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Bassurelle Sandbank SAC Monitoring Report 2017

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Please Note:

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Since 2010, offshore MPA surveys and associated reporting have been delivered by JNCC and Cefas through a JNCC\Cefas Partnership Agreement (which remained the vehicle for delivering the offshore survey work funded by MPAG between 2012 and 2020).

Contents

Abbreviations

ANOSIM	Analysis of Similarities
ANOVA	Analysis of Variance
BSH	Broadscale Habitats
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CP2	Charting Progress 2
CHP	Civil Hydrography Programme
CV	Coefficient of Variation
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
EA	Environment Agency
EUNIS	European Nature Information System
FOCI	Feature of Conservation Interest
GAM	Generalised Additive Models
GES	Good Environmental Status
GMA	General Management Approach
IFCA	Inshore Fisheries and Conservation Authority
JNCC	Joint Nature Conservation Committee
MBES	Multibeam Echosounder
MCZ	Marine Conservation Zone
MESH	Mapping European Seabed Habitats
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPAG	Marine Protected Areas Group
MSFD	Marine Strategy Framework Directive
MSL	Mean Sea Level
NE	Natural England
NIS	Non-Indigenous Species
NMBAQC	North-East Atlantic Marine Biological Analytical Quality Control Scheme
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OSU	Oregon State University
PRIMER	Plymouth Routines in Multivariate Ecological Research
PSA	Particle Size Analysis
PSD	Particle Size Distribution
RSP	Relative Slope Position

RV	Research Vessel
SAC	Special Area of Conservation
SACO	Supplementary Advice on Conservation Objectives
SAGA	System for Automated Geoscientific Analyses
SIMPER	Similarity Percentage Analysis
SIMPROF	Similarity Profile Analysis
SNCB	Statutory Nature Conservation Body
SOCI	Species of Conservation Interest
SSS	Sidescan Sonar
STR	Subsea Technology and Rentals
VMS	Vessel Monitoring System
WoRMS	Word Register of Marine Species

Glossary

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

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

Favourable Condition	When the ecological condition of a species or habitat is in line with the conservation objectives for that feature. The term ‘favourable’ encompasses a range of ecological conditions depending on the objectives for individual features.*
Feature	A species, habitat, geological or geomorphological entity for which an MPA is identified and managed.*
Feature Attributes	Ecological characteristics defined for each feature within site-specific Supplementary Advice on Conservation Objectives (SACO). Feature Attributes are monitored to determine whether condition is favourable.
Features of Conservation Importance (FOCI)	Habitats and species that are rare, threatened or declining in Secretary of State waters.*
General Management Approach (GMA)	The management approach required to achieve favourable condition at the site level; either maintain in, or recover to favourable condition.
Habitats of Conservation Importance (HOCI)	Habitats that are rare, threatened, or declining in Secretary of State waters.*
Impact	The consequence of pressures (e.g. habitat degradation) where a change occurs that is different to that expected under natural conditions (Robinson *et al.* 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 *et al.* 2008).*
Sentinel (Type 1)	This type of monitoring provides the context to distinguish monitoring directional trends from short-scale variability in space and time by representing variability across space at any one time and documenting changes over time. To achieve this objective efficiently, a long-term commitment to regular and consistent data collection is necessary; this means time-series must be established as their power in identifying trends is far superior to any combination of independent studies.
Special Areas of Conservation (SAC)	Protected sites designated under the European Habitats Directive for species and habitats of European importance, as listed in Annex I and II of the Directive.*
Species of Conservation Importance (SOCI)	Habitats and species that are rare, threatened or declining in Secretary of State waters.*
Supplementary Advice on Conservation Objectives (SACO)	Site-specific advice providing more detailed information on the ecological characteristics or ‘attributes’ of the site’s designated feature(s). This advice is issued by Natural England and/or JNCC.

Executive Summary

Bassurelle Sandbank Special Area of Conservation (SAC) is a Marine Protected Area (MPA) located in the Dover Strait, 30km south of the Dungeness peninsula within the 'Eastern English Channel' Charting Progress 2 (CP2) sea area. The site was designated to protect the Annex I Habitat 'Sandbanks which are slightly covered by seawater all the time'. This monitoring report is informed by data acquired during the first Sentinel (Type 1) monitoring survey carried out at the Bassurelle Sandbank SAC in 2017 and will form part of the ongoing time series data for this MPA. The report describes the extent and distribution of the topographical sandbank and supporting habitat and determines the structural and functional attributes of this feature. It also compares sediment composition and biological assemblages to observations made during the habitat verification survey in 2013.

Sediment data acquired in 2017 (and bathymetry data acquired in 2014) reaffirm a previous conclusion that the Annex I Sandbank feature extends to the boundary of the SAC. Two EUNIS Level 3 Habitats associated with the feature, 'A5.2 Sublittoral sand' and 'A5.1 Sublittoral coarse sediment', supported distinct benthic assemblages. A combination of benthic grab and beam trawl samples showed that communities associated with the former habitat belong to the biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand'. Communities associated with the latter habitat could not be matched to an existing biotope but were characterised by the sea urchins *Psammechinus miliaris* and *Echinocyamus pusillus*, the scallop *Aequipecten opercularis* and diverse polychaetes. More subtle variation in communities was observed in relation to sandbank topography, while small-scale (within-station; <50m) spatial variability was minor.

Analysis of temporal change within the SAC revealed that sediment composition has largely remained stable over time. Some changes to infaunal community composition were observed, but these changes were subtle and the abundances of most key taxa either remained stable or increased between 2013 and 2017. This was also reflected in the total abundance and diversity of infauna, which increased somewhat in 'A5.2 Sublittoral sand' and remained stable in 'A5.1 Sublittoral coarse sediment'. One key species, the sea potato *Echinocardium cordatum*, did however decline in numbers over time.

To achieve monitoring objectives, future surveys of Bassurelle Sandbank SAC should continue to monitor large-scale topography, sediment composition and associated biological assemblages throughout the site. The collection of individual grab samples from many stations would appear to be suitable for assessing broad spatio-temporal variation in assemblages and biotopes. However, if future surveys aim to detect subtle changes to community composition and diversity, then replicate samples should continue to be collected at a fixed set of stations that are representative of the habitats present. Grab and beam trawl samples provided complimentary information and should continue to be used in tandem. Further operational and analytical recommendations for future monitoring within the Bassurelle Sandbank SAC (and comparable sites) are provided.

1. Introduction

The Bassurelle Sandbank Special Area of Conservation (SAC) was originally designated to meet conservation objectives under the European Commission (EC) Habitats Directive (92/43/EEC) and is part of an ecologically coherent network of Marine Protected Areas (MPAs) within UK waters, also contributing to the OSPAR network of MPAs across the North-East Atlantic.

The Bassurelle Sandbank SAC is designated to protect the Annex I Habitat feature 'Sandbanks which are slightly covered by seawater all the time'. This monitoring report primarily explores data acquired from the first dedicated Sentinel (Type 1) monitoring survey of the Bassurelle Sandbank SAC. The data collected will form a) the first point in an epifaunal time series, and b) the second point in sediment and infaunal time series.

The specific aims of the report are discussed in detail in section 1.4.3.

1.1 Feature description

As stated in the Interpretation Manual of European Union Habitats (EC 2013), which provides standard descriptions for Annex I habitats:

'Sandbanks are elevated, elongated, rounded or irregular topographical features, permanently submerged and predominantly surrounded by deeper water. They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including mud may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata. "Slightly covered by sea water all the time" means that above a sandbank the water depth is seldom more than 20m below chart datum. Sandbanks can, however, extend beneath 20m below chart datum. It can, therefore, be appropriate to include in designations such areas where they are part of the feature and host its biological assemblages.'

Annex I Sandbank features are composed of several finer scale habitats. These include (but are not limited to) 'A5.2 Sublittoral sand', 'A5.1 Sublittoral coarse sediment' and 'A5.4 Sublittoral mixed sediments', as per the EUNIS classification[1]. Sublittoral sand is the dominant habitat type within the Annex I Sandbanks feature, comprised of clean medium to fine sands or non-cohesive slightly muddy sands. Sublittoral coarse sediment is a combination of sand and gravel through to pure gravel. Coarse sediments are often unstable due to tidal currents and/or wave action. Sublittoral mixed sediments are composed of a range of different sediment types, from muddy gravelly sands to mosaics of cobbles and pebbles embedded in or lying on sand, gravel or mud. Mosaic habitats also include seabed where waves or ribbons of sand form on the surface of a gravel bed (Parry 2019).

1.2 Site overview

The Bassurelle Sandbank SAC is located in the Dover Strait, 30km south of the Dungeness peninsula. It is in the jurisdictional area of the Marine Management Organisation (MMO) and falls within the wider 'Charting Progress 2' (CP2) area 'Eastern English Channel'. The site is adjacent to the Ridens et dunes hydrauliques du Detroit du Pas de Calais SAC[2] in French

[1] http://eunis.eea.europa.eu/habitats-code-browser.jsp [accessed 17/05/20]
[2] https://eunis.eea.europa.eu/sites/FR3102004 [accessed 17/05/20]

waters and is neighboured by Offshore Overfalls Marine Conservation Zone (MCZ) and Offshore Brighton MCZ in UK waters (Figure 1).

The sole designated feature within the Bassurelle Sandbank SAC is the Annex I Habitat 'Sandbanks which are slightly covered by seawater all the time'. The feature is considered to include the bank, flanks and trough within the site. Bassurelle Sandbank is a linear, open shelf ridge sandbank that straddles the boundary between UK and French waters. The part of the sandbank within UK waters extends for about 15km in a north-east to south-west direction to the UK-France median line and is approximately 2.5km at its widest point.

Bassurelle Sandbank is comprised of a mixture of sand and gravelly sand, with shell and gravel visible at the surface. Although the surrounding seabed is also predominantly sandy, the sandbank is distinct due to the thickness of the sediment (up to 25m thick) and its elevation above the surrounding area. Within the SAC, water depth ranges from 8 to 44 metres below Mean Sea Level (chart datum). The surface tidal currents along the bank are weak to moderately strong (peak spring surface current velocity of $0.7ms^{-1}$) and run in the direction of the sandbank.

Surveys during 2005-06, within what is now the Bassurelle Sandbank SAC, revealed areas of fine sand with an infaunal assemblage dominated by polychaete worms, such as *Lagis koreni* and *Spiophanes bombyx*, and the bivalves *Moerella pygmaea* (Little Tellin) and *Ensis* spp. (Razor Shell) (James *et al.* 2007). The sediment was slightly gravellier and shellier in other areas of the sandbank and on the margin of the wider sandwave field, with the coarser sediment often collecting in the troughs between sandwaves. A slightly different assemblage of infaunal polychaetes dominated these areas.

The same surveys found an epifaunal community within the SAC that is typical of a sand and gravelly sand habitat. On the bank itself, the hermit crab *Pagurus bernhardus* was observed, along with the brittlestar *Ophiura* spp. and the hydroid *Hydrallmania falcata*, the latter of which lives attached to shell and gravel fragments. The Sand Eel (*Ammodytes tobianus*) and Weever Fish (Trachinidae) have been observed on the sandbank, although they were absent from the sandy areas surrounding the bank. The region is a nursery ground for Lemon Sole (*Microstomus kitt*), Mackerel (*Scomber scombrus*) and Sand Eel, and is a spawning area for Cod (*Gadus morhua*), Lemon Sole, Dover Sole (*Solea solea*), European Plaice (*Pleuronectes platessa*), Sand Eel and Sprat (*Sprattus sprattus*) (Coull *et al.* 1998; Ellis *et al.* 2010a; Ellis *et al.* 2010b; Ellis *et al.* 2012).

Following review of the faunal assemblages observed at the site in 2013, the JNCC have defined the extent of the Annex I feature "Sandbanks which are slightly covered by seawater all the time" as extending to the boundary of the Bassurelle Sandbank SAC (Duncan 2016).

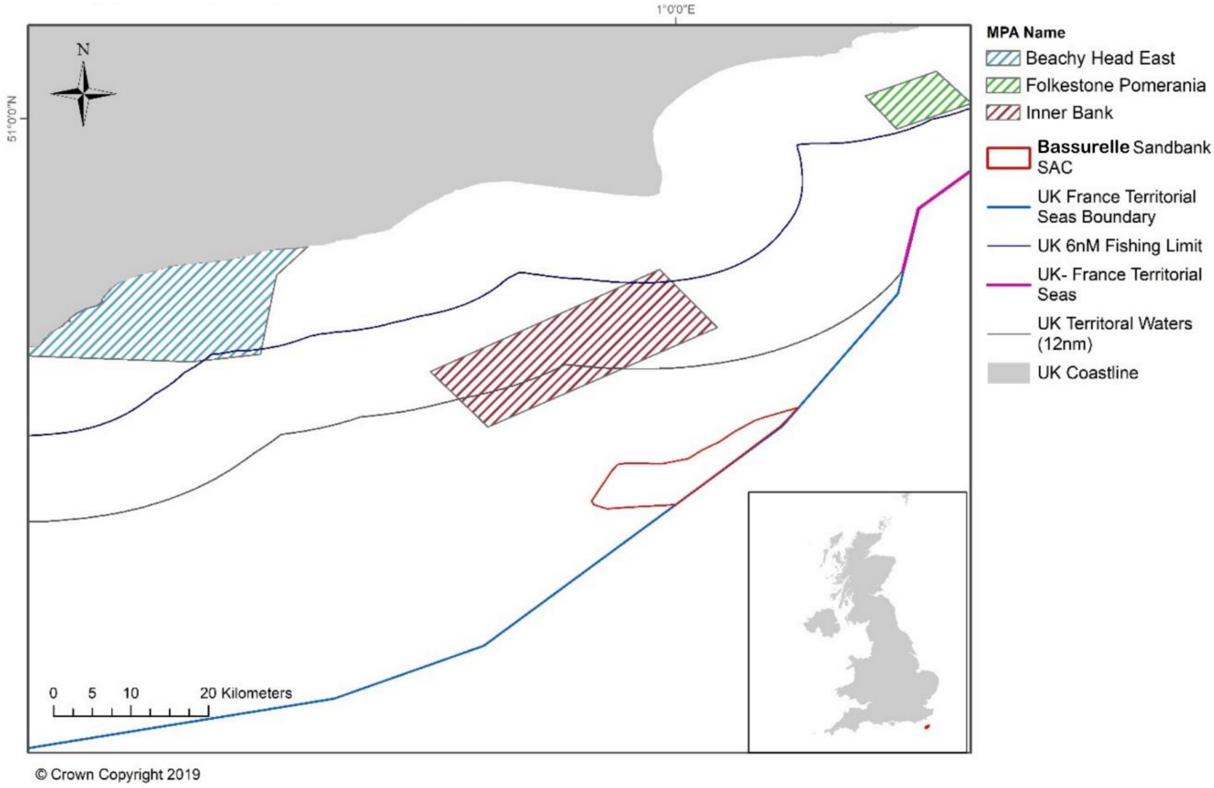

Figure 1. Location of the Bassurelle Sandbank SAC in the context of Marine Protected Areas and management jurisdictions proximal to the site.

1.3 Existing data and habitat maps

Benthic grab samples (sediment particle size distribution and infauna; collected using a 0.1m^2 mini-Hamon Grab) collected from 88 stations during a habitat verification survey of the site in March 2013 (Barrio-Froján *et al.* 2017) are used here as historical data to monitor changes to physical and biological structure over time (Figure 2). The location of the majority of these groundtruthing stations was based on a 1km triangular grid across the site, divided into two boxes. Further stations were added for groundtruthing bathymetric features. A predicted habitat map derived from the 2013 data (Figure 2) is also used as a reference against which to compare the spatial distribution of habitats (and associated fauna) inferred from samples collected during the 2017 survey that is the focus of this report. Multibeam echosounder (MBES) bathymetry data collected as part of the UKHO Civil Hydrography Programme (CHP) in 2014 are used to describe the topography of the site, as such data were not collected during the 2017 survey. These data are reported with respect to Mean Sea Level (MSL).

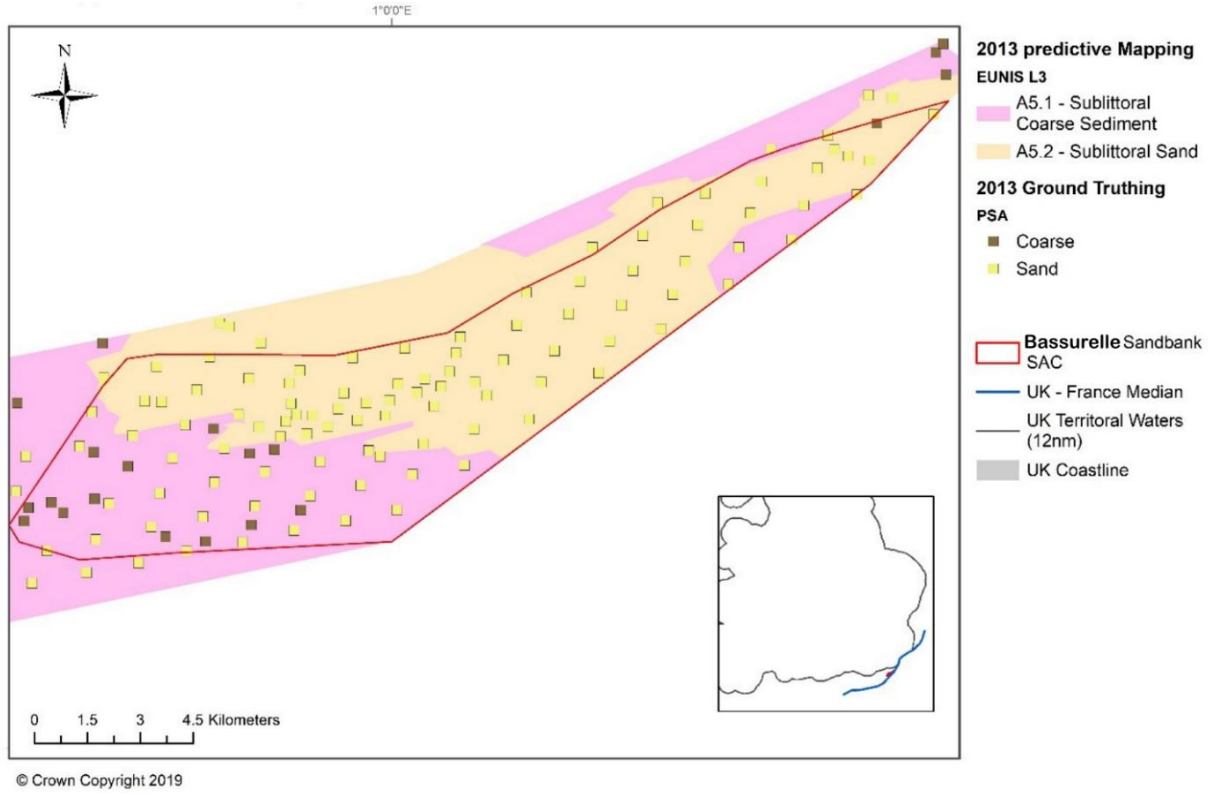

Figure 2. EUNIS Level 3 Habitat map for the Bassurelle Sandbank SAC predicted using data collected during a habitat verification survey conducted in 2013 (Barrio-Froján *et al.* 2017).

