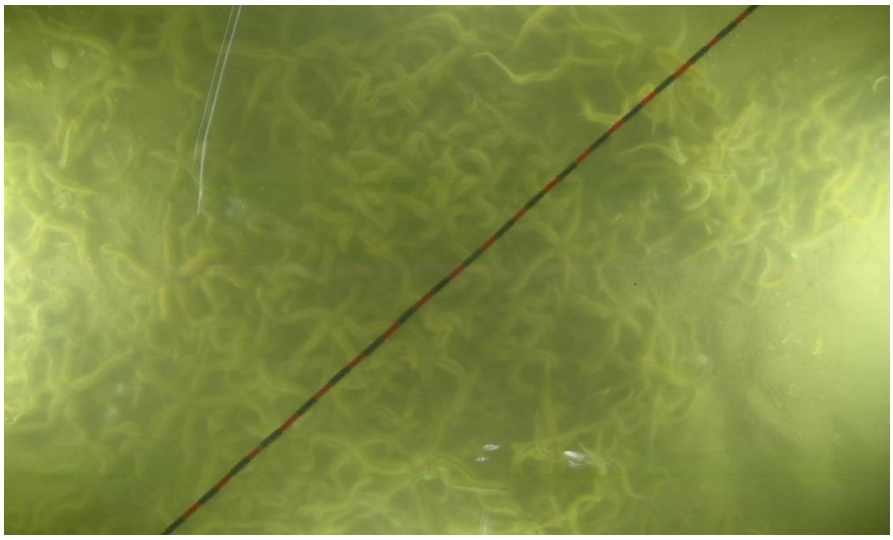


Figure 27. Image of a brittlestar bed present in the 2017-18 Thanet Coast MCZ. Field of view scale graduations = 12 mm (© Environment Agency and Natural England 2017-18).

4.4 Habitat FOCI

This section discusses each Habitat FOCI in turn with reference to the Feature Attributes set out in the reporting sub-objectives (Table 2).

4.4.1 Subtidal chalk

During the Thanet Coast MCZ survey multiple grabs at 25 of the 88 stations attempted yielded insufficient material for infauna or particle size analyses (<0.5 litre) (Figure 2). With one exception, all of these abandoned grab stations were located in the eastern half of the MCZ between Margate and Ramsgate. Samplers noted minimal sediment with chalk pebbles and cobbles (Figure 28). Historical subtidal chalk mapping for the SAC designation revealed that the subtidal chalk reef along the east coast extended out to approximately 1.5 km offshore (Davies, 1995). Three subtidal transects

(Whiteness, North Foreland and Dumpton Gap) were surveyed by divers within this area in 1997 (Tittley *et al*., 1998). The divers reported exposed chalk bedrock extending out from the shore to a maximum distance of 50 m; beyond that point, the soft piddock-bored chalk was covered by a mix of boulders, cobbles, pebbles and finer sediment interspersed with discrete low-lying chalk outcrops. Along the north coast, the chalk extended to approximately 500 m offshore where it then gradually disappeared beneath a layer of sediment (Davies, 1995). Beyond 1 km offshore, the seabed was predominantly sedimentary in nature. This matches with the findings from the present survey where all chalk observed (with a single exception) was located between Margate and Ramsgate in the eastern area of the MCZ (Figure 17).

Figure 28. Discarded Mini-Hamon Grab sample 2017-18 Thanet Coast MCZ (© Environment Agency and Natural England 2017-18).

The subtidal chalk within the Thanet Coast MCZ is 99% calcium carbonate (Fowler and Tittley, 1993). The purity makes it particularly soft (Fowler and Tittley, 1993) which has necessitated the installation of extensive erosion prevention measures to protect coastal urban developments (Figure 29). In 1993, Fowler and Tittley reported that between the year 1900 and 1986, of the 23 km of chalk coastline present in Thanet, 74% had been modified for this purpose. The friable and easily eroded nature of the chalk produces an unstable substratum for fauna and particularly larger algal species to colonise, as evidenced by the fact that only a single *Laminaria* sp. observation (5% cover) was recorded at station THNC91. Coupled with this, the exposed nature of the Thanet Coast, high turbidity and large variations in water temperature have resulted in species poor communities (JNCC, 2008). The chalk biotope 'Soft rock communities (CR.MCR.SfR, A4.23)' was assigned to four videos (out of a total of 50 across the whole survey) captured at stations THNC01 (n = 2), 04 and 06. Only four taxa were

identified: hydroids, Flustridae sp., *Asterias rubens* and *Pholas dactylus*. There were no Rhodophyta species present, however the seasonal timing of the survey (January 2018) meant that macroalgae is likely to be less frequently observed due to seasonal dieback. In 2013 Sheehan *et al.* (2015) did not identify the chalk biotope, however the locations surveyed varied slightly from those in the 2017-18 surveys (Figure 7). The dive surveys conducted in 1997 (Tittley *et al*., 1998) identified the seaward limit of the CR.MCR.SfR chalk biotope to be <500 m from the shore.

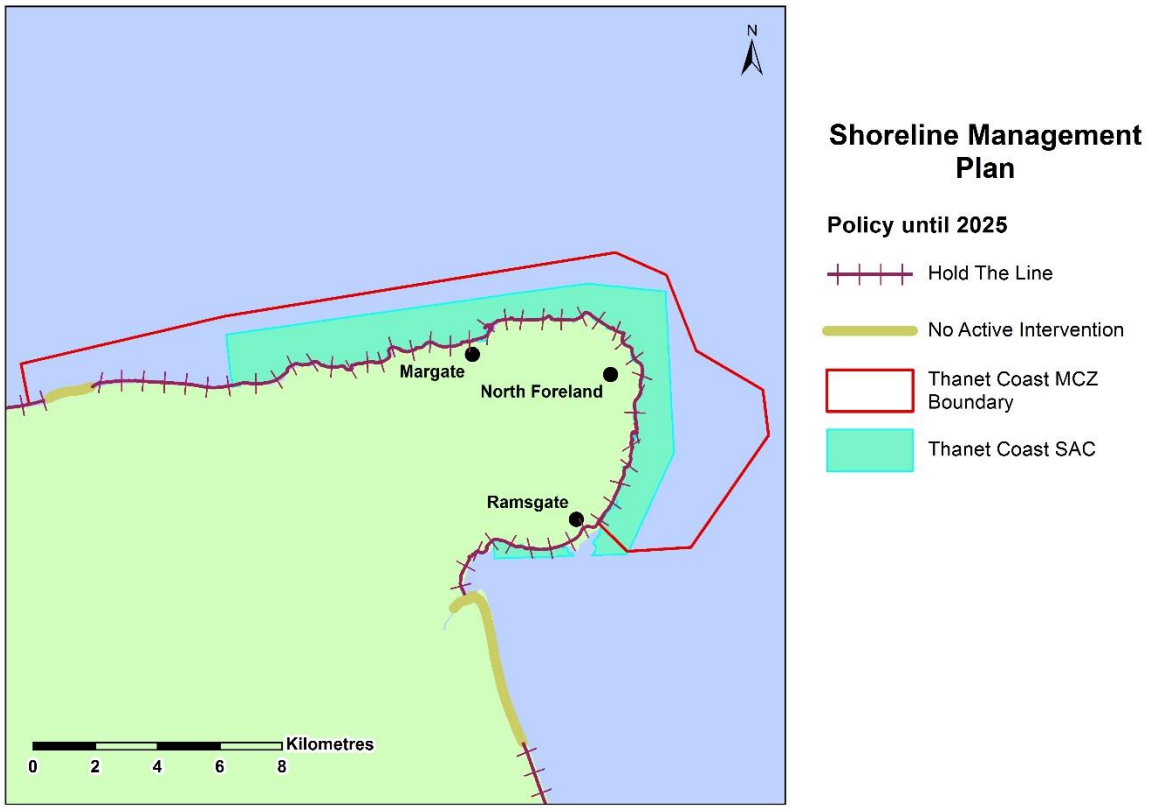


Figure 29. Thanet Coast shoreline management plan until 2025 (Environment Agency, 2015) (© Natural England and Environment Agency 2022).

4.4.2 Blue Mussel Beds

The SAD (Balanced Seas, 2011) estimated that the intertidal Thanet Coast Blue Mussel Beds cover an area of 0.01 km^2, however no information was provided to indicate the presence of subtidal beds within the proposed MCZ. The highest mean abundance (0.95 individuals per m^2) of *Mytilus edulis* reported by Sheehan *et al.* (2015) was found **outside** the MCZ boundary in an area due south of Ramsgate Harbour.

During the Thanet MCZ survey, 96.7% of all *Mytilus edulis* individuals in the subtidal Mini-Hamon Grab samples collected along the north coast of the MCZ were juveniles, with the exception of one adult found at station THNC77. However, more significant aggregations of live adult mussels were observed at nine Drop Camera stations off the east coast. Subtidal chalk was also present at all but one of these stations (THNC52 being the exception) providing evidence of a possible supporting habitat

function. The predatory starfish *Asterias rubens* (JNCC, 2008) was also identified at all nine stations, and in some videos observed actively feeding on the mussels. Individuals of the anemone *Urticina* sp., another commonly associated species with mussel beds (JNCC, 2008) was noted at three stations (THNC15, 16 and 23). Despite the poor visibility encountered, the data gathered from this survey does suggest *Mytilus edulis* beds are present within the subtidal area of the Thanet Coast MCZ.