1.4 Aims and objectives

1.4.1 High-level conservation objectives

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

Maintaining or restoring this feature to favourable condition thus ensures site integrity in the long-term and provides a contribution to UK wide Favourable Conservation Status of 'Annex I Sandbanks which are slightly covered by seawater all the time'.

This contribution would be achieved by maintaining or restoring, subject to natural change, the following feature attributes:

- the extent and distribution of the qualifying habitat in the site;
- the structure and function of the qualifying habitat in the site; and
- the supporting processes on which the qualifying habitat relies.

The conservation advice package for the Bassurelle Sandbank SAC was updated in April 2018 after the survey had taken place. The Supplementary Advice for the conservation objectives for this site provided more detailed conservation objectives for each feature attribute in April 2018 (Table 1).

Table 1. Conservation objectives for the feature attributes of the Annex I Habitat ‘Sandbanks which are slightly covered by seawater all the time’ at Bassurelle Sandbank SAC[3]

Feature attribute	Conservation objective
Extent and Distribution	Maintain
Structure and Function	Restore
Supporting processes	Maintain

1.4.2 Definition of favourable condition

Favourable conservation status 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 JNCC have defined the extent of the feature “Annex I Sandbanks which are slightly covered by seawater all the time” as extending to the boundary of the Bassurelle Sandbank SAC (Duncan 2016). As such, the total area covered by the feature is 67km^2, matching the total area of the SAC. Within the 2016 report, the extents of the “underlying topographical banks” were retained for further information. As such, only the extent and distribution of the “underlying topographical bank” will be assessed here.

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).

1.4.3 Report aims and objectives

The primary aims of this monitoring report are to determine the attributes of the designated feature within the Bassurelle Sandbank SAC, to enable future assessment and monitoring of feature condition, and to compare the infaunal community to that recorded during a habitat verification survey of the site in 2013. 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.

[3] http://jncc.defra.gov.uk/pdf/Bassurelle_SACO_V1.0.pdf [accessed 15/07/20]

The broad objectives of this monitoring report are provided below:

1) Provide a description of the **extent**[4], **distribution,** and the **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) Evaluate small-scale, within-station variability in sediment composition and infaunal communities at the replicated sub-set of stations sampled in 2017;
3) Conduct a broad comparison of EUNIS Level 3 Habitat distribution and sediment composition in 2013 and 2017;
4) Conduct a T1 analysis of changes to infaunal assemblages between 2013 and 2017;
5) Compare epifaunal assemblages sampled by a beam trawl and a camera sledge in 2017;
6) Present any available evidence on the supporting processes of the designated features of the site (see Table 2 for more detail);
7) Note observations of any Annex I habitats and OSPAR Threatened and/or Declining Species and Habitats not covered by Designation Order as features of the site;
8) Present evidence relating to non-indigenous species (Descriptor 2) and marine litter (Descriptor 10), to satisfy requirements of the MSFD;
9) 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.

1.4.4 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 (SACO) developed by JNCC for Bassurelle Sandbank SAC[2]).

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.

Feature Attributes	Sub-attributes	Outputs
Extent and distribution	Large-scale topography	Maps of bathymetry to reveal large-scale bedforms Delineation of the “underlying topographical bank”
	Sediment composition	Analysis of gravel, sand and mud contents (Annex I Sandbanks are mainly sand and have <30% gravel)
	Biological assemblages	Assign biotopes and cross-check against biotopes associated with Annex I Sandbanks
Structure and function	Physical structure: fine-scale topography	Profile analysis of sand waves between megaripples

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

Feature Attributes	Sub-attributes	Outputs
	Physical structure: sediment composition and distribution	Maps of EUNIS Level 3 Habitats and finer-resolution measures of sediment composition
Structure and function (continued)	Biological structure: characteristic communities	Biotopes and community analysis (the association of infauna and epifauna with habitats and large-scale topography)
	Biological structure: key and influential species	Note the identities of biotope-defining species and any known prey species for commercial fish
	Ecosystem function: nutrition	Secondary production analysis and maps of fish distribution in relation to production
Supporting processes	Hydrodynamic regime	Tidal model

1.4.5 What is not covered by this report

As stated in the executive summary, this report **does not** aim to assess the condition of the designated features. SNCBs use evidence from MPA monitoring reports in conjunction with other available evidence (e.g. activities, pressures, sensitivities, historical data, survey data collected from other organisations or collected to address different drivers) to make assessments on the condition of designated features within an MPA.

2. Methods

2.1 Survey design

A dedicated Sentinel (Type 1) monitoring survey was conducted at the Bassurelle Sandbank SAC onboard the RV *Cefas Endeavour* in May 2017 (McIlwaine *et al.* 2017).

Sediment and infauna were sampled at 100 stations, as determined by a power analysis of the 2013 infaunal community data from the habitat verification survey. This was the number of samples required to detect 20% change in taxonomic richness with a power of 0.8. All 100 stations were uniformly distributed (using a triangular grid, spaced at 850m) throughout the SAC to provide full coverage of the site. A similar coverage was achieved in 2013 (Barrio-Froján *et al.* 2017) and, therefore, the two surveys are considered comparable. It should be noted, however, that the habitat verification survey was conducted two months earlier in the year (March).

Infaunal and sediment samples were acquired using a 0.1m^2 mini-Hamon Grab. A single grab sample was collected at 90 stations. At an additional ten stations, five replicate samples were collected to quantify small-scale (within-station) spatial variability in sediment composition and infaunal assemblages. Of these ten stations, five were placed in areas predicted to be ‘A5.1 Sublittoral coarse sediment’ and five were placed in areas predicted to be ‘A5.2 Sublittoral sand’ based on a habitat map produced using survey data collected from the site in 2013 (Barrio-Froján *et al.* 2017; Figure 3).

Epifauna were sampled using a 2m beam trawl and a camera sledge at 50 of the stations sampled with the mini-Hamon Grab; 25 in areas predicted to be ‘A5.1 Sublittoral coarse sediment’ and 25 in areas predicted to be ‘A5.2 Sublittoral sand’ (Figure 3). Both gears were used so that results could be compared and the efficacy of seabed imagery for indicating epifaunal community composition could be qualitatively assessed. Beam trawl samples were collected in two replicate hauls at each station. Seabed imagery was recorded over a single tow.

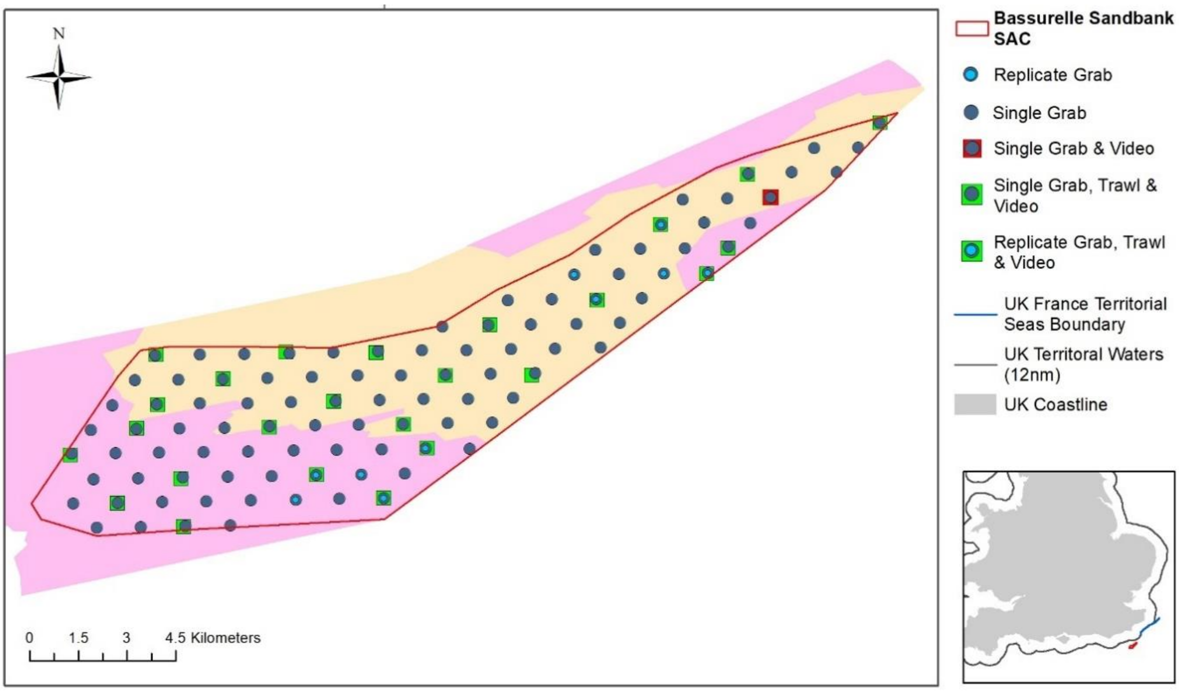

Figure 3. Location of grab, beam trawl and seabed imagery samples collected at the Bassurelle Sandbank SAC in 2017. At stations where replicate grab samples were collected, n = 5.

2.2 Data acquisition and processing

2.2.1 Grab sampling

Sediment samples for particle size distribution (PSD) and infauna analyses were collected using a 0.1m^2 mini-Hamon Grab. This grabbing device was selected due to its versatility in sampling the different sediment habitats present within the Bassurelle Sandbank SAC.

A 500ml sub-sample was taken from each grab sample and stored at -20°C prior to determining the PSD. Sediment samples were processed by Cefas following the recommended methodology of the North-East Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme (Mason 2011). The less than 1mm sediment fraction was analysed using laser diffraction and the greater than 1mm fraction was dried, sieved and weighed at 0.5phi (ϕ) intervals. PSD data from the <1mm and >1mm fractions were then merged.

Grab samples were sieved over a 1mm mesh, photographed and the retained organisms were fixed in buffered 4% formaldehyde for infauna analysis. Organisms were identified to the lowest taxonomic level possible, enumerated and weighed (blotted wet weight) to the nearest 0.0001g, following the recommendations of the NMBAQC scheme (Worsfold *et al.* 2010).

2.2.2 Beam trawling

A 2m scientific (Jennings) beam trawl was used to sample epifauna. Each tow was conducted for five minutes at a speed of 1.0 knot (0.5ms^{-1}), travelling a distance of approximately 150m and sweeping an area of approximately 300m^2. A total of 600m^2 (two replicate hauls) of the seabed was swept at each station. Penetration depth of the Jennings beam trawl is unknown, however a comprehensive review of benthic gear penetration (Szostek *et al.* 2017) indicates that the average penetration depth in sand for commercial 2m beam trawls is ~1.6cm (maximum ~6cm).

Epifaunal organisms were processed and identified on board. Colonial taxa were noted as ‘present’ when attached to substratum and weighed when free living. Solitary taxa were individually weighed (to 0.1g) and counted. Length was also recorded for all fish (to 1mm). Reference specimens of taxa identified with a degree of uncertainty were retained for later quality assurance procedures. Taxa that were easily and rapidly identified on board were not routinely kept. Quality assurance was carried out by expert benthic taxonomists.

2.2.3 Seabed imagery

Seabed imagery data (video footage and stills) were collected using an STR SeaSpyder “Telemetry” camera sledge system, following Mapping European Seabed Habitats (MESH) recommended operating guidelines (Coggan *et al.* 2007). The camera sledge was towed at a speed of 0.3 knots for ten minutes during seabed imagery data collection, covering approximately 100m at each station. Still images were acquired every minute (10m) and additional images were collected in any areas of heterogeneous Broadscale Habitats (BSH) or if Feature of Conservation Interest (FOCI) were observed. Full details of acquisition and processing methodologies can be found in the survey report (McIlwaine *et al.* 2017).

2.2.4 Biological data truncation

Infaunal taxa recorded in mini-Hamon Grab samples were checked for the application of consistent and up-to-date nomenclature using the WoRMS match taxa tool[5]. Any taxa not considered as macrofauna (e.g. fish) were removed from the dataset. Juveniles were generally retained in the dataset and their abundances merged with those of adults of the same species. Only juveniles identified to a lower taxonomic resolution than adults were removed from the dataset, rather than having to reduce the resolution of the adult records (*sensu* Callaway *et al.* 2018; Downie *et al.* 2018). In cases where it was not possible to determine whether one or more individuals of a taxon were present (e.g. with small colonial taxa) an abundance of ‘1’ was assigned (*sensu* Callaway *et al.* 2018; Downie *et al.* 2018). For analyses focused on the 2017 data, the truncation process was applied to this dataset only. For analyses of differences in infaunal communities between 2013 and 2017, data from the two years were combined and the truncation process was applied to this integrated dataset. A full description and rationale for this truncation process is provided in Annex 1. The only epifaunal data used for analysis were from the beam trawl, owing to the lack of useable data from the video footage and still images acquired (due to very poor visibility in highly turbid waters). These trawl abundance data were firstly quality assured through taxonomic identification of reference samples retained during the cruise. This allowed for uncertain identifications to be corrected and for problematic taxa to be truncated to the appropriate level. Highly mobile megafauna (fish and cephalopods) were removed from the dataset, along with macroalgae, polychaete tubes, and egg masses. Taxa which were not identified to a sufficient resolution (e.g. ‘Gastropoda’ and ‘Polychaeta’) were also removed. The final epifaunal taxa list was then checked for the application of consistent and up-to-date nomenclature using the WoRMS match taxa tool[5]. As each station was comprised of two replicate trawls, the data were summed for each trawl (A1 and B1) at each station before community analysis was undertaken. A total of 87 taxa were included in the epifaunal community analysis, listed in Annex 2.

2.2.5 Secondary production estimates

Infaunal and epifaunal secondary production ($KJm^{-2}yr^{-1}$) were estimated indirectly for each station using abundance and biomass data. First, any taxa that could not be both enumerated and weighed were removed from the datasets. Measured (wet) biomass values

[5] http://www.marinespecies.org/aphia.php?p=match [accessed 15/07/20]

were then converted to energy values, using published conversion factors (Brey *et al.* 2010), and converted to annual production values using a multi-parameter empirical model (Brey 2001). This method unifies previous habitat-specific approaches into a multiple regression model and is one of the most reliable and robust methods for estimating secondary production (Cusson & Bourget 2005; Dolbeth *et al.* 2005).

Calculations were made separately for infaunal and epifaunal components of the benthos. To derive estimates for each station, the mean biomass (kJm^{-2}), mean abundance (individuals m^{-2}) and individual body mass (kJ) of each taxon were entered into the empirical model along with station-specific depths (recorded during the survey) and modelled mean annual bottom water temperatures. The broad taxonomic group of each taxon was specified, along with whether it is subtidal or intertidal (all subtidal in this case), infaunal or epifaunal and motile or sessile. With this information, production by each taxon was calculated and these values summed to estimate the total secondary production at each station.

As the prediction error associated with community level production values is unknown, caution must be applied when interpreting model results. That said, the large prediction errors typically associated with population-level estimates are greatly reduced when pooled to the community level (Brey 2001). It should also be noted that the model requires mean annual abundance and biomass data for each taxon, whereas the available community data in 2017 are from a single survey conducted in May. As the taxon abundance and biomass typically varies throughout the year, an under- or overestimation of total production is possible. The degree to which this influences results will depend on how closely abundance and biomass in May resemble annual values.

2.3 Data analysis

2.3.1 Large-scale topography

The Annex I Sandbank feature has been defined as “extending to the boundary of the SAC” (Duncan 2016). Large-scale topography of the site was investigated to provide information necessary to assess the current extent of the “underlying topographical bank” (report objective 1; see section 1.4.3, Table 2 and section 2.3.4) in greater detail. With respect to topography, the classification criteria are those used in the 2017 report (Barrio-Froján *et al.* 2017). These are that the bank is elevated, elongated, rounded or irregular, is permanently submerged (summit is <20m depth) and is predominantly surrounded by deeper water (EC 2013).

Previously, large-scale topography was investigated using partial coverage MBES data acquired during the 2013 habitat verification survey (Barrio-Froján *et al.* 2017). Here, the extent and distribution of the underlying topographical sandbank was reassessed using MBES bathymetry data collected in 2014 as part of the UKHO CHP. While there is only one year between surveys, reassessment was considered appropriate due to the more complete spatial coverage provided by the more recent dataset.

The method of assessment was in keeping with that employed in the first delineation of the feature (Barrio-Froján *et al.* 2017), using the 0.5° slope threshold and expert judgment to determine feature extent. After this approach, efforts were made to semi-automate delineation of the feature and thus mitigate the subjectivity of expert judgment. Ultimately, however, manual detection of the principle point of slope change was required to delineate the extent of the feature in some areas. Following the underlying topographical bank delineation, the distribution of large-scale bedforms such as megaripples was determined with the 2014 MBES data using a derivative called Relative Slope Position (RSP). Megaripples are rapidly generated mobile bedforms, with crest heights of between 0.06 and

2m and wavelengths up to 20m (Idier *et al.* 2004). A detailed description of large-scale topographical analysis is provided in Annex 3.