4.4.3 Ross Worm (*Sabellaria spinulosa*) Reef

Sabellaria spinulosa is widespread around the UK, often forming spatially localised and temporary crusts or aggregations which are not considered true reefs (JNCC, 2008). The Thanet Coast SAC protects the Annex 1 biogenic reef features, which is largely an intertidal feature (Balanced Seas, 2011). The maximum number of *Sabellaria spinulosa* individuals found in a single sample (0.1 m^2) during this subtidal survey was 40 worms. This was significantly lower than at the nearby Dover to Deal MCZ where the average *Sabellaria spinulosa* abundance per grab assigned to reef biotopes was 406 compared to 12 in non-reef biotopes (Newton and Green, in prep.). No evidence of subtidal Ross Worm Reef presence (Gubbay, 2007) was collected during the survey, however as this was not a targeted study to detect the presence of *S. spinulosa* Annex I reef features, absence of reef should not be interpreted as absence from the site.

4.5 Species FOCI

The red macroalgae species *Chondrus crispus* was identified as present in grab samples collected from stations THNC41 and THNC48, very close to the western boundary of the MCZ. The samples were collected from the 'A5.4 Sublittoral mixed sediments' BSH and assigned to the biotope '*Laminaria saccharina* and red seaweeds on infralittoral sediments' (SS.SMP.KSwSS.LsacR, A5.521). *C. crispus* is acknowledged to be a preferred substratum for the Stalked Jellyfish *Calvadosia cruxmelitensis* (Tyler-Walters and Richards, 2017). *C. cruxmelitensis* is a sedentary organism and has never been reported attached to solid substratum (Tyler-Walters and Richards, 2017). It is therefore reasonable to conclude that any physical pressure resulting in a loss or change in habitat/substratum in this area of the MCZ could adversely impact the presence of this species FOCI (MarLIN, 2020).

4.6 Non-indigenous species

Over a 12-year OSPAR assessment period (2003–2014), 107 new NIS were recorded in the Greater North Sea (OSPAR, 2017a). The average number of new records per year was 8.92 (OSPAR, 2017a). The assessment concluded that longer term datasets are required and hence more sustained monitoring, to accurately determine whether the rate of introduction of new NIS is stable or changing (OSPAR, 2017a).

NIS were found in ten Mini-Hamon Grab samples collected during the Thanet Coast MCZ survey. Within each sediment BSH feature, abundance (total n = 71) was

distributed as follows: 1.5% in ‘A5.1 Subtidal coarse sediment’, 1.5% in ‘A5.2 Subtidal sand’, 42% in ‘A5.3 Subtidal mud’ and 55% in ‘A5.4 Subtidal mixed sediments’.

Crepidula fornicata, categorised as high impact on the WFD TAG list and selected for preventing the assessment of GES under the MSFD was present at five stations (THNC40, 41, 44, 46 and 48). All five stations were assigned to the ‘A5.4 Subtidal mixed sediments’ BSH. Abundance was one to six individuals per sample. For comparison, 113 individuals were found in a single sample collected during the Poole Rocks MCZ verification survey (Godsell, 2014). This species was also found in both neighbouring MCZs (The Swale Estuary MCZ and Dover to Deal MCZ) and is of particular concern due to its ability to smother Blue Mussel Beds, if present in high numbers.

4.6.1 Didemnidae

Didemnum vexillum is a highly invasive species well known for its rapid growth and consequent smothering risk (GBNNSS, 2011). It is very difficult to discern from similar native species through visual examination (GBNNSS, 2011) and thus has necessitated the development of DNA techniques to achieve positive identification. Following extensive eDNA sampling during the Thanet Coast MCZ survey, the presence of *D. vexillum* was confirmed at one station (THNC48). Two other samples (THNC46 and 54) produced signals in the real-time PCR assay but these were not replicated by subsequent conventional PCR and sequencing. These two samples were therefore considered ‘dubious positives’ (Cefas, 2018). Particle size results assigned all three of these samples to the ‘A5.4 Subtidal mixed sediments’ BSH. It therefore seems prudent to focus future eDNA sampling effort on this habitat.

4.7 Supporting processes

Sediment was collected from four stations for sediment contaminant analyses during the Thanet Coast MCZ survey. Particle size analysis assigned two samples to ‘A5.4 Subtidal mixed sediments’ (THNC41 and 77), one to ‘A5.1 Subtidal coarse sediment’ (THNC30) and the fourth to ‘A5.3 Subtidal mud’ (THNC58). THNC30 was the most metal contaminated sample, with three ERL exceedances for chromium, lead and zinc. The IQI for station THNC30 and the nearest station to it THNC29 was moderate suggesting there may be a link between the pressure and benthic community structure but this would require further investigation. At the other three stations, chromium also exceeded the OSPAR ERL threshold (which is the same as the BAC threshold of 81 mg kg^{-1}). Chromium is not one of the substances identified by OSPAR for ‘priority action’ but concentrations should continue to be monitored to observe future trends, and establish if it is accumulating within the site (OSPAR, 2014). At THNC41, the concentration of mercury (0.35 mg kg^{-1}) exceeded the ERL (0.15 mg kg^{-1}). Lead and mercury are both OSPAR priority heavy metals and the Kent North WFD Water Body is currently assessed to be ‘At Risk’ for mercury. Considering the Thanet Coast MCZ survey results in a wider context, the OSPAR Commission has reported that mean