2.3.2 Physical structure

Fine-scale topography

Fine-scale topography (defined by the SACO as bedforms smaller than megaripples) was investigated to gain more detailed insight into the physical structure of the sandbank (report objective 1; see section 1.4.3, Table 2 and section 2.2.4). This could not be done using the video data collected in 2017, as the visibility was too poor to consistently identify fine-scale bedforms. Instead, the size and distribution of smaller bedforms was undertaken at a 1.5m resolution using profiles of MBES bathymetry data collected as part of the CHP in 2014.

Sediment composition and distribution

To provide additional information necessary to assess the extent of the underlying topographical sandbank (report objective 1; see section 1.4.3, Table 2 and section 2.2.4), sediment PSD data (0.5 ϕ classes) derived from mini-Hamon Grab samples were grouped into the percentage contribution of gravel (>2mm diameter), sand (0.063–2mm) and mud (<0.063mm) based on the classification system proposed by Folk (1954). To be classified as ‘Sandbanks which are slightly covered by seawater all the time’, sediment must consist primarily of sand and contain less than 30% gravel and more sand than mud (Duncan 2016). Pie charts of sediment composition were overlaid onto a map of the SAC and any stations that did not meet these criteria were highlighted.

The composition and distribution of sediments associated with the underlying topographical sandbank (report objective 1; see section 1.4.3 and Table 2) was further explored by assigning each sediment sample to one of four EUNIS Level 3 Habitats based on the contents of gravel, sand and mud (Long 2006): ‘A5.1 Sublittoral coarse sediment’, ‘A5.2 Sublittoral sand’, ‘A5.3 Sublittoral mud’ and ‘A5.4 Sublittoral mixed sediments’. Maps were produced showing the EUNIS Level 3 Habitat of each station and providing a high-level overview of habitat type throughout the site. The observed distribution was compared to the predictions of the habitat map derived from samples collected in 2013.

Further assessment of sediment composition and distribution was conducted by dividing sand into sub-fractions based on the Wentworth Scale (Wentworth 1922): fine sand (0.063–0.25mm), medium sand (0.25–0.5mm) and coarse sand (0.5–2mm). A second set of pie charts were then overlaid onto stations, this time showing the relative proportions of each sand sub-fraction, to reveal how the dominant sediment component varies spatially within the site and determines the degree to which this corresponds to patterns in EUNIS Level 3 Habitat type.

Within-station variability

To assess small-scale spatial variability in sediment composition (report objective 2; see section 1.4.3), the proportions of sand and its sub-fractions were inspected at each station where replicate grab samples were collected. The analysis focused on sand as it is the dominant sediment component and the other sediment components decreased proportionally as sand content increased (R^2 = 0.99 and 0.79 for gravel and mud, respectively). Therefore, variation in sand content largely reflects variation in the other sediment fractions and no additional information would be gained from their analysis. Small-scale variability was quantified using the coefficient of variation (CV), i.e. standard deviation / mean percent contribution to total sediment volume, and each station was categorised as having low (CV <0.25), medium (CV 0.25–0.5), high (CV 0.5–1.0) or very high (CV >1.0) small-scale variability. The EUNIS Level 3 Habitat type inferred from each of the five replicate samples was also noted for each station.

Temporal variation

Finally, a temporal comparison of PSD data was conducted to explore the possibility of any broad changes in habitat type and/or sediment composition over time (report objective 3; see section 1.4.3). First, the spatial distribution of EUNIS Level 3 Habitats throughout the site in 2017 was compared to the spatial distribution observed in 2013. Any clear similarities or differences between the two years were noted. The same approach was then used to assess spatio-temporal variation in the contents of gravel, sand and mud to allow any subtler changes in sediment composition to be identified.

2.3.3 Biological structure

Biological assemblages were analysed with respect to the composition, density and diversity of infauna (mini-Hamon Grab samples) and epifauna (beam trawl samples). Although epifauna were sampled using the camera sledge as well as the beam trawl, image quality was too poor for useful taxonomic data to be obtained. The difference in taxonomic resolution between beam trawl and imagery datasets is so great as to be easily inferred by simple review of the taxa list in Annex 2. For example, there are 79 entries in the trawl taxa list, and 43 in the camera, with only six entries at the genus or species level for the camera list, compared with 70 in the trawl dataset. As such, seabed imagery could not be used to describe biological communities within the SAC at anything other than a very coarse resolution and a formal comparison of epifaunal data collected using the beam trawl and camera sledge (report objective 5; see section 1.4.3) was not completed.

For analyses that considered all 100 stations, infaunal data were standardised by using only the first sample from each station. This form of standardisation allows for like-for-like comparisons between stations with and without replication. The first replicate was also used to indicate sediment composition for these analyses. When analysing within-station variability of infaunal assemblages at the stations where five replicate samples were collected (see Figure 3), all available data were used. Epifaunal data were matched to the EUNIS Level 3 Habitat inferred from the grab sample located closest to the beam trawl transect (i.e. the habitat most likely encountered by the epifaunal organisms sampled).

Characteristic communities

To analyse community composition, infaunal and epifaunal taxa abundance datasets were imported into the statistical package PRIMER (version 7; Clarke & Gorley 2015). Taxa abundances were transformed by $\log_e(x+1)$ to downweigh the influence of numerically dominant taxa and allow variation in less abundant taxa to be detected. For each faunal dataset, a resemblance matrix was created from the Bray-Curtis similarities of each pair of stations. Hierarchical cluster analysis was then performed in association with similarity profile analysis (SIMPROF) to identify sets of stations with significantly distinct infaunal and epifaunal communities ($p < 0.05$). For epifauna, a group of taxa that were both highly abundant and widespread (hermit crabs belonging to the family Paguridae and their symbionts) were removed from the community dataset for this stage of the analysis due to the large effect they had on clustering (even following transformation).

The spatial distributions of distinct infaunal and epifaunal communities were overlaid onto maps of predicted habitat type and large-scale topography (RSP; see section 2.3.1), with information on the spatial distribution and densities of the removed epifaunal taxa presented alongside. The EUNIS Level 3 Habitats associated with each cluster (as derived from Particle Size Analysis (PSA)) were also noted. Following cluster analysis, the similarity percentage (SIMPER) routine was used to identify the taxa that characterised each distinct infaunal and epifaunal community. These taxa were used, along with information on the presence of highly abundant epifaunal taxa (such as Paguridae) and physical habitat (such as depth and substrate) to infer the main biotopes within the SAC, following the procedure described in Parry (2015). This allowed characteristic communities and key (i.e. biotope-defining) species to be identified, while also providing biological information necessary to assess the extent and distribution of the Annex I Habitat 'Sandbanks which are slightly covered by seawater all the time' (report objective 1; see section 1.4.3, Table 2 and section 2.2.4). To be classified as an Annex I Sandbank, the feature must support biotopes typical of sandbanks. Note, however, that communities were matched to biotopes using epifauna sampled with beam trawls, whereas existing biotopes are generally based on epifauna observed using seafloor imagery. The taxonomic resolution of seafloor imagery data collected at the Bassurelle Sandbank in 2017 was too low to be used for determining biotopes.

Fauna-sediment associations were further investigated to determine an appropriate level at which to divide habitats for monitoring of biological assemblages (report objective 9; see section 1.4.3). First, variation in infaunal and epifaunal community composition between EUNIS Level 3 Habitats was assessed using analysis of similarities (ANOSIM) in PRIMER. All taxa were included in the infaunal and epifaunal datasets for this analysis, as the purpose was to quantify within- and between-habitat similarity based on the full assemblage. However, the analysis was also performed on the reduced epifaunal dataset (i.e. with highly abundant, widespread taxa removed) to allow a like-for-like comparison of within-habitat and within-cluster variability. Statistically significant ($p < 0.05$) and large ($R > 0.5$) differences between EUNIS Level 3 Habitats were taken to indicate that the habitats should be considered separately for monitoring, as they support distinct biological assemblages, whereas small and/or insignificant differences were taken to suggest that it may be appropriate to group EUNIS Level 3 Habitats together for monitoring. The level of within-habitat similarity in community composition was determined using SIMPER and used to assess the possible benefits of further dividing habitats (e.g. by geographic area and/or relation to topography) for monitoring biological assemblages (report objectives 4 and 10; see section 1.4.3), with low within-habitat similarity taken to suggest that further division may be useful.

An analogous procedure was then carried out using a set of univariate biotic indices that may be useful for monitoring. The following indices were calculated in PRIMER: total abundance, total number of species (i.e. 'species richness'), the Margalef Diversity Index (Margalef 1958; hereafter 'Margalef Index') and the Shannon Diversity Index (Shannon 1948; hereafter 'Shannon Index'). Total abundance and species richness were used as they are fundamental and commonly used measures of faunal density and diversity. The Margalef Index (species richness relative to the log of total abundance) was selected because there is evidence that it could be a good general indicator of physical, organic and chemical disturbance (van Loon *et al.* 2018) and may therefore be responsive to a range of anthropogenic pressures. The Shannon Index is an integrated measure of both species richness and evenness (i.e. how evenly total abundance is distributed across species) and was used for its ability to respond to changes in either aspect of biodiversity. Mean values for these univariate indices were determined for each EUNIS Level 3 Habitat and differences across habitats were tested using ANOVA, performed in R version 3.4.1 (R Core Team 2018). A significant difference was taken as $p < 0.05$. Assumptions of homogenous variance and normality of residuals were checked by inspection of plots of residuals against fits and normal quantile plots, respectively. Data were transformed by $\log_e (x+1)$, where necessary, to meet test assumptions.

Within-station variability

To assess small-scale spatial variability in infaunal assemblages (report objective 2; see section 1.4.3), SIMPER was used to calculate within-station community similarity at each station where replicate grab samples were collected. Hierarchical cluster analysis and SIMPROF were then used to determine whether community samples from the same station consistently clustered together (not significantly different; $p > 0.05$), i.e. whether single samples can be reliably used to characterise the community composition of a station. Finally, SIMPER was used to assess within-EUNIS Level 3 Habitat community similarity based on the first sample *vs* all five replicate samples, to gauge whether the collection of a single sample per station will accurately indicate within-habitat community similarity during monitoring (report objective 9; see section 1.4.3). For univariate biotic indices, small-scale spatial variability was quantified using the CV, following the same approach described for the analysis of small-scale variability in sediment composition (see section 2.3.2) (report objective 2). Estimates of richness (based on the first sample collected at each station) were then correlated (Pearson's R^2) with estimates based on all five replicate samples and the predicted total number of species (*Smax*), to assess how well a single sample is likely to represent the relative diversity of a station. Subsequently, the within-habitat CV was calculated based on the first sample *vs* all five replicates, to determine whether the collection of a single sample per station will accurately indicate within-habitat variability in indices potentially used for monitoring (report objective 9; see section 1.4.3). *Smax* was calculated using species accumulation curves (the Michaelis-Menton model) created in PRIMER v7.

Temporal variation

Finally, variation in infaunal community composition, density and diversity between 2013 (T_0) and 2017 (T_1) was assessed (report objective 4; see section 1.4.3). For this analysis, infauna associated with different EUNIS Level 3 Habitats were analysed separately due to the observed level of variation within and across habitats. ANOSIM was used to test changes in community composition, with taxa abundances again transformed by $\log_e(x+1)$ to downweigh the influence of numerically dominant species and allow variation in less abundant taxa to be detected. If communities differed significantly ($p < 0.05$), then SIMPER was used to determine which taxa were responsible for the observed temporal change. Differences in univariate biotic indices between 2013 and 2017 were tested using ANOVA. Test assumptions were checked and, if necessary, data were transformed as described for analyses of variation in univariate indices across EUNIS Level 3 Habitats (see section 2.3.3, 'Characteristic communities').

2.3.4 Ecological function

To assess the potential for benthic communities within the SAC to provide nutrition for demersal fish (report objective 1; see section 1.4.3, Table 2), infaunal and epifaunal production were calculated for the site (averaged across all stations) and spatial variation in production by each component of the benthos was mapped. A third map showing the distribution of commercially important fish species found in beam trawl samples was also produced and any apparent associations with infaunal and/or epifaunal production were noted. The focus was placed on fish species known to use the region as feeding, nursery and/or spawning grounds: Common Dab (*Limanda limanda*), European Plaice (*Pleuronectes platessa*), Dover Sole (*Solea solea*), Lesser Sand Eel (*Ammodytes tobianus*) and Great Sand Eel (*Hyperoplus lanceolatus*) (Coull *et al.* 1998; Ellis *et al.* 2010a, Ellis *et al.* 2010b; Ellis *et al.* 2012).

2.3.5 Tidal modelling

To assess the level of exposure of the Annex I Habitat feature (report objective 6; see section 1.4.3, Table 2), mean and maximum tidal current velocities (ms^{-1}) at the seabed and direction of flow at the peak of the flood tide were obtained from a high-resolution depth-averaged model of the English Channel. The model was built with an unstructured triangular mesh, using the software Telemac2D (v7p1). The mesh had a resolution of 5km around the open boundary, reducing to ~500m along the coastline. Within the Bassurelle SAC the resolution was refined further to 200m. Bathymetry for the model was sourced from the Defra Marine Digital Elevation Model (DEM) (Astrium 2011). The resolution of the bathymetry dataset was 1 arc second (~30m). The hydrodynamics were forced along the open boundaries using 11 tidal constituents (M2, S2, N2, K2, K1, O1, P1, Q1, M4, MS4 and MN4) from the OSU TPXO European Shelf 1/30° regional model (OSU Tidal Data Inversion). After a spin-up period of 10 days, the model was run for 30 days to cover a full spring-neap cycle. The modelled max tidal current velocities were calculated over the full spring-neap cycle, whereas the modelled peak flood and ebb directions were the instantaneous directions which occurred at the timestamp of peak flood and ebb tide in the centre of the SAC.

2.3.6 Other OSPAR threatened and/or declining features

Mini-Hamon Grab and beam trawl datasets were inspected for any OSPAR Threatened and/or Declining Species and any species indicative of OSPAR Threatened and/or Declining Habitats. The distributions of any features identified during this process were mapped (report objective 7; see section 1.4.3).

2.3.7 Non-indigenous species

The infaunal and epifaunal taxa lists generated from the grab and beam trawl samples were cross-referenced against a list of non-indigenous target species (NIS) which have been selected for assessment of GES in GB waters under MSFD Descriptor 2 and identified as significant by the GB Non-Native Species Secretariat (Stebbing *et al.* 2014; Table 12 in Annex 4). Observed taxa were also cross-referenced against an additional list of taxa identified as invasive in the ‘Non-native marine species in British waters: a review and directory’ (Eno *et al.* in 1997; Table 13 in Annex 4).

A map was produced showing the locations where NIS were located (report objective 8; see section 1.4.3).

2.3.8 Marine litter

Items of litter found in mini-Hamon Grab and beam trawl samples were identified according to the categories in Annex 5 and a map was produced showing where each item was located (report objective 8; see section 1.4.3). Any litter items recorded in the seabed imagery datasets were also noted.

3 Results

3.1 Large-scale topography

The extent of the "underlying topographical bank" can be seen from the 2014 MBES bathymetry data to be clearly elongated, elevated and rounded, as well as being permanently submerged with a summit depth of <20m (Figure 4a). The methodology for delineating this extent was based initially on the >0.5° slope threshold as used by Barrio-Froján *et al.* (2017) and described in section 2.3.1. With the slope layer calculated for the entire SAC, one can immediately see the difficulty in using this threshold to define a topographical sandbank feature in a repeatable manner. Specifically, the extension of the area >0.5° to the north of the North-West region of the site is associated with the large transverse megaripples on the northern flank of the sandbank feature, which causes difficulties in automated delineation.

The Slope-Aspect map was produced to attempt to remove the noise introduced to the slope data by the presence of the megaripples at the northern flank of the feature. These reclassified slope and aspect raster images were then summed, meaning that any cell of value 82 was considered representative of the northern flank extent (Figure 4b). This allowed for better delineation of the majority of the northern flank; however, the signal remained masked by the megaripple features and so the Slope-Aspect map could not be used to further delineate the feature at its SW extent.

Manual determination of topographical extent (described above) was undertaken using transversely orientated profiles, run along the length of ripples. These are presented in Figure 5, alongside a map marking the principle point of slope change in relation to the 2013 topographical feature boundary. As the principal points were in close proximity to the previous boundary, it was concluded that the NW extent of the underlying topographical bank was approximately the same as inferred in 2013 and, therefore, the same boundary was applied here.

The extent and distribution of the underlying topographical bank, in comparison with that calculated in 2013, are shown in Figure 4c. The new boundaries constitute an almost identical extent (48.29km^2 in 2019 *vs* 48.56km^2 in 2013).