concentrations of mercury and lead (2005 – 2015 data) in the Southern North Sea and English Channel OSPAR assessment regions (Regional Seas) are above the ERL (OSPAR, 2017b). Temporal trends of both substances show a decrease in the Southern North Sea Regional Sea and no statistically significant change in the English Channel Regional Sea (OSPAR 2017b).

The only organic contaminant to exceed the EAC (Environmental Assessment Criteria) threshold was the Polyaromatic Hydrocarbon (PAH) benzo(ghi)perylene at stations THNC58 and 77 (Annex 7). Despite this, the IQI at both stations was high (THNC58 = 0.769 and THNC77 = 0.899). The levels of PAHs at three stations (THNC41, 58 and 77) were predominantly found to be above the BAC but below the EAC and therefore unlikely to cause adverse effects in marine organisms. More generally, in the Southern North Sea and English Channel OSPAR Regional Seas, mean PAH concentrations in sediment are above the BAC but below the EAC (OSPAR, 2017c). In the English Channel the data collected between 1995 and 2015 showed that PAH concentrations are decreasing (OSPAR, 2017c).

With so many potential point and diffuse sources of anthropogenic contaminants in the local area, sediment concentrations should continue to be monitored within the site, particularly those above the OSPAR BAC threshold.

4.8 Marine litter

Trawl surveys conducted for OSPAR monitoring have revealed that litter is widespread on the seafloor across all areas assessed, with plastic the predominant material encountered (OSPAR, 2017d). The English Channel has higher amounts of litter and plastic when compared to other areas such as the northern Greater North Sea and Celtic Seas, likely due to larger anthropogenic inputs, rivers, prevailing winds and / or currents. (OSPAR, 2017d). The number of plastic fragments found within the Thanet Coast MCZ grab samples was generally low (0 to 38 items per grab) when compared to other recent surveys in the south east of England. One sample collected during the (neighbouring) Swale Estuary MCZ baseline survey had 252 fragments (Miller and Green, 2018), although it is difficult to put that number into a wider context. In contrast only single plastic fragments were discovered in samples collected from the Dover Deal MCZ (Newton and Green, 2016).

4.9 Structure: presence and abundance of key structural and influential species

Guidance is still being developed by NE on the selection of species that fall under this category. Species present in this study that could be considered under this attribute (based on their abundances, biomass and ecology), include:

Structural

- Despite the low numbers found during this survey, *Sabellaria spinulosa* and Blue mussels (*Mytilus edulis*) could be considered key structural species for assessing this attribute in the future.

Influential

- The Sand mason worm (*Lanice conchilega*), present in 45 % of the samples collected, with abundances up to 253 individuals per Mini-Hamon Grab sample. When present in high densities, this tube-building polychaete can stabilise mobile substratum to allow more complex biotopes to form (JNCC, 2015).

- Another tube-building polychaete (*Galathowenia oculata*) was present in 45 % of samples with a maximum abundance of 53 individuals in a single Mini-Hamon Grab.

- The bivalve *Abra alba* was present in 45 % of the samples, predominately in mixed sediments, and is a rapid-recruiting species that can quickly colonise after disturbances.

5 Recommendations for future monitoring

To fulfil **report objective 6**, various recommendations have been made in the following two sections for future Thanet Coast MCZ monitoring.

5.1 Operational and survey strategy recommendations

- The grab data from the 2017-18 survey provides important information such as locations of target habitats and variability of the biological communities which may be used for determining sampling effort and locations in the planning of future surveys in the Thanet Coast MCZ.
- With particle size analysis ground truthing data acquired from 63 stations across the site, a new bathymetric survey would enable a new habitat map to be generated. This should be considered a priority and would prove particularly useful for any future sediment grab survey planning. Interpretation of the multibeam echosounder backscatter data to assess the extent of the sediment BSHs may prove challenging however, given the dynamic nature of the subtidal environment within the Thanet Coast MCZ.
- No fishing activity has been observed in the area since 2014 (KEIFCA pers. comm.), however if activity was to increase this could present a viable incentive for an impact study in the future.
- The poor visibility and strong tidal streams along the Thanet Coast present a significant challenge when considering future monitoring strategies for the east coast subtidal rock and associated reef features. Underwater video surveys are a natural choice for examining features of this type, however the data generated will likely be of limited use. The Big Picture group 2019 action plan includes two tasks related to this: (1) to produce guidelines around minimum suitable conditions for acquisition on survey and (2) to develop ‘live’ methods for assessing image quality in the field. The outputs from these tasks will assist decision-making on a suitable survey approach for this site.
- As the visibility is reported to be generally poor in the area all year round. Diver surveys may be the most viable method for acquiring high resolution information on communities and species present for assigning biotopes and assessing attributes such as population and structure.
- The collection of viable grab samples for assessing the sediment BSHs during this survey proved challenging, particularly off the east Thanet Coast (as evidenced by the high number of discards). As historical surveys (Davies 1995 and Tittley *et al*., 1998) have indicated, divers can investigate if the sediment layer above the chalk bedrock is merely a veneer or of sufficient depth to support infaunal communities.
- Sub-bottom profiling is worthy of consideration as a safer alternative to divers for investigating the extent of the sediment-smothered chalk bedrock.