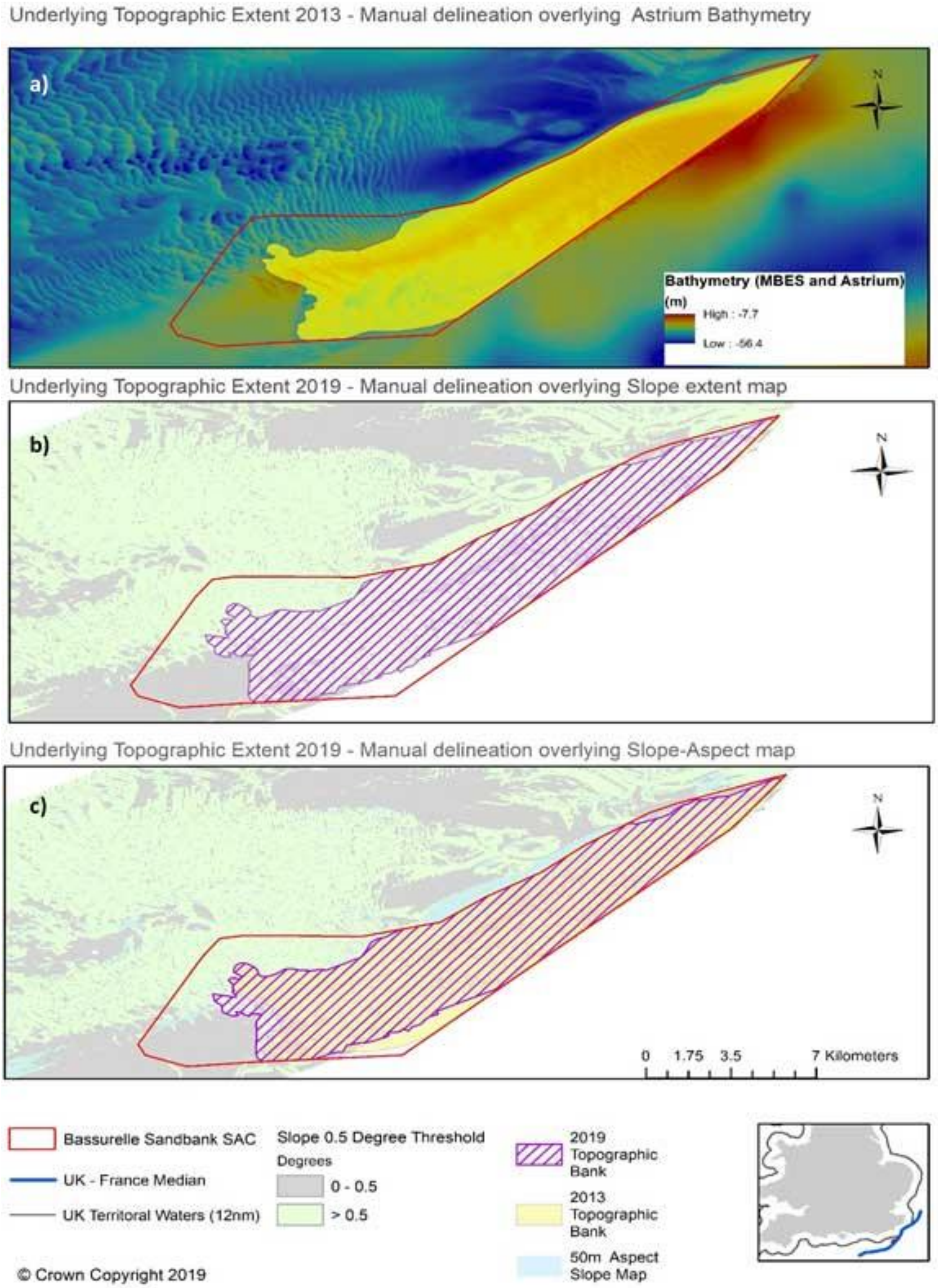

Figure 4. Large-scale topography of the Bassurelle Sandbank SAC and adjacent waters, showing a) bathymetry (depth in metres) and inferred topographical extent based on a 0.5° slope threshold, b) Slope-Aspect used in an attempt to delineate feature boundaries in the NW area of the site where megaripples are present and c) the proposed topographical extent of the sandbank based on a combination of automated and manual delineation methods, and its relation to feature extent drawn in 2013.

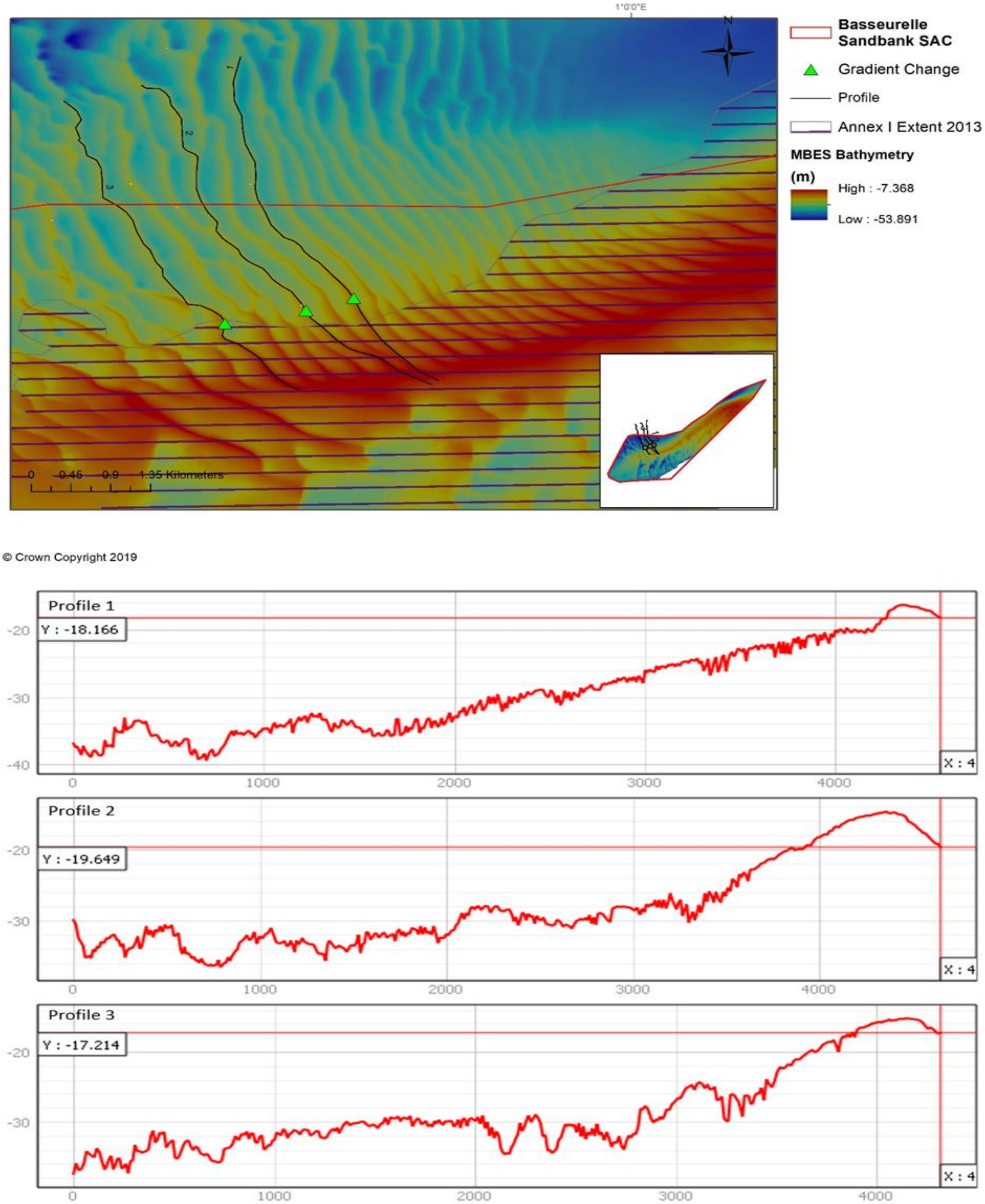

Figure 5. Along megaripple profiles showing the general profile of the northern flank of the sandbank feature. Change in profile points marked as green triangles on map. Profile 1 – change in gradient noted at 3,307m, Profile 2 change at 3,298m, Profile 3 at 3,249m.

Further investigation into the large-scale topography showed that the Bassurelle Sandbank is extensively covered by large sand megaripple features, orientated transverse to the tide. The spatial distribution of megaripples across the site can be seen at 10m resolution through both MBES bathymetry data and the derived RSP at 10m resolution (Figure 6a and b, respectively).

Although megaripples were observed throughout the site, their wavelength varied spatially. Megaripples in the NW of the site (on the northern flank of the sandbank) show a peak-to-peak distance of between 150 and 200m, while in the extreme NE of the site (where the megaripples are located on the summit of the sandbank) the average wavelength decreases to between 50 and 150m. The zoomed inset in Figure 6b shows the use of RSP in determining extent of these features, as there is a noticeable break in megaripple continuation on the sandbank summit at this location.

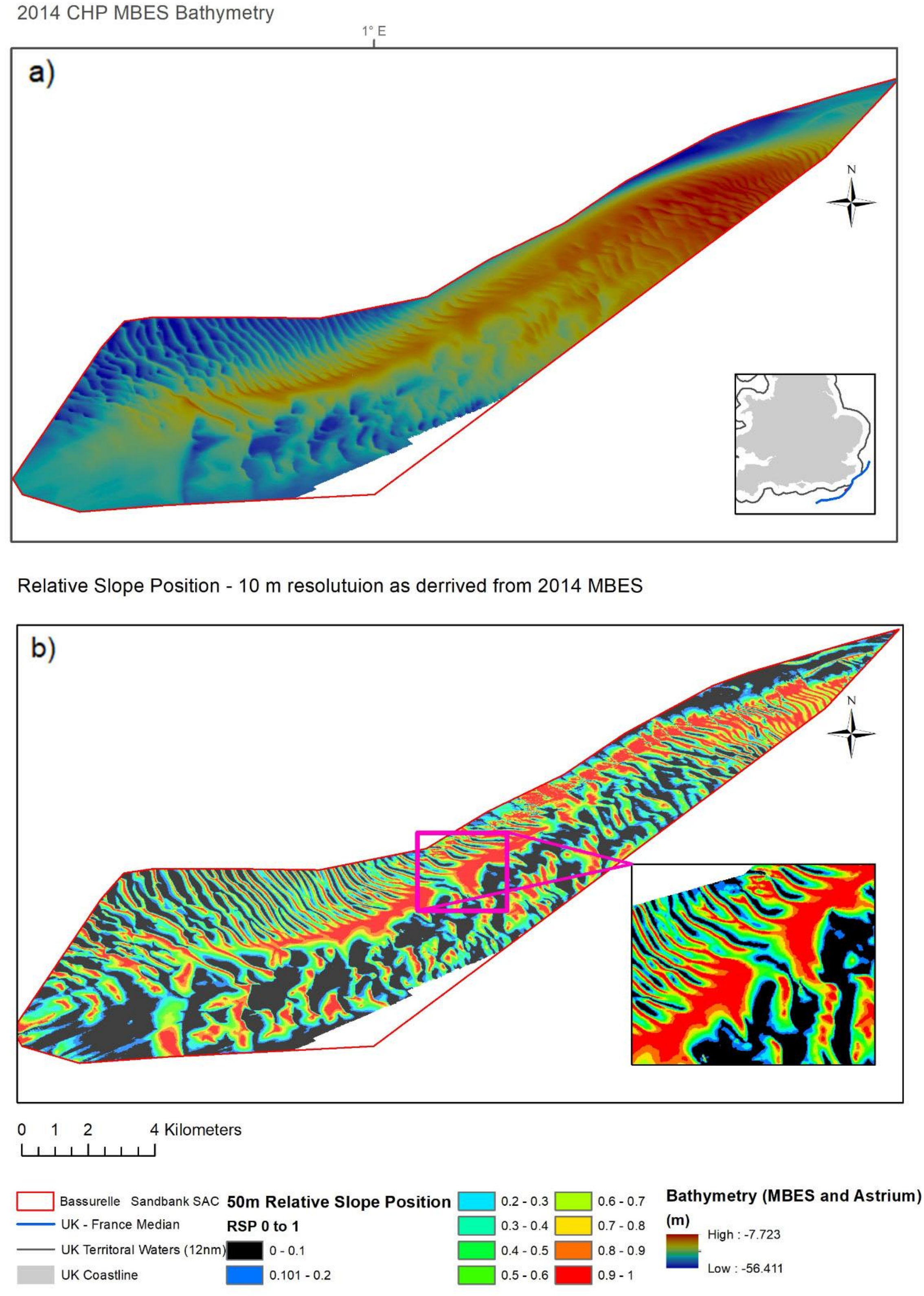

Figure 6. Large-scale topography of the Bassurelle Sandbank SAC with respect to a) high-resolution multibeam echosounder (MBES) data and b) the corrresponding Relative Slope Position (RSP) derrivative layer, highlighting the extent and connectivity of features.

3.2 Physical structure

3.2.1 Fine-scale topography

Using the very high-resolution (1.5m) MBES bathymetry data from the CHP 2014 survey, it is possible to detect fine-scale topography of the sandbank. Figure 7 shows an inter megaripple profile from the NW of the site, with smaller sand waves with wavelengths of ~30m and heights of ~10cm apparent. These same features are not present, or are less prominent, between other megaripples across the site.

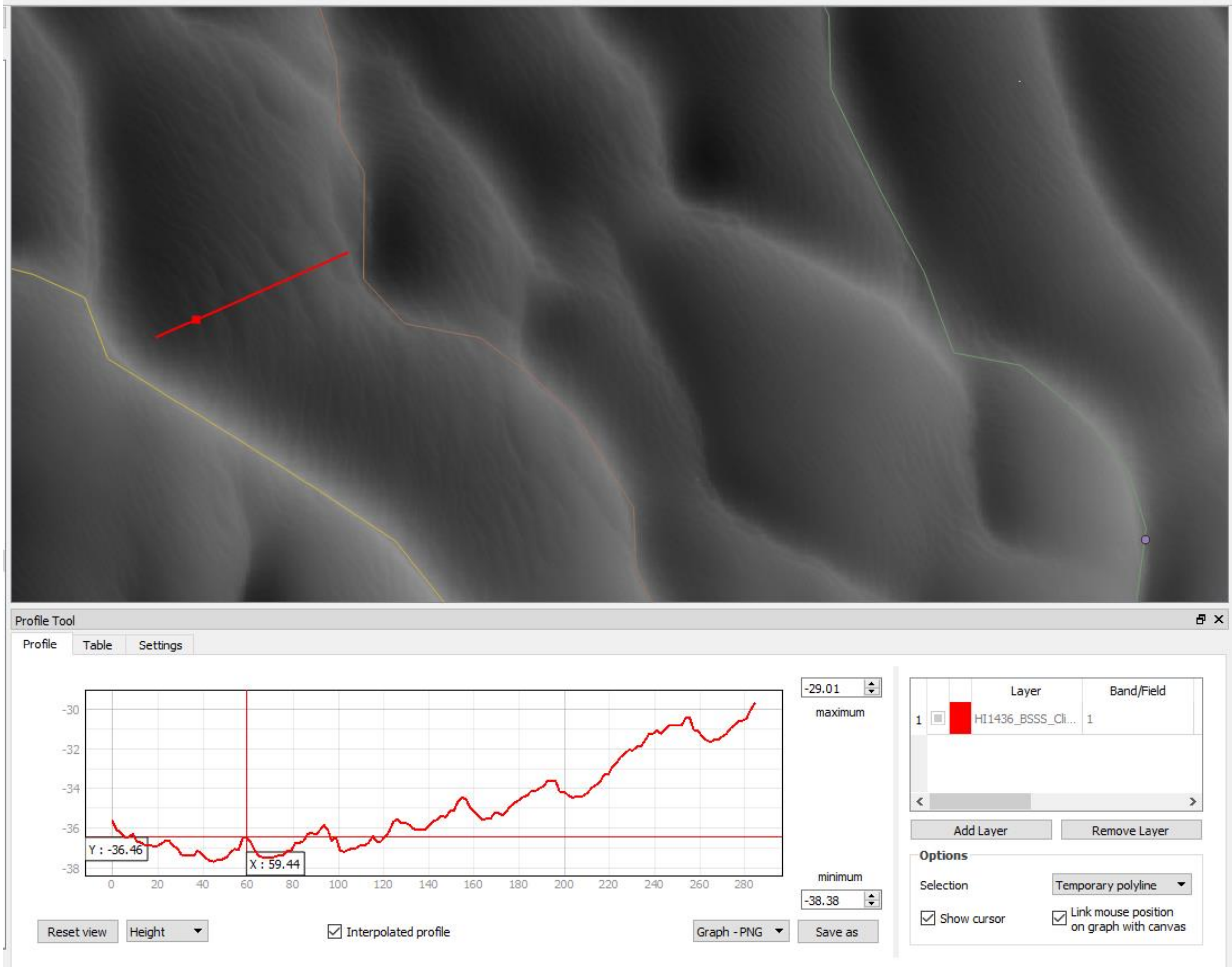

Figure 7. Fine-scale topography profiles of sandwaves associated with the megaripple field on the NW flank of the sandbank feature based on multibeam echosounder (MBES) data collected within the Bassurelle Sandbank SAC in 2014.

3.2.2 Sediment composition and distribution

Sand was the dominant sediment component at all stations and no stations had a gravel content of >30% (Figure 8). Therefore, the analysis supports the previous decision to extend the boundary of the Annex I feature 'Sandbanks which are slightly covered by seawater all the time' to the entire SAC with respect to sediment composition (as per Duncan 2016).

Stations were largely split into two clusters with respect to gravel content: those <3% (n = 69) and those >10% (n = 26) (Figure 8). This separation was represented spatially, with the narrow northern section of the site consisting almost entirely of sand and the most southerly area having a relatively high gravel content (10-28%) (Figure 10a). Mud content was very low (<2%) at most stations, but slightly higher (5-8%) at the northern tip of the site and several stations in the south (Figure 10a).

Patterns in sediment composition were reflected in the spatial distribution of EUNIS Level 3 Habitats, with the very south of the site classified as 'A5.1 Sublittoral coarse sediment' and the rest of the site classified as 'A5.2 Sublittoral sand' (Figure 10b). One station, BSS012, was classified as 'A5.1 Sublittoral coarse sediment' based on the first replicate grab sample but as 'A5.4 Sublittoral mixed sediments' for three of the five replicates collected at this station (see inset of Figure 10b). Replicate grab samples collected at the nine other stations consistently indicated the same EUNIS Level 3 Habitat. The observed distribution of EUNIS Level 3 Habitats largely matches the predictions of the habitat map; however, an area predicted to be 'A5.1 Sublittoral coarse sediment' in the north of the site was found to be 'A5.2 Sublittoral sand' (Figure 10b). The number of samples classified as each EUNIS Level 3 Habitat are shown in Table 3.

Assessment of the spatial distribution of different sand fractions revealed that the proportion of fine sand increased at stations located on the summit of the sandbank and in the north of the site (Figure 11). Coarse sand increased in prevalence from the northern tip of the site toward the southwest and comprised the majority of the sand fraction at many of the stations in the southern area (Figure 11). Medium sand made up a substantial proportion of the sediment (20-80%) at all stations and tended to be the dominant fraction midway between the northern and southern limits of the site (Figure 11).

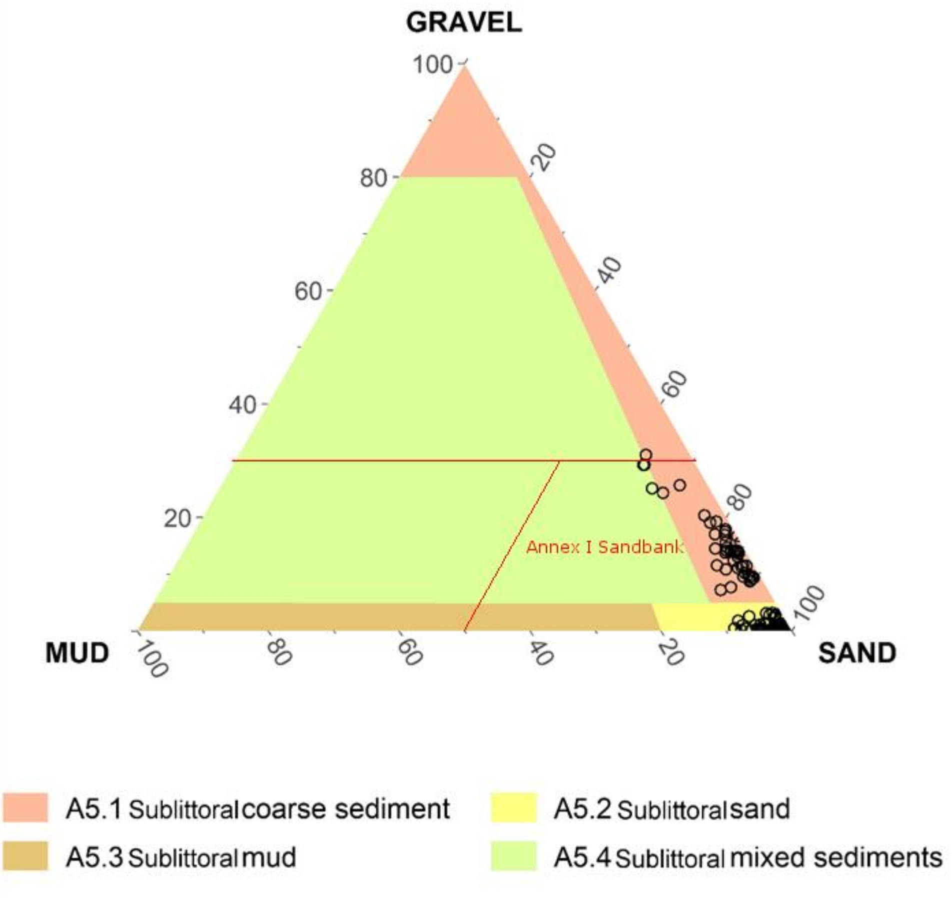

Figure 8. Contents of gravel, sand and mud at stations (hollow black circles) within the Bassurelle Sandbank SAC in 2017 and the associated EUNIS Level 3 Habitats (coloured areas) plotted onto a true-scale subdivision of the Folk triangle into the simplified classification for UKSeaMap (Long 2006; Folk 1954).

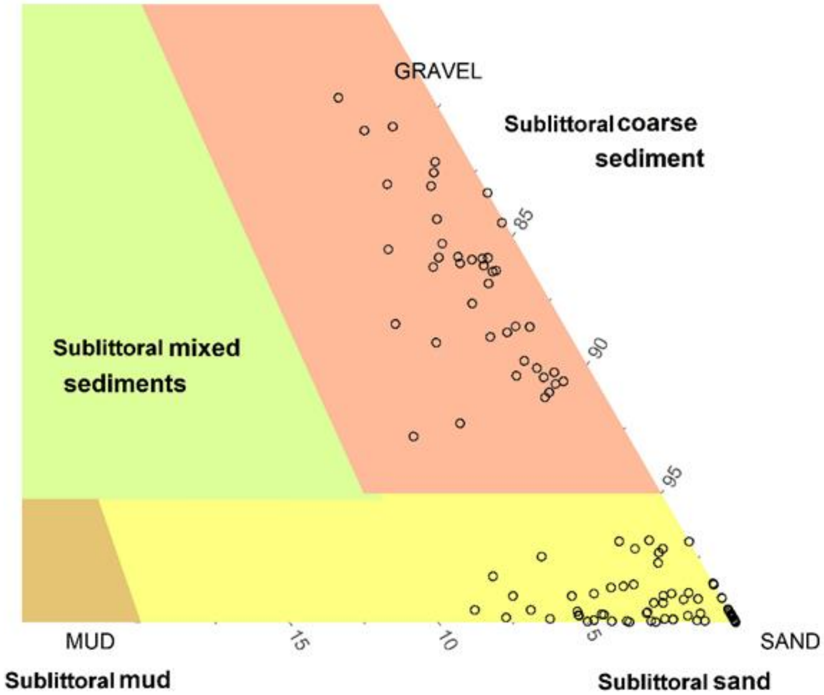

Figure 9. Zoom showing the proportions of gravel, sand and mud at stations (hollow black circles) within the Bassurelle Sandbank SAC in 2017 and the associated EUNIS Level 3 Habitats (coloured areas) plotted onto a true-scale subdivision of the Folk triangle into the simplified classification for UKSeaMap (Long 2006; Folk 1954).

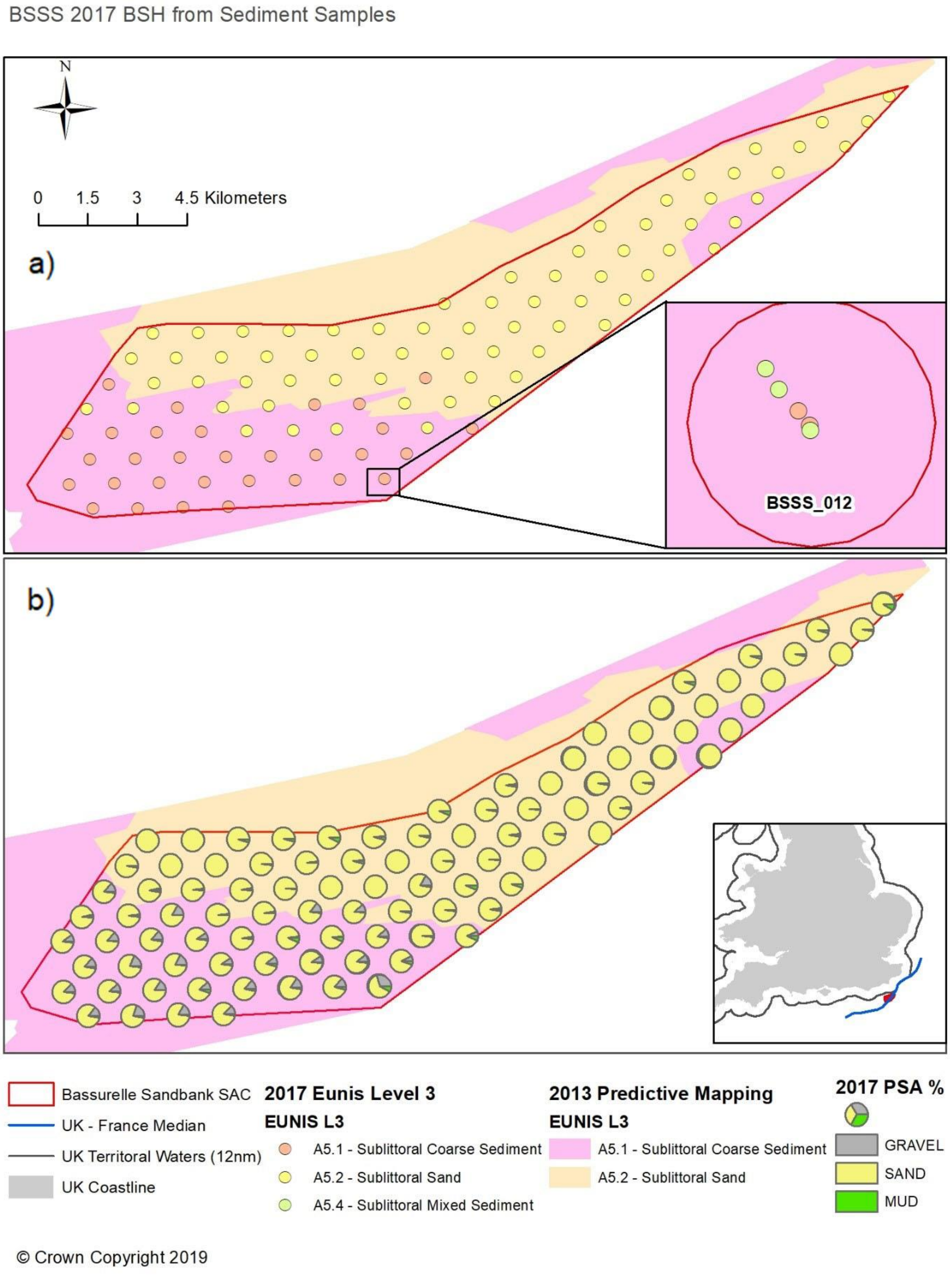

Figure 10. Spatial variation in a) the contents of gravel, sand and mud and b) EUNIS Level 3 Habitat type based on mini-Hamon Grab samples collected from 100 stations within the Bassurelle Sandbank SAC in 2017. The underlying predicted habitat map is based on samples collected in 2013 (Barrio-Froján *et al.* 2017).

Table 3. The number of samples from each EUNIS Level 3 Habitat in the Bassurelle Sandbank SAC in 2017 based on: the first grab sample collected from all stations, all grab samples collected from the ten stations where five replicate samples were collected (Rep stations) and the grab sample that was closest to the beam trawl transects at stations where epifaunal communities were sampled.

EUNIS Level 3 Habitat	All stations (first rep only)	Rep. stations (all five reps)	Stations sampled with beam trawl (closest rep only)
A5.1 Sublittoral coarse sediment	31	17	5
A5.2 Sublittoral sand	69	30	19
A5.4 Sublittoral mixed sediments	0	3	1

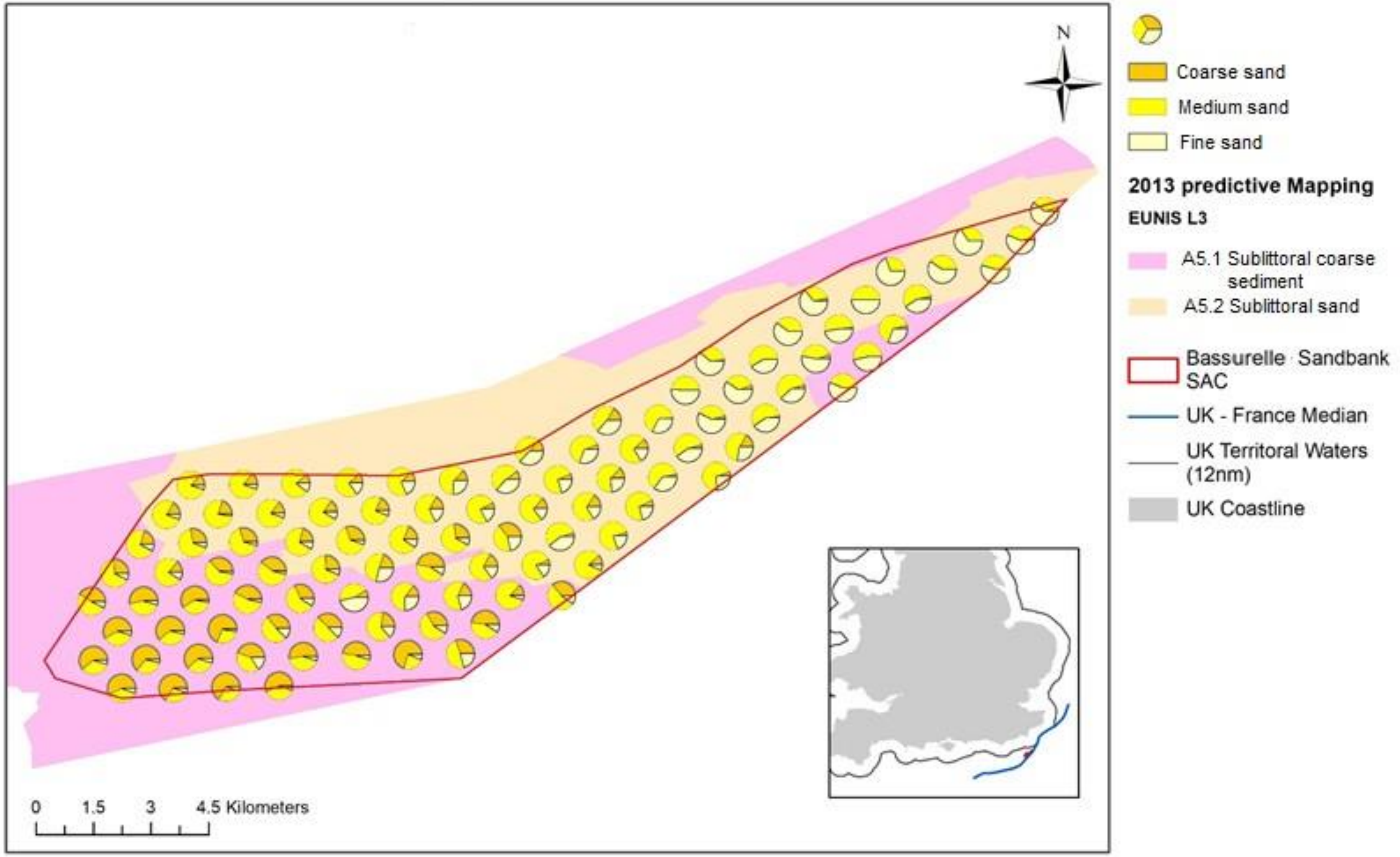

Figure 11. Spatial variation in coarse, medium and fine sand based on mini-Hamon Grab samples collected from 100 stations within the Bassurelle Sandbank SAC in 2017. The underlying predicted habitat map is based on samples collected in 2013.

There was little small-scale (within-station) spatial variability in sand content at all ten stations where replicate grab samples were collected, indicated by a low CV (Figure 12a). CV was also generally low for coarse sand, medium sand and fine sand (Figure 12b-d). However, at two stations (BSSS081 and BSSS084) CV was high for coarse sand and at another station (BSSS029) CV was medium for fine sand (Figure 12b and d, respectively). In each case, small-scale spatial variability was highest where the mean percent contribution of the fraction of interest (i.e. coarse or medium sand) was low.

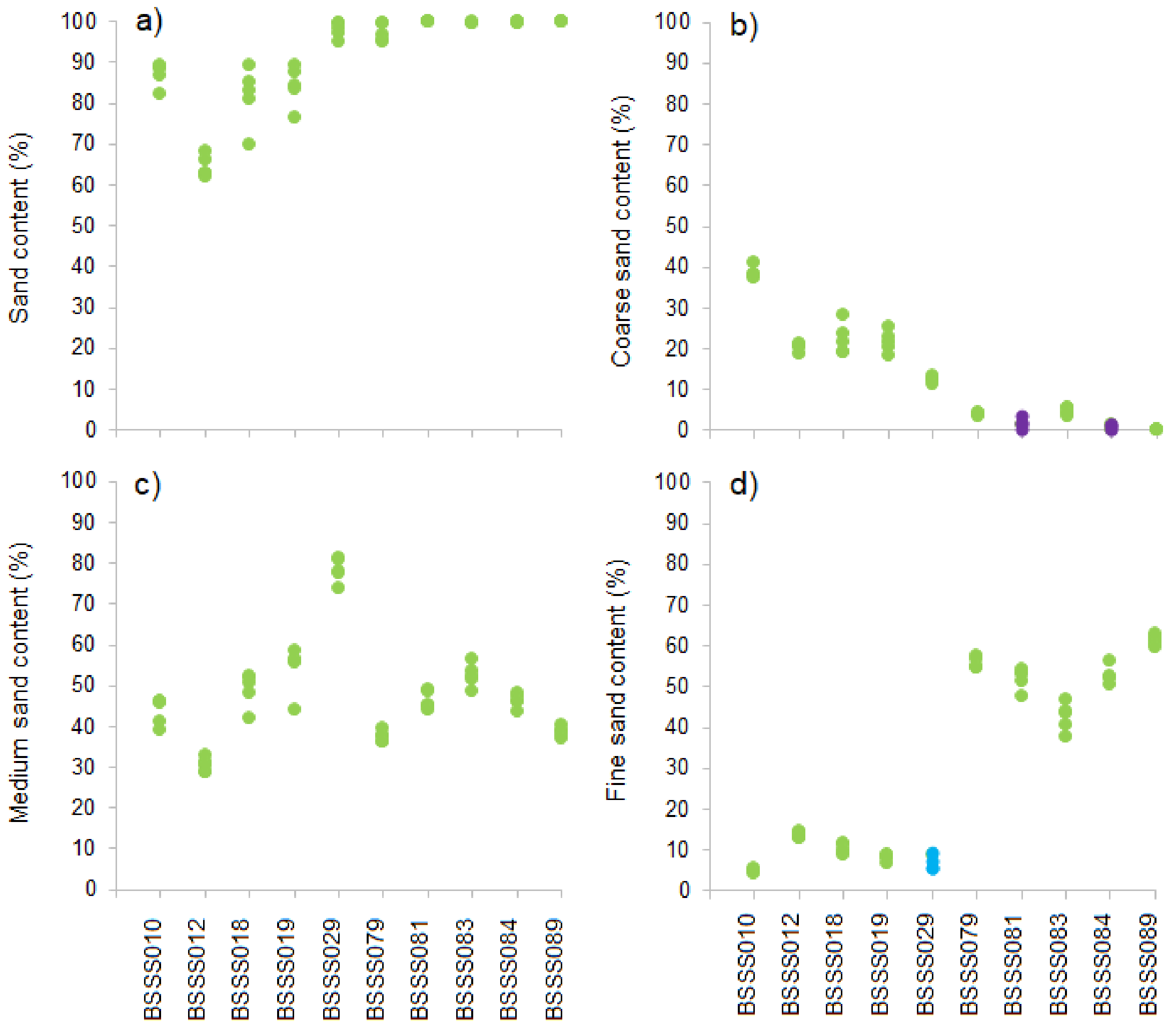

Figure 12. Contents of a) sand, b) coarse sand, c) medium sand and d) fine sand in the five replicate sediment samples collected at ten stations within the Bassurelle Sandbank SAC in 2017. Stations with a low (<25%) coefficient of variation (CV) are in green, medium (25-49%) CV are in blue and high (50-100%) CV are in purple. Coarse, medium and fine sand are expressed as a percentage of total sand content, not total sediment content.