- Due to anticipated issues with visibility, remote sensing techniques such as sonar cameras or side scan sonar systems could be considered for examining subtidal rock features and certain Habitat FOCI such as Ross Worm (*Sabellaria spinulosa*) Reefs.
- The highly invasive non-native tunicate *Didemnum vexillum* was found at one station during this survey, located at the western end of the MCZ. The 'A5.4 Subtidal mixed sediments' grab sample was assigned the biotope '*Laminaria saccharina* and red seaweeds on infralittoral sediments' (SS.SMP.KSwSS.SlatR, A5.521). Sampling non-native species such as *D. vexillum* using traditional monitoring methods tends to be difficult and labour-intensive. The current MPA surveys conducted in English inshore waters have therefore not included NIS monitoring in the survey objectives (other than reporting on incidental records). Once the technique has been standardised, tested and validated, eDNA could offer a viable method for NIS monitoring alongside other monitoring activities on existing surveys. On the Thanet Coast MCZ characterisation 2017-18 survey, *D. vexillum* detection using eDNA produced inconclusive results (Cefas, 2018). Since this survey, further progress has been made in the development and validation of assays for *D. vexillum* detection in the UK, including as part of the collaborative Defra DNA Centre of Excellence project on "Development of a protocol for monitoring high-risk marine invasive species". Molecular methods are likely to become more sensitive, cost-effective and accessible in the near future and may soon provide an effective technique for marine NIS monitoring. Due to the confirmed presence and distribution of *D. vexillum* in the intertidal areas of the Thanet Coast MCZ, inclusion of this MCZ in future eDNA method testing and surveillance of marine NIS using eDNA is recommended.
- The movement and redistribution of plastic particles within the site is likely to be significantly affected by the strong tidal streams (Blumenröder *et al*., 2017); despite this, by using a standardised counting and recording protocol, continued marine litter monitoring could potentially provide data on the breakdown products of larger items already in the marine environment and generate evidence of the effectiveness of terrestrial waste handling in the area. Techniques to potentially identify the source of marine litter found in infauna samples are currently being researched, which may influence how this type of monitoring is planned in the future.
- In 1993 only two locations on the Thanet Coast were reported to have remained untouched by coastal protection works, these were Epple Bay (north coast) and Botany Bay (north east). Cliff falls provide an important supply of chalk boulders for subtidal chalk associated communities. Coastal protection works prevents this important supply (Fowler and Tittley, 1993). The effects of the coastal protection works on the subtidal chalk communities along the Thanet Coast remains largely unknown. With the proportion of unprotected coastline being

low (<25%), it is of particular importance that the effects of coastal protection on the subtidal chalk communities are fully understood in assessing the impacts of future coastal protection works.

- Undertake future monitoring to assess any subtidal *Sabellaria spinulosa* present against the full criteria needed for determining presence of Annex I reef features (Gubbay, 2007).
- A sample collected at station THNC30 and analysed for sediment contaminants revealed three ERL exceedances for chromium, lead and zinc. The IQI for station THNC30 and the nearest station to it (THNC29) was moderate, suggesting there may be a link between the pressure and benthic community structure. Given that THNC30 was also located off the west coast of the MCZ in an area exposed to more intense shipping activity (MMO, 2014) it would be prudent to incorporate sediment contaminant monitoring in to future survey plans.

5.2 Analysis and interpretation recommendations

- For video survey techniques, temporal comparisons between separate monitoring events will be challenging as biotope resolution and quantitative analyses are heavily dependent on video/digital still image quality. Sheehan *et al.* (2015) incorporated a number of indicator species in to their towed video study; this strategy may prove a more effective measure. An evaluation phase would be needed to assess if a subset of indicator species could fulfil report sub-objectives.
- Definitive biotope assignment for five grab samples (collected across all four sediment BSHs) was found to be challenging due to a mismatch between the physical habitat (determined from the PSA results) and communities present. Another issue encountered was the assignments of Level 5 MNCR biotopes, where the communities present indicated a transition between two or more biotopes. Despite the differences between the process of biotope assignment and SIMPROF analysis in PRIMER, the number of biotopes identified and number of SIMPROF groups were the same for three BSHs (‘A5.1 Subtidal coarse sediment’, ‘A5.2 Subtidal sand’ and ‘A5.3 Subtidal mud’). The method by which these two approaches complement each other and how they are applied to monitoring datasets in the future bears further investigation.