Temporal variation

Inspection of spatial variation in EUNIS Level 3 Habitats using PSD data collected in 2013 and 2017 showed no large-scale temporal changes to habitat type (Figure 13), thus reaffirming the broad agreement between 2017 PSD data and predictions of the 2013 habitat map. Moreover, the station where three of five samples were classified as ‘A5.4 Sublittoral mixed sediments’ in 2017 is within the vicinity of the only station classified as this habitat type in 2013 (Figure 13). Inspection of spatial patterns in the contents of gravel, sand and mud also indicate very little change to sediment composition over time (Figure 14).

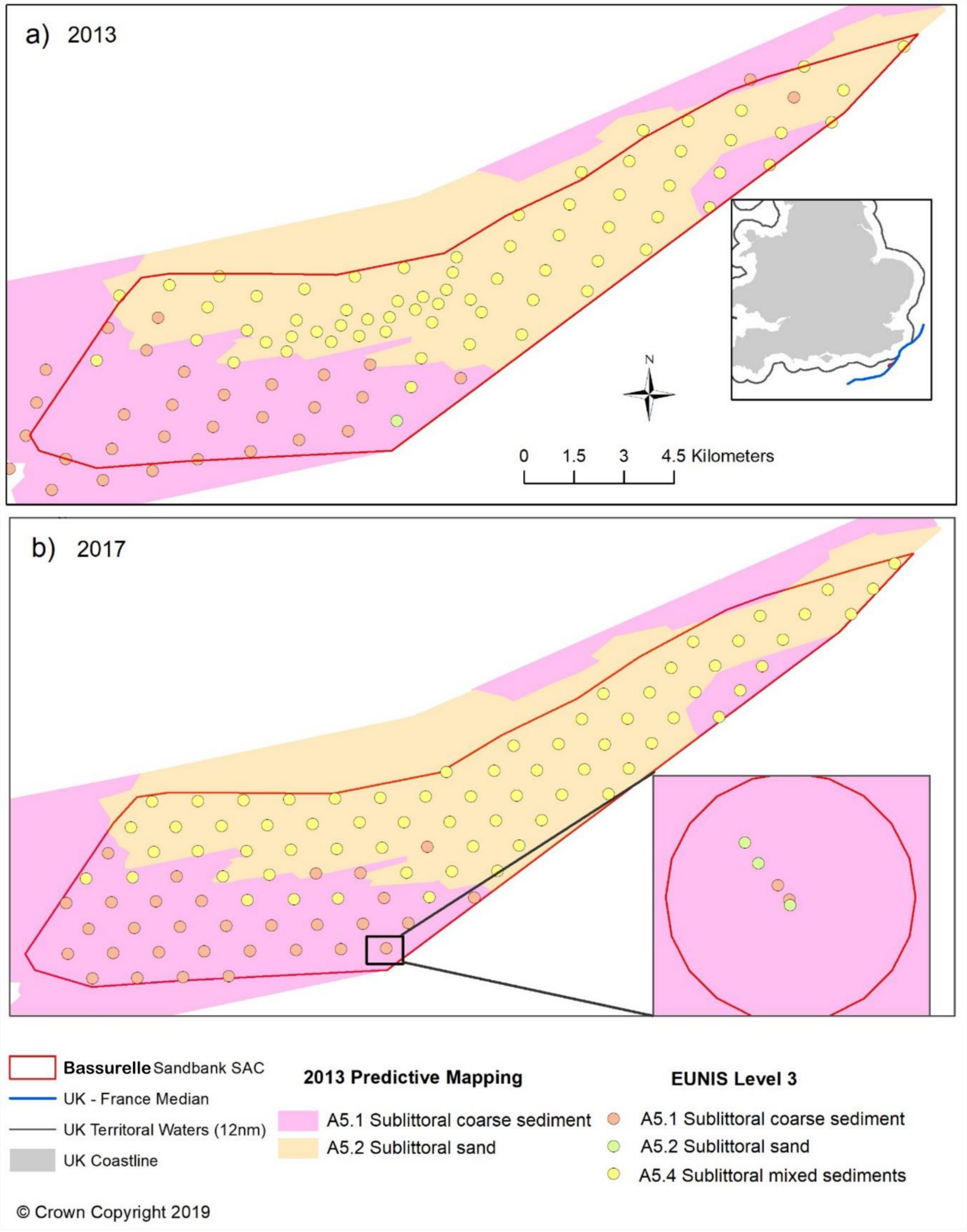

Figure 13. Spatial variation in EUNIS Level 3 Habitat type based on mini-Hamon Grab samples collected within the Bassurelle Sandbank SAC in a) 2013 and b) 2017. The underlying predicted habitat map is based on samples collected in 2013.

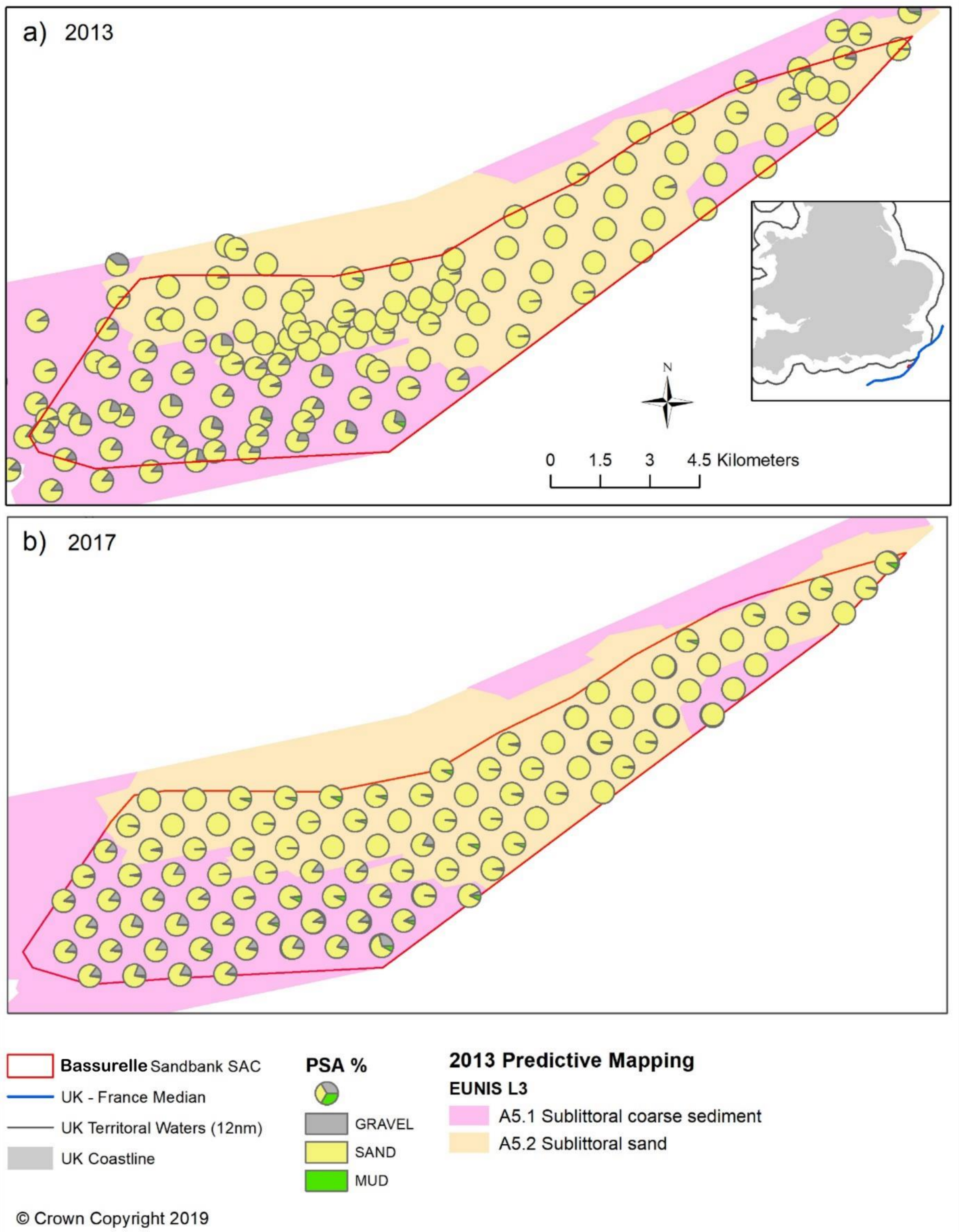

Figure 14. Spatial variation in the contents of gravel, sand and mud based on mini-Hamon Grab samples collected within the Bassurelle Sandbank SAC in a) 2013 and b) 2017. The underlying predicted habitat map is based on samples collected in 2013.

3.3 Biological structure

3.3.1 Infauna

Characteristic communities

Infaunal assemblages were represented by ten statistically distinct community clusters (SIMPROF: $p < 0.05$; Figure 15). Clusters a-d were mainly associated with 'A5.2 Sublittoral sand' and characterised by the polychaete *Nephtys cirrosa* and amphipods of the genus *Bathyporeia* (Table 4; Figure 16a). For cluster c, *Bathyporeia* species were not among the top five characteristic taxa, but *B. elegans* was in the top ten and *B. guilliamsoniana* in the top 15. The polychaetes *Magelona johnstoni* and *Scolelepis squamata* were notably abundant in clusters a and d, respectively. Clusters e-j were exclusively associated with 'A5.1 Sublittoral coarse sediment' and, except for cluster h, were characterised by the sea urchin *Echinocyamus pusillus* (Table 4; Figure 16a). Other taxa characteristic of multiple clusters include the polychaetes *Notomastus* spp. (e and g), *Poecilochaetus serpens* (e and g), *Syllis pontxioi* (h and i) and *Glycera lapidum* (i and j) and the bivalves *Asbjornsenia pygmaea* (e and h) and *Thracia villosiuscula* (f and h).

Clusters a-d were found in the north of the SAC, with cluster b occurring on both flanks along the length of the sandbank, cluster a occupying flatter areas at the foot of the flanks and the northern part of the megaripple field, cluster d comprising a single station in the megaripple field and cluster c occurring toward the southwestern limit of the sandbank (Figure 16b). Clusters e-j occupied areas south of the topographical extent of the sandbank, where the substrate was predicted (and confirmed) to be relatively coarse, with stations from each cluster tending to be aggregated on a finer spatial scale (Figure 16b).

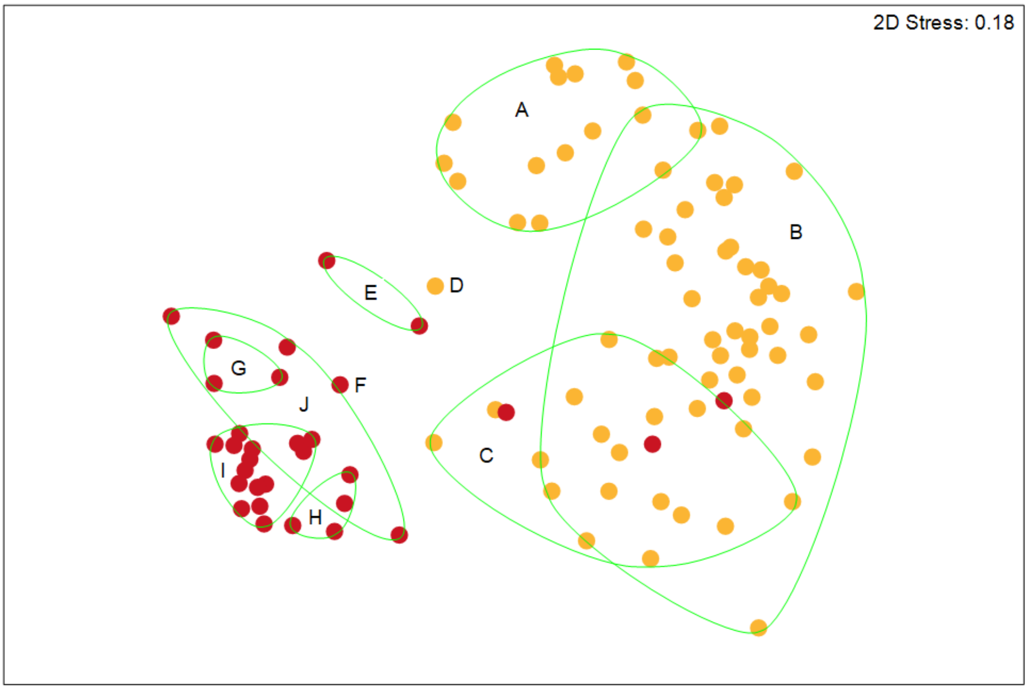

Figure 15. Non-metric multidimensional scaling ordination of infaunal community composition, based on $\log_e(x+1)$-transformed taxa abundances, in 'A5.1 Sublittoral coarse sediment' ● and 'A5.2 Sublittoral sand' ● within the Bassurelle Sandbank SAC in 2017. Clusters a-j (see Table 5) are indicated by green rings. The apparent overlap of clusters is due to the fairly high-level of 2D stress.

Table 4. The five taxa that contributed most to the internal similarity of statistically distinct infaunal community clusters observed in the Bassurelle Sandbank SAC in 2017 when taxa abundances were transformed by $\log_e(x+1)$. Where clusters consist of just one sample, the numerically dominant taxa are listed as the main taxa. *For cluster d, which only contained two taxa with an abundance greater than one, the third and fourth main taxa are shown because they are biotope-defining species; no fifth taxon is shown. The EUNIS Level 3 Habitats ('A5.1 Sublittoral coarse sediment' and 'A5.2 Sublittoral sand') associated with clusters are shown, with the numbers in brackets indicating how many stations were located on each habitat type.

Cluster	EUNIS	Percent similarity of stations	Main taxa	Average abundance (individuals per sample)	Percent contribution to similarity	Average similarity / standard deviation
a	A5.2 (14)	39.03	*Magelona johnstoni*	8.78	16.17	1.09
			Bathyporeia tenuipes	2.78	10.21	1.09
			Tellimya ferruginosa	2.53	9.47	1.00
			Nephtys cirrosa	1.29	8.84	2.02
			Poecilochaetus serpens	3.90	8.68	0.90
b	A5.2 (39) A5.1 (2)	32.06	*Nephtys cirrosa*	2.03	28.94	1.56
			Bathyporeia elegans	1.64	19.95	0.82
			Urothoe brevicornis	1.14	12.78	0.65
			Bathyporeia guilliamsoniana	1.05	11.17	0.76
			Scoloplos armiger	0.82	9.22	0.64
c	A5.2 (16) A5.1 (1)	28.68	*Nephtys cirrosa*	2.22	40.10	3.56
			Asbjornsenia pygmaea	1.75	23.94	1.33
			Spisula elliptica	0.45	5.42	0.44
			Eurydice spinigera	0.30	4.63	0.35
			Gastrosaccus spinifer	0.36	4.34	0.36
d		n/a	*Scolelepis squamata*	5	n/a	n/a

Cluster	EUNIS	Percent similarity of stations	Main taxa	Average abundance (individuals per sample)	Percent contribution to similarity	Average similarity / standard deviation
	A5.2 (1)		Polynoidae	3		
			*Nephtys cirrosa**	1		
			*Bathyporeia elegans**	1		
			*Abra alba**	1		
e	A5.1 (2)	32.25	*Notomastus* spp.	4.47	12.08	n/a
			Poecilochaetus serpens	10.36	12.08	
			Echinocyamus pusillus	4.31	10.40	
			Mediomastus fragilis	2.46	8.24	
			Asbjornsenia pygmaea	1.46	5.20	
f	A5.1 (1)	n/a	*Dipolydora saintjosephi*	32	n/a	n/a
			Cirriformia tentaculata	6		
			Aphelochaeta	5		
			Echinocyamus pusillus	5		
			Thracia villosiuscula	5		
g	A5.1 (3)	45.22	*Echinocyamus pusillus*	14.80	12.92	7.89
			Syllis garciai	5.75	7.35	9.73
			Poecilochaetus serpens	4.87	7.07	19.60
			Notomastus spp.	6.77	6.69	2.88
			Polynoidae	2.56	5.33	14.49
h	A5.1 (3)	50.17	*Syllis pontxioi*	3.66	10.35	20.98
			Asbjornsenia pygmaea	4.42	9.84	20.33
			Eulalia mustela	2.29	7.80	20.33
			Spisula elliptica	2.56	7.80	20.33
			Thracia villosiuscula	2.00	7.80	20.33
i	A5.1 (15)	51.16	*Aonides paucibranchiata*	9.07	8.26	3.00
			Echinocyamus pusillus	6.17	7.22	4.65
			Syllis pontxioi	4.99	6.73	4.89
			Glycera lapidum	3.14	4.82	2.05
			Glycymeris glycymeris	2.74	4.69	2.88
j	A5.1 (4)	35.75	*Echinocyamus pusillus*	5.42	17.03	4.77
			Diplodonta rotundata	2.78	9.22	2.80
			Lumbrineris aniara	3.06	9.05	0.90
			Glycera lapidum	1.64	8.73	3.59
			Nemertea	1.46	8.7	3.86