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Annex 1. Abbreviations

BAP	Biodiversity Action Plan
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
DC	Drop Camera
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
MNCR	Marine Nature Conservation Review
MPA	Marine Protected Area
MPAG	Marine Protected Areas Group
MSFD	Marine Strategy Framework Directive
NE	Natural England
NIS	Non-Indigenous Species
OSPAR	The Convention for the Protection of the Marine Environment of the North East Atlantic
PRIMER	Plymouth Routines in Multivariate Ecological Research
PSA	Particle Size Analysis
PSD	Particle Size Distribution
RV	Research Vessel
SAC	Special Area of Conservation
SNCB	Statutory Nature Conservation Body

SOCI	Species of Conservation Interest
SSS	Sidescan sonar

Annex 2. Glossary

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

Activity	A human action which may have an effect on the marine environment; e.g. fishing, energy production (Robinson, Rogers and Frid, 2008).*
Annex I Habitats	Habitats of conservation importance listed in Annex I of the EC Habitats Directive, for which Special Areas of Conservation (SAC) are designated.
Anthropogenic	Caused by humans or human activities; usually used in reference to environmental degradation.*
Assemblage	A collection of plants and/or animals characteristically associated with a particular environment that can be used as an indicator of that environment. The term has a neutral connotation, and does not imply any specific relationship between the component organisms, whereas terms such as 'community' imply interactions (Allaby, 2015).
Benthic	A description for animals, plants and habitats associated with the seabed. All plants and animals that live in, on or near the seabed are benthos (e.g. sponges, crabs, seagrass beds).*
Biotope	The physical habitat with its associated, distinctive biological communities. A biotope is the smallest unit of a habitat that can be delineated conveniently and is characterised by the community of plants and animals living there.*
Broadscale Habitats	Habitats which have been broadly categorised based on a shared set of ecological requirements, aligning with level 3 of the EUNIS habitat classification. Examples of Broadscale Habitats are protected across the MCZ network.
Community	A general term applied to any grouping of populations of different organisms found living together in a particular environment; essentially the biotic component of an ecosystem. The organisms interact and give the community a structure (Allaby, 2015).
Conservation Objective	A statement of the nature conservation aspirations for the feature(s) of interest within a site, and an assessment of those human pressures likely to affect the feature(s).*
EC Habitats	The EC Habitats Directive (Council Directive 92/43/EEC on the

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

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

Annex 3. Infauna data truncation

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

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

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

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

Annex 4. Marine litter categories

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

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

Related size categories

A: ≤ 5*5 cm = 25 cm^2

B: ≤ 10*10 cm = 100 cm^2

C: ≤ 20*20 cm = 400 cm^2

D: ≤ 50*50 cm = 2500 cm^2

E: ≤ 100*100 cm = 10000 cm^2

F: ≥ 100*100 cm = 10000 cm^2

Annex 5. Non-indigenous species lists

Table 8. Taxa listed as non-indigenous species (present and horizon) which have been selected for assessment of Good Environmental Status in the waters of Great Britain under MSFD Descriptor 2 (Stebbing *et al*., 2014).

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

Table 9. Additional taxa listed as non-indigenous species in the JNCC 'Non-native marine species in British waters: a review and directory' report by Eno *et al*. (1997) which have not been selected for assessment of Good Environmental Status in GB waters under MSFD.

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

Species name (1997)	Updated name (2017)
Rhithropanopeus harrissii	
Potamopyrgus antipodarum	
Tiostrea lutaria	*Tiostrea chilensis*
Mercenaria mercenaria	
Petricola pholadiformis	
Mya arenaria	

Table 10. Water Framework Directive UK Technical Advisory Group (WFD UK TAG) classification of alien species found in UK transitional and coastal waters in terms of their impact on native habitats and biota (WFD UK TAG, 2015).

Species	Classification
Spartina anglica	High
Eriocheir sinensis	High
Crepidula fornicata	High
Styela clava	High
Urosalpinx cinerea	High
Non-native Didemnidae spp.	High
Ficopomatus enigmaticus	High
Crassostrea gigas	Moderate
Potamopyrgus antipodarum	Moderate
Caprella mutica	Moderate
Pikea californica	Low
Sargassum muticum	Low
Corophium sextonae	Low
Clymenella torquata	Low
Marenzellaria viridis	Low
Tiostrea lutaria	Low
Aulacomya ater	Low
Mercenaria mercenaria	Low
Austrominius modestus	Low
Sterlet/Sturgeons - all species except *A. sturio*, which is protected on Schedule 5 of the Wildlife & Countryside Act	Unknown
Odontella sinensis (Diatom)	Unknown
Pleurosigma simonsensii (Diatom)	Unknown
Thalassiosira punctigera (Diatom)	Unknown
Thalassiosira tealata (Diatom)	Unknown
Coscinodiscus wailesii (Diatom)	Unknown
Asparagopsis armata (Red seaweed)	Unknown
Bonnemaisonia hamifera (Red seaweed)	Unknown
Grateloupia doryphora (Red seaweed)	Unknown
Grateloupia filicina var. luxurians (Red seaweed)	Unknown
Agardhiella subulata (Red seaweed)	Unknown
Solieria chordalis (Red seaweed)	Unknown
Antithamnionella spirographidis (Red seaweed)	Unknown

Species	Classification
Antithamnionella ternifolia (Red seaweed)	Unknown
Polysiphonia harveyi (Red seaweed)	Unknown
Undaria pinnatifida	Unknown
Codium fragile subspp. *atlanticum* & *tomentosoides*	Unknown
Petricola pholadiformis	Unknown
Mya arenaria	Unknown
Ensis leei (formerly *E. americanus, E. directus*)	Unknown
Colpomenia peregrina	Unknown
Mytilposis leucophaeta	Unknown
Balanus amphitrite	Unknown
Acartia tonsa	Unknown
Eusarsiella zostericola	Unknown
Rhithropanopeus harrisii	Unknown
Gonionemus vertens	Unknown
Haliplanella lineata	Unknown
Goniadella gracilis	Unknown
Clavopsella navis	Unknown
Hydroides ezoensis (Marine tubeworm)	Unknown
Hydroides dianthus (Marine tubeworm)	Unknown
Janua brasiliensis (Marine tubeworm)	Unknown
Pileolaria berkeleyana (Marine tubeworm)	Unknown
Ammothea hilgendorf	Unknown
Gracilaria vermiculophylla	Unknown
Mytilopsis leucophaeata	Unknown
Pinctada imbricata radiata	Unknown
Marsupenaeus japonicus	Unknown
Hemigrapsus sanguineus	Waiting
Hemigrapsus takanoi	Waiting
Homarus americanus	Waiting

Annex 6. Sediment Contaminants

Sediment contaminant results for the four stations sampled for contaminants analysis during the 2017-18 Thanet Coast MCZ survey (© Natural England and Environment Agency 2022). Heavy metal contaminants are normalised to 5% aluminium and organic contaminants are normalised to 2.5% carbon. No normalised values have been calculated for organic contaminants below the minimum reporting value (MRV). Aluminium, organic carbon and nitrogen are presented as non-normalised values. BAC = Background Assessment Concentrations, EAC = Environmental Assessment Criteria and ERL = Effects Range-Low OSPAR thresholds. Note some total organic carbon (TOC) results were below the Minimum Recordable Value of 0.1 % (MRV, i.e. the detection limit for the machine) therefore any normalised organic contaminants (PCBs, PAHs) using the <0.1 TOC value should be used with caution, and could be higher than the calculated normalised contaminant value. These results have red text.

Below MRV: Equivalent to blue, below Minimum Recordable Value of the machine.
Blue: Below BAC threshold, considered at background levels
Green: Above BAC, Below EAC/ERL threshold - elevated levels in the marine environment
Red: Above EAC/ERL threshold - at level considered harmful to some marine fauna

	Material (Dry Weight)	Units	MRV	Accreditation	OSPAR BAC	OSPAR EAC	OSPAR ERL	Station			
								THNC30	THNC41	THNC58	THNC77
Heavy metals (hydrofluoric acid digest)	**Mercury**	mg/kg	0.002	UKAS	**0.07**	-	**0.15**	0.07	0.35	0.08	0.08
	Aluminium, HF Digest	mg/kg	90	UKAS				50000.00	50000.00	50000.00	50000.00
	Iron, HF Digest	mg/kg	60	UKAS				111038.96	330396.48	40942.93	40740.74
	Arsenic, HF Digest	mg/kg	0.2	UKAS	**25**	-	**None**	147.08	216.08	23.08	37.91
	Cadmium, HF Digest	mg/kg	0.01	UKAS	**0.31**	-	**1.2**	0.66	0.42	0.22	0.17
	Chromium, HF Digest	mg/kg	3	UKAS	**81**	-	**81**	746.75	348.02	120.35	131.81
	Copper, HF Digest	mg/kg	0.4	UKAS	**27**	-	**34**	26.98	30.18	18.98	17.86
	Lead, HF Digest	mg/kg	0.2	UKAS	**38**	-	**47**	50.65	30.18	27.42	28.54
	Lithium, HF Digest	mg/kg	0.5	UKAS				83.77	38.77	44.67	44.55
	Manganese, HF Digest	mg/kg	2	UKAS				834.42	522.03	404.47	435.73
	Nickel, HF Digest	mg/kg	0.6	UKAS	**36**	-	**None**	418.83	262.11	40.69	52.83
	Zinc HF Digest	mg/kg	0.05	UKAS	**122**	-	**150**	180.19	127.53	83.00	97.06
Chloro-carbons	**Hexachlorobenzene**	ug/kg	0.1	None				< MRV	< MRV	< MRV	< MRV
	Hexachlorobutadiene	ug/kg	0.1	None				< MRV	< MRV	< MRV	< MRV