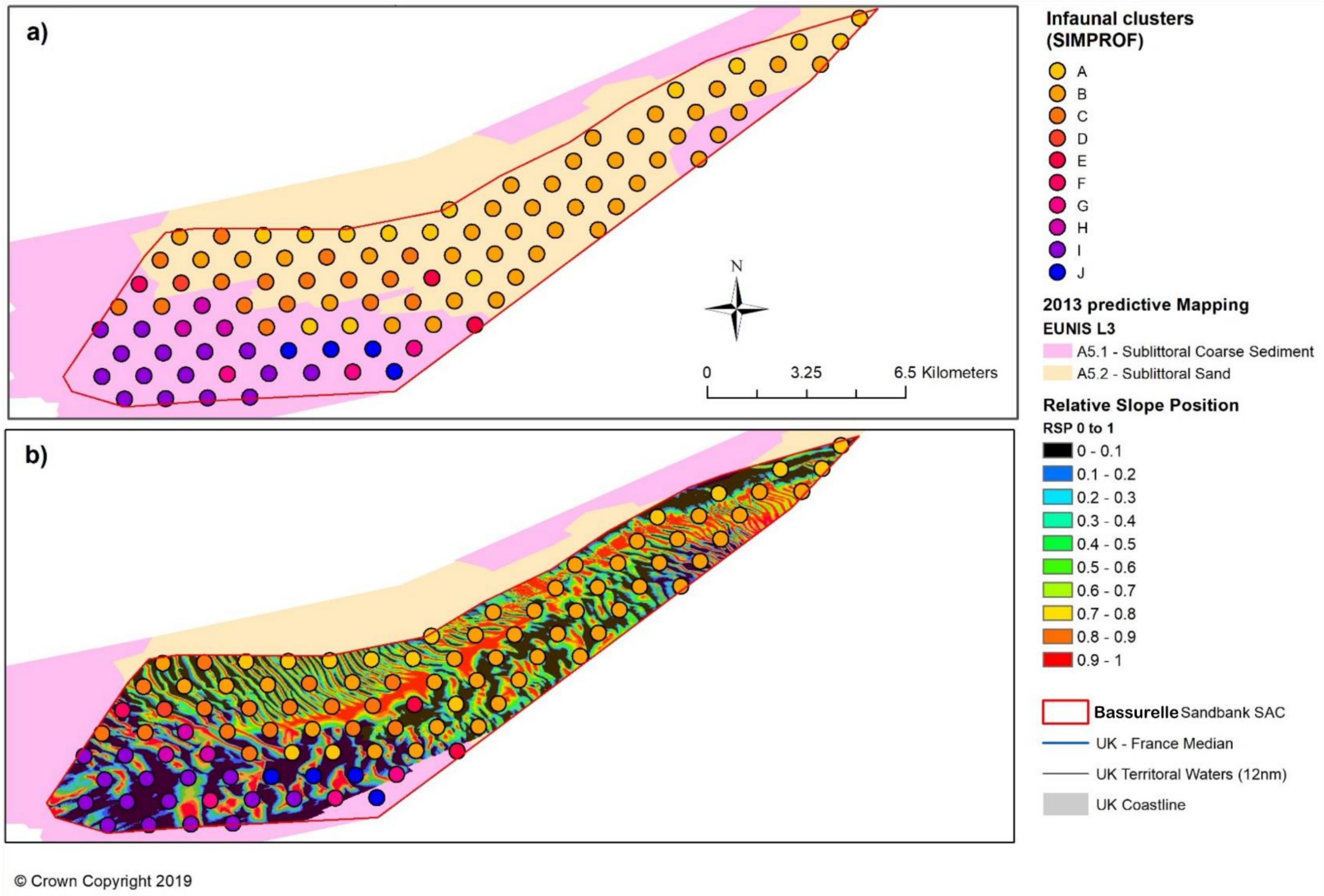

Figure 16. The spatial distribution of distinct ($p < 0.05$) infaunal community clusters within the Bassurelle Sandbank SAC in 2017. The similarity of communities from different clusters is indicated by their colour; a more similar colour indicates a more similar community composition. The underlying predicted habitat map in a) is based on samples collected in 2013 (Barrio-Froján *et al.* 2017) and the map of Relative Slope Position (RSP) in b) is based on data collected in 2014.

When data were grouped by EUNIS Level 3 Habitat type, infaunal communities in 'A5.1 Sublittoral coarse sediment' and 'A5.2 Sublittoral sand' were found to be highly distinct (ANOSIM: p <0.001; R = 0.74; SIMPER: 8% average similarity). Community variability within habitats was high (average similarity of 33% for 'A5.1' and 24% for 'A5.2'), but not substantially different from that observed for clusters associated with each habitat (i.e. 32-51% for clusters associated with 'A5.1' and 27-39% for those associated 'A5.2'). The taxa that characterised each habitat were largely the same as those that characterised community clusters associated with each habitat (Table 5).

Table 5. Taxa that contributed most to the internal similarity of infaunal community composition in 'A5.1 Sublittoral coarse sediment' (n = 31) and 'A5.2 Sublittoral sand' (n = 69) within the Bassurelle Sandbank SAC in 2017.

EUNIS	Similarity	Main taxa	Average abundance (individuals per sample)	Contribution to similarity (%)	Average similarity / standard deviation
A5.1	32.86	*Echinocyamus pusillus*	4.37	8.95	1.51
		Syllis pontxioi	2.63	6.74	1.20
		Nemertea	1.94	6.22	1.39
		Aonides paucibranchiata	3.22	5.72	0.91
		Glycera lapidum	1.94	5.11	1.09
		Thracia villosiuscula	1.46	4.27	0.96
		Notomastus spp.	1.64	4.18	1.00
		Syllis garciai	1.59	4.05	1.01
		Asbjornsenia pygmaea	1.36	3.35	0.84
		Epizoanthus couchii	0.72	3.13	1.14
A5.2	23.84	*Nephtys cirrosa*	1.89	33.20	1.52
		Bathyporeia elegans	0.90	11.54	0.49
		Urothoe brevicornis	0.68	7.86	0.42
		Magelona johnstoni	1.44	7.45	0.41
		Bathyporeia guilliamsoniana	0.67	7.34	0.50
		Scoloplos armiger	0.58	6.08	0.46
		Asbjornsenia pygmaea	0.39	3.18	0.28
		Magelona filiformis	0.48	2.81	0.32
		Nemertea	0.31	2.30	0.28
		Tellimya ferruginosa	0.45	1.72	0.23

As with community composition, there were substantial differences between 'A5.1 Sublittoral coarse sediment' and 'A5.2 Sublittoral sand' for the set of univariate indices used to describe infaunal density and diversity (ANOVA: p <0.05; Figure 17; Table 14 in Annex 6). Mean total abundance, species richness, Margalef Index and Shannon Index were all higher in 'A5.1 Sublittoral coarse sediment' than in 'A5.2 Sublittoral sand' (Figure 17).

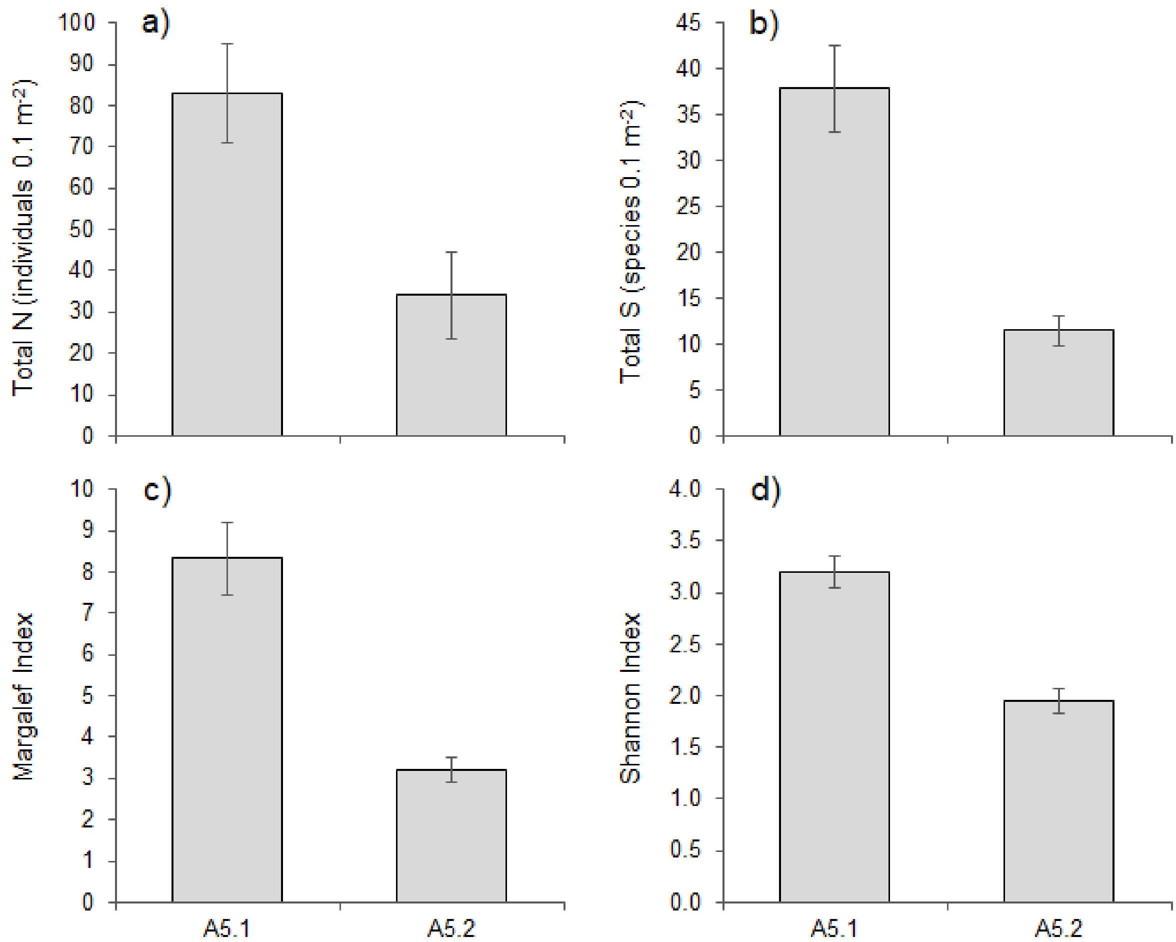

Figure 17. Mean and 95% confidence intervals of a) total abundance, b) total number of species (species richness), c) Margalef Index, and d) Shannon Index of infauna in ‘A5.1 Sublittoral coarse sediment’ (n = 31) and ‘A5.2 Sublittoral sand’ (n = 69) within the Bassurelle Sandbank in 2017.

Within-station variability

Analysis of small-scale (within-station) spatial variability in infaunal community composition revealed that average replicate similarity ranged from 36-56% (Table 6). The only station that was assigned multiple EUNIS Level 3 Habitats based on replicate sediment samples, BSSS012, was one of the least variable stations in terms of infaunal community composition. One of the two stations with the highest small-scale spatial variability in infaunal community composition, BSSS019, was located on ‘A5.1 Sublittoral coarse sediment’ while the other, BSSS029, was located on ‘A5.2 Sublittoral sand’. Therefore, no clear effect of habitat type on small-scale spatial variability in infaunal communities was apparent.

Replicate samples from the same station were generally grouped together by SIMPROF (i.e. they were not significantly different; $p > 0.05$), indicating that a single sample generally provides a good indication of the community composition at a station. However, a single sample from BSSS019, BSSS029, BSSS083 and BSSS084 clustered into different groups than the other four samples from the same station ($p < 0.05$; Figure 18). The level of within-habitat community similarity, based on the ten stations where replicate samples were collected, increased from 32% to 44% for ‘A5.1 Sublittoral coarse sediment’ and from 31% to 49% for ‘A5.2 Sublittoral sand’ when the number of samples increased from one to five. Therefore, by collecting a single sample per station and not capturing within-station variability, the level of within-habitat variability can be overestimated.

Table 6. The percent similarity in infaunal community composition of replicate samples (n = 5) collected at stations within the Bassurelle Sandbank SAC in 2017. The EUNIS Level 3 Habitats ('A5.1 Sublittoral coarse sediment', 'A5.2 Sublittoral sand' and 'A5.4 Sublittoral mixed sediments') that stations were located on are shown, with the numbers in brackets indicating how many stations were located on each habitat type.

Station	EUNIS	Percent similarity of samples
BSSS010	A5.1 (5)	54.18
BSSS012	A5.1 (2), A5.4 (3)	51.42
BSSS018	A5.1 (5)	46.71
BSSS019	A5.1 (5)	35.96
BSSS029	A5.2 (5)	35.62
BSSS079	A5.2 (5)	50.08
BSSS081	A5.2 (5)	49.06
BSSS083	A5.2 (5)	45.31
BSSS084	A5.2 (5)	40.37
BSSS089	A5.2 (5)	56.00

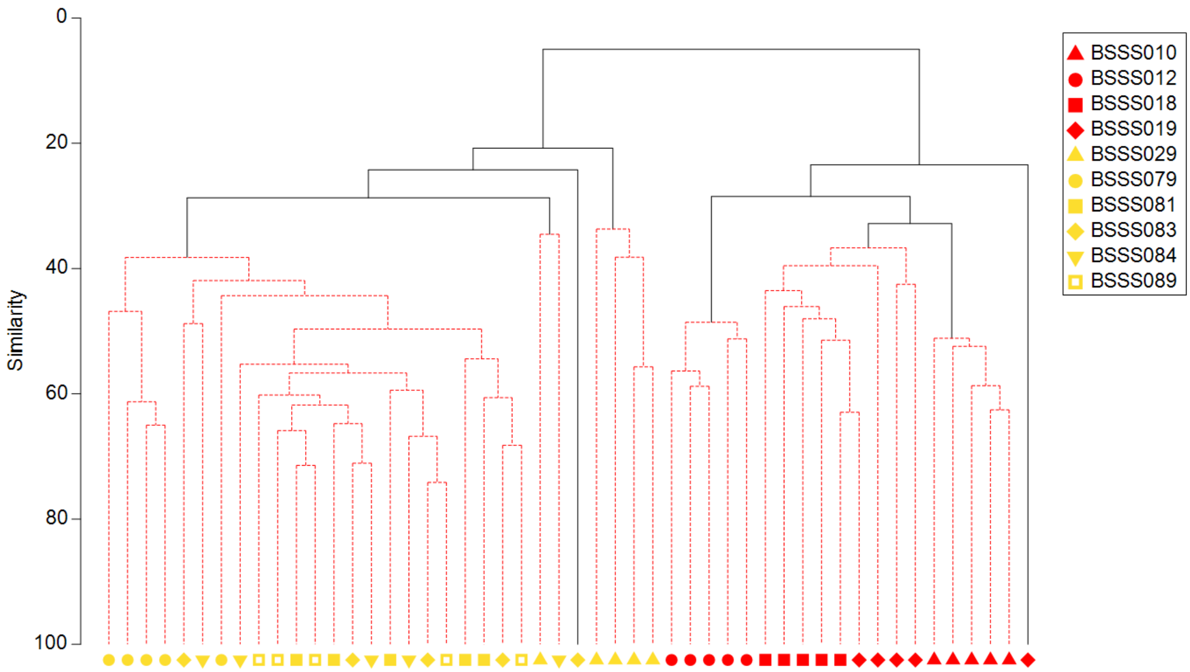

Figure 18. Dendrogram of infaunal community composition, based on $log_e(x+1)$-transformed taxa abundances, of the five replicate samples collected from ten stations within the Bassurelle Sandbank SAC in 2017. Distinct clusters (significantly different at *p* <0.05) are separated by black branches. Samples within the same cluster (not significantly different from each other) are separated by red branches. Stations with red symbols are from 'A5.1 Sublittoral coarse sediment' and stations with yellow symbols are from 'A5.2 Sublittoral sand'. Note, however, that three of the samples at BSSS012 were classified as 'A5.4 Sublittoral mixed sediments'.

Of the four univariate biotic indices considered, total abundance had the highest small-scale (within-station) spatial variability, with the CV in the 'medium' range at seven stations, in the 'high' range at one station and in the 'low' range at two stations (Figure 19a). For species richness, five stations were in the 'medium' range and five were in the 'low' range (Figure 19b). All stations were in the 'low' range for the Margalef Index and the Shannon Index (Figure 19c & d, respectively).

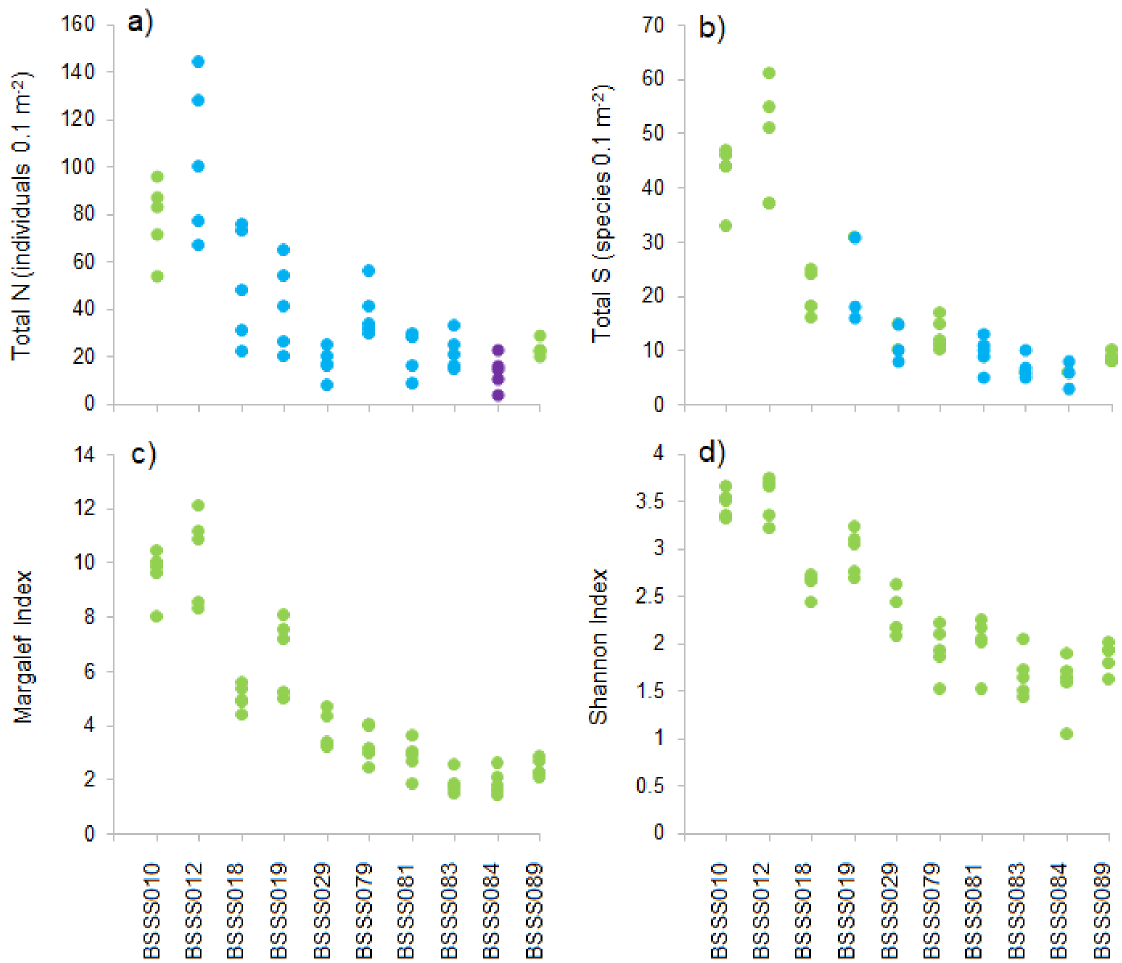

Figure 19. Small-scale (within-station) spatial variability in a) total abundance (N), b) total number of species (S), c) Margalef Index and d) Shannon Index for the five replicate samples collected at ten stations within the Bassurelle Sandbank SAC in 2017. Stations with a low (< 25%) coefficient of variation (CV) are in green, medium (25-49%) CV are in blue and high (50-100%) CV are in purple.