	Material (Dry Weight)	Units	MRV	Accreditation	OSPAR BAC	OSPAR EAC	OSPAR ERL	Station			
								THNC30	THNC41	THNC58	THNC77
Polyaromatic hydrocarbons (PAHs)	**Anthracene**	ug/kg	1	UKAS	**5**	**85**	**-**	< MRV	7.59	30.89	30.67
	Benzo(a)anthracene	ug/kg	1	UKAS	**16**	**261**	**-**	< MRV	34.35	120.64	98.08
	Benzo(a)pyrene	ug/kg	1	UKAS	**30**	**430**	**-**	< MRV	44.16	128.63	119.23
	Benzo(ghi)perylene	ug/kg	1	UKAS	**80**	**85**	**-**	< MRV	41.00	107.56	102.88
	Chrysene + Triphenylene	ug/kg	3	None	**20**	**384**	**-**	< MRV	44.22	137.35	111.54
	Fluoranthene	ug/kg	1	UKAS	**39**	**600**	**-**	< MRV	67.17	231.10	210.58
	Indeno(1,2,3-c,d)pyrene	ug/kg	1	UKAS	**103**	**240**	**-**	< MRV	32.01	83.58	83.17
	Naphthalene	ug/kg	5	UKAS	**8**	**160**	**-**	< MRV	< MRV	39.53	< MRV
	Phenanthrene	ug/kg	5	UKAS	**32**	**240**	**-**	< MRV	43.05	172.24	165.38
	Pyrene	ug/kg	1	UKAS	**24**	**665**	**-**	< MRV	61.92	232.56	191.35
Polybrominated diphenyl ethers (PBDEs)	**2,2,4,4,5,5-Hexabromodiphenyl ether - {PBDE 153}**	ug/kg	0.02	None				0.023	< MRV	< MRV	0.025
	2,2,4,4,5,6-Hexabromodiphenyl ether - {PBDE 154}	ug/kg	0.02	None				0.024	< MRV	< MRV	0.024
	2,2,4,4,5-Pentabromodiphenyl ether - {PBDE 99}	ug/kg	0.05	None				< MRV	< MRV	< MRV	< MRV
	2,2,4,4,6-Pentabromodiphenyl ether - {PBDE 100}	ug/kg	0.02	None				0.025	< MRV	< MRV	0.023
	2,2,4,4-Tetrabromodiphenyl ether - {PBDE 47}	ug/kg	0.07	None				< MRV	< MRV	< MRV	< MRV
	2,4,4-Tribromodiphenyl ether - {PBDE 28}	ug/kg	0.02	None				< MRV	< MRV	< MRV	< MRV
Polychlorinated biphenyls (PCBs)	**PCB - 028**	ug/kg	0.1	UKAS	**0.22**	**1.7**	**-**	< MRV	< MRV	< MRV	< MRV
	PCB - 052	ug/kg	0.1	UKAS	**0.12**	**2.7**	**-**	< MRV	< MRV	< MRV	< MRV
	PCB - 101	ug/kg	0.1	UKAS	**0.14**	**3**	**-**	< MRV	< MRV	< MRV	< MRV
	PCB - 118	ug/kg	0.1	UKAS	**0.17**	**0.6**	**-**	< MRV	< MRV	< MRV	< MRV
	PCB - 138	ug/kg	0.1	UKAS	**0.15**	**7.9**	**-**	< MRV	< MRV	< MRV	< MRV
	PCB - 153	ug/kg	0.1	UKAS	**0.19**	**40**	**-**	< MRV	< MRV	< MRV	< MRV
	PCB - 180	ug/kg	0.1	UKAS	**0.1**	**12**	**-**	< MRV	< MRV	< MRV	< MRV
	Tributyl Tin as Cation	ug/kg	1	UKAS				< MRV	< MRV	< MRV	< MRV
	Nitrogen as N	mg/kg	200	UKAS	-	-	-	436	1090	1040	501
	Carbon, Organic as C	%	0.1	UKAS	-	-	-	0.1	0.428	0.344	0.26

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