The number of infaunal taxa in a single sample had a strong (Pearson's R^2 = 0.85) positive linear relationship with the number of taxa recorded in all five replicate samples from the same station (Figure 20a) and a slightly weaker (R^2 = 0.74) relationship with the estimated total number of taxa at the station based on the Michaelis-Menton model (*Smax*; Figure 20b). Increasing replication from one to five samples per station generally reduced within-habitat variability in the univariate indices considered, though in 'A5.1 Sublittoral coarse sediment' this had the opposite effect on the Shannon Index and did not affect within-habitat variability in the Margalef Index (Table 7).

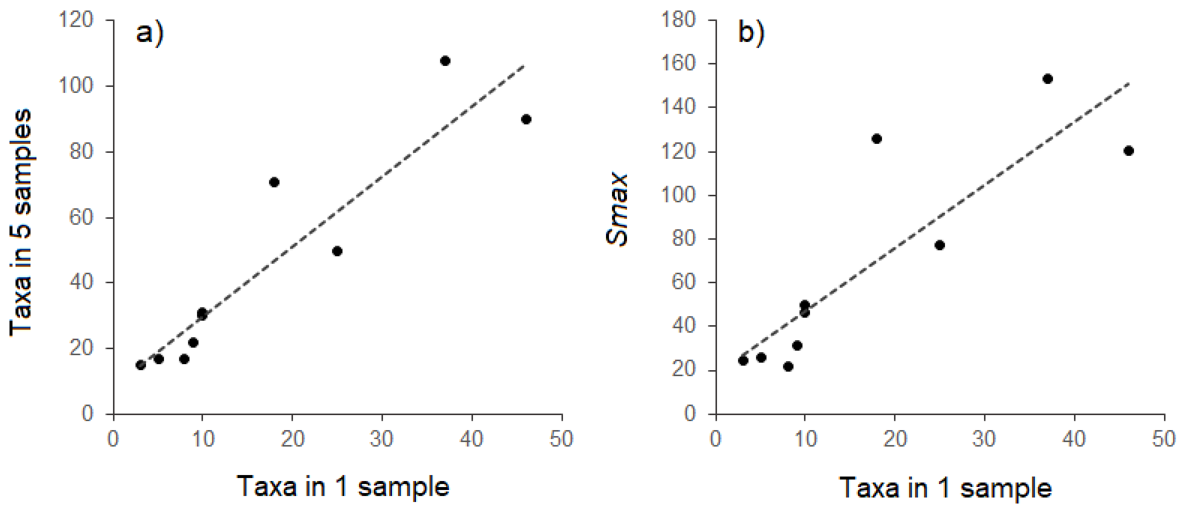

Figure 20. Relationships between the number of taxa in the first grab sample collected and a) the number in all five samples collected at the same station (R^2 = 0.85) and b) the estimated total number of taxa at the same station based on the Michaelis-Menton model (*Smax*) (R^2 = 0.74).

Table 7. Within-habitat variability (coefficient of variation) for the total number of species (S), total abundance (N), Margalef Index and Shannon Index in ‘A5.1 Sublittoral coarse sediment’ and ‘A5.2 Sublittoral sand’ when values for each station were calculated from one sample vs five replicate samples.

BSH	no. samples	Total S	Total N	Margalef	Shannon
A5.1	1	0.40	0.44	0.31	0.11
	5	0.31	0.41	0.31	0.14
A5.2	1	0.38	0.63	0.32	0.25
	5	0.32	0.37	0.28	0.14

Temporal variation

Analysis of temporal variation in infaunal community composition revealed minor, but statistically significant ($p < 0.05$) changes. Differences between 2013 and 2017 were larger for ‘A5.1 Sublittoral coarse sediment’ (ANOSIM: $p < 0.001$; R = 0.32; Figure 21a) than for ‘A5.2 Sublittoral sand’ (ANOSIM: $p < 0.001$; R = 0.09; Figure 21b). The taxa that contributed most to compositional dissimilarity were largely those that characterised respective EUNIS Level 3 Habitats, most of which occurred in higher abundances in 2017 (seven of the top ten in ‘A5.1 Sublittoral coarse sediment’; six of the top ten in ‘A5.2 Sublittoral sand’; Table 8). Of the 79 taxa that together contributed 70% of community dissimilarity in ‘A5.1 Sublittoral coarse sediment’, eight were recorded only in 2013 and twelve were recorded only in 2017 (Table 9). None of the taxa that contributed 70% of community dissimilarity in ‘A5.2 Sublittoral sand’ were recorded in only one year.

There were no significant differences in total abundance, species richness, Margalef Index or Shannon Index between 2013 and 2017 in ‘A5.1 Sublittoral coarse sediment’ (ANOVA: $p \geq 0.05$; Figure 22; Table 15 in Annex 6). In ‘A5.2 Sublittoral sand’, there was a significant increase in each of these indices over time (ANOVA: $p < 0.05$; Figure 22; Table 16 in Annex 6).

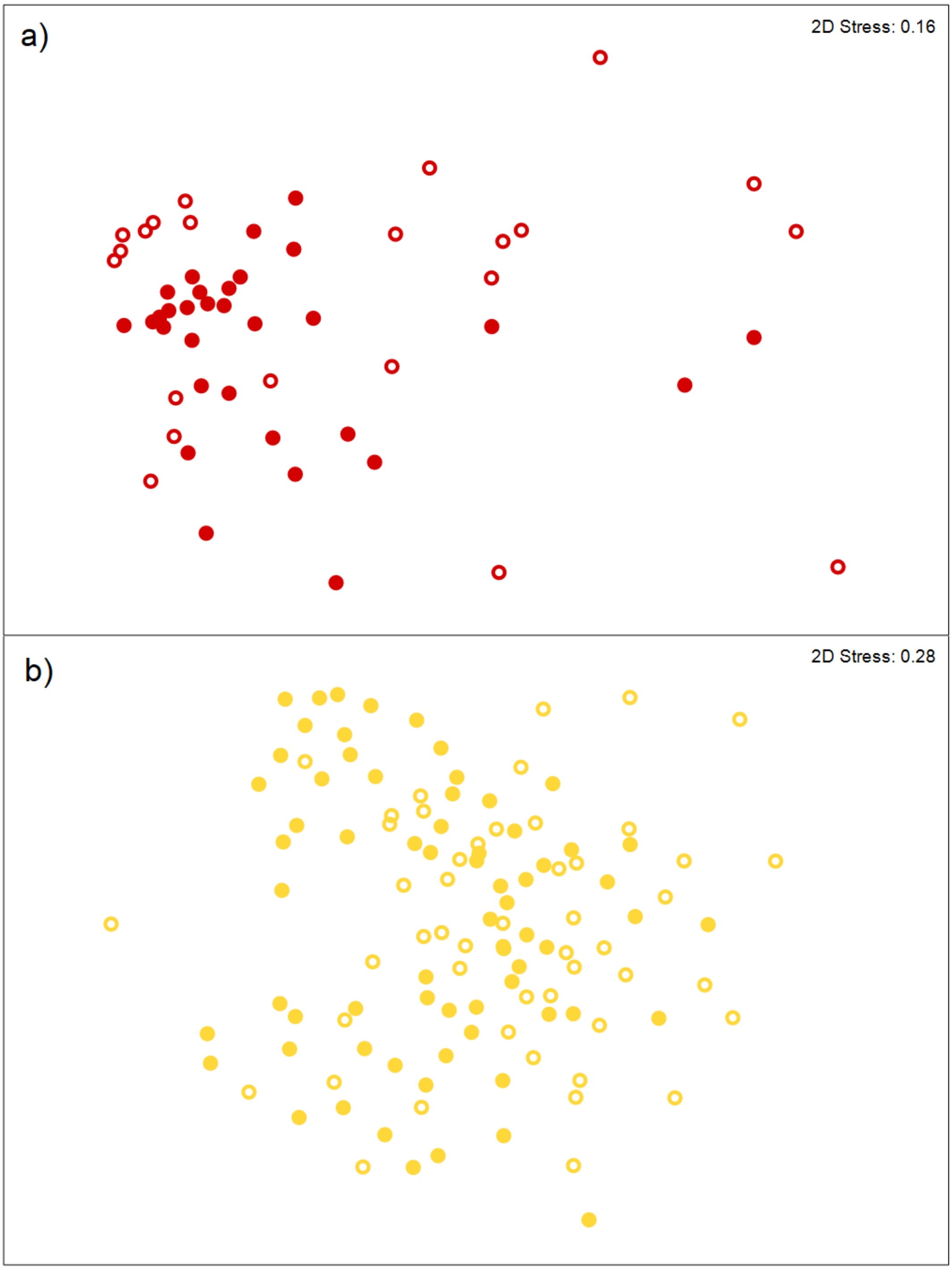

Figure 21. Non-metric multidimensional scaling ordination of community composition, based on $\log_e(x+1)$-transformed taxa abundances, in 2013 (hollow circles) and 2017 (solid circles) for infauna associated with a) 'A5.1 Sublittoral coarse sediment' and b) 'A5.2 Sublittoral sand' within the Bassurelle Sandbank SAC. An anomalous data point, representing a highly distinct assemblage in 2013, has been removed from panel b) to facilitate the interpretation of the broad temporal pattern. Two-dimensional stress is high for panel b) and therefore the representation of community dissimilarity is limited.

Table 8. Taxa that contributed most to dissimilarity in infaunal community composition between 2013 and 2017 in 'A5.1 Sublittoral coarse sediment' and 'A5.2 Sublittoral sand' within the Bassurelle Sandbank SAC.

EUNIS	Main taxa	Average abundance 2013	Average abundance 2017	Contribution to dissimilarity (%)	Average dissimilarity / standard deviation
A5.1	*Echinocyamus pusillus*	4.99	4.37	2.54	1.22
	Aonides paucibranchiata	1.44	3.22	2.40	1.13
	Syllis pontxioi	1.05	2.63	2.07	1.21
	Glycera lapidum	2.42	1.94	1.96	1.26
	Notomastus spp.	0.43	1.64	1.77	1.19
	Nemertea	2.86	1.94	1.73	1.06
	Asbjornsenia pygmaea	0.99	1.36	1.66	0.91
	Thracia villosiuscula	0.60	1.46	1.61	1.09
	Syllis garciai	1.01	1.59	1.58	1.16
	Glycymeris glycymeris	0.65	1.23	1.54	1.11
A5.2	*Magelona johnstoni*	0.75	1.44	7.09	0.91
	Bathyporeia elegans	0.51	0.90	5.90	0.89
	Nephtys cirrosa	1.89	1.89	5.06	1.00
	Urothoe brevicornis	0.43	0.68	4.80	0.85
	Scoloplos armiger	0.65	0.58	4.74	0.92
	Bathyporeia guilliamsoniana	0.34	0.67	4.32	0.91
	Magelona filiformis	0.32	0.48	3.31	0.77
	Asbjornsenia pygmaea	0.15	0.39	3.17	0.60
	Echinocardium cordatum	0.48	0.17	3.08	0.73
	Ophelia borealis	0.43	0.06	2.98	0.71

Table 9. Taxa that were recorded only in one year (2013 or 2017) and contributed to a cumulative 70% of infaunal community dissimilarity in 'A5.1 Sublittoral coarse sediment' between years.

Taxa	Average abundance 2013	Average abundance 2017	Contribution to dissimilarity (%)	Average dissimilarity / standard deviation
Pseudonotomastus southerni	0.71	0	1.17	0.85
Lumbrineris cingulata	0.46	0	0.86	0.87
Syllis hyalina	0.53	0	0.81	0.67
Scrupocellaria scruposa	0.35	0	0.54	0.88
Polygordius appendiculatus	0.37	0	0.49	0.57
Polycirrus denticulatus	0.33	0	0.48	0.60
Leiochone johnstoni	0.24	0	0.43	0.72
Puellina innominata	0.28	0	0.43	0.51
Dipolydora saintjosephi	0	0.95	1.17	0.79
Lumbrineris aniara	0	0.55	0.96	0.57
Polynoidae	0	0.67	0.91	0.87
Cribrilaria innominata	0	0.52	0.78	1.06
Hemiasterellidae	0	0.49	0.72	1.03

Taxa	Average abundance 2013	Average abundance 2017	Contribution to dissimilarity (%)	Average dissimilarity / standard deviation
Chorizopora brongniartii	0	0.49	0.71	1.04
Syllis armillaris	0	0.48	0.67	0.69
Gastrosaccus spinifer	0	0.34	0.64	0.58
Goodallia triangularis	0	0.42	0.62	0.59
Cliona celata	0	0.36	0.56	0.81
Polygordius spp.	0	0.31	0.54	0.41
Dosinia lupinus	0	0.32	0.47	0.46

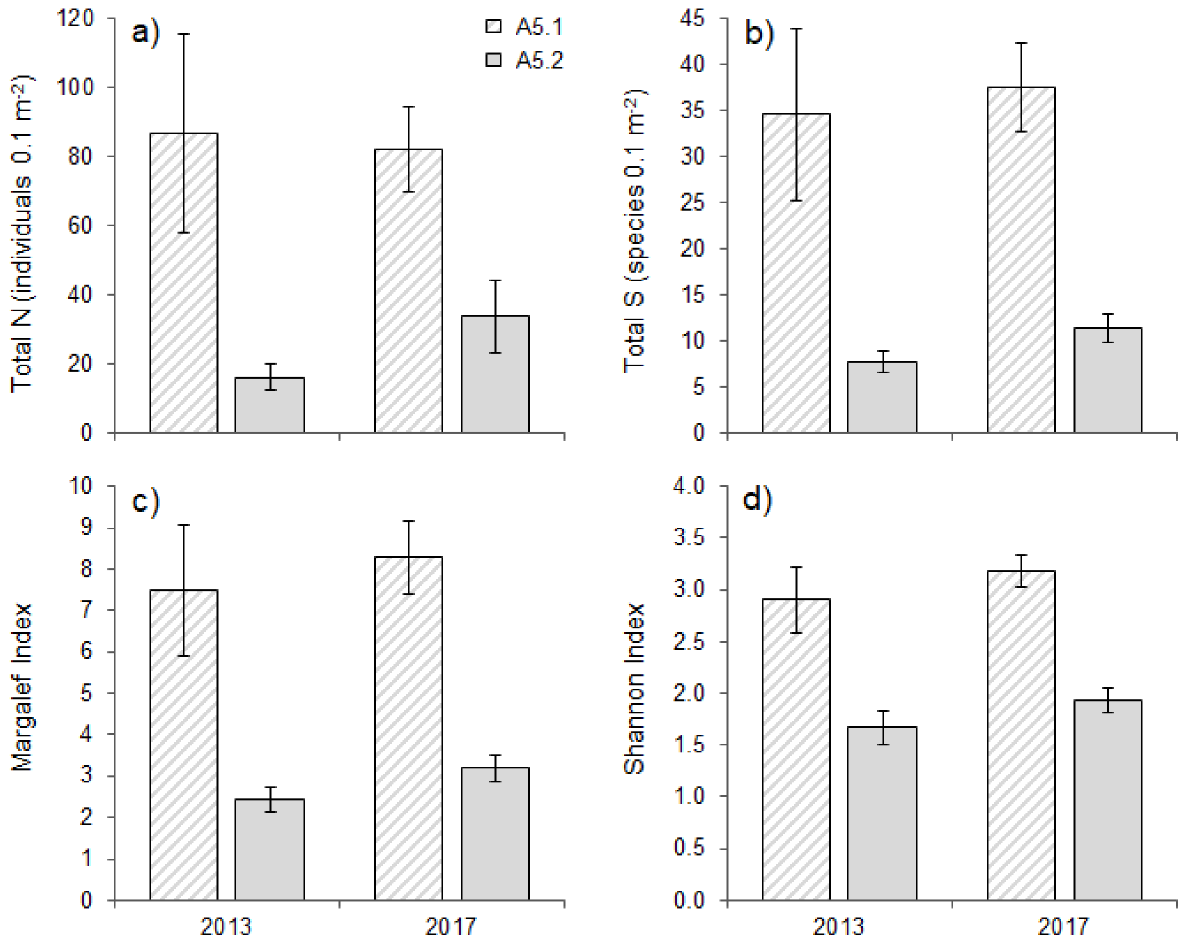

Figure 22. Mean and 95% confidence intervals of a) total abundance, b) total number of species (species richness), c) Margalef Index, and d) Shannon Index of infauna associated with 'A5.1 Sublittoral coarse sediment' (hatched bars) and 'A5.2 Sublittoral sand' (solid bars) in the Bassurelle Sandbank SAC in 2013 (n = 22 and 31 for A5.1 and A5.2, respectively) and 2017 (n = 31 and 69 for A5.1 and A5.2, respectively).

3.3.2 Epifauna

Characteristic communities

After removing data for the hermit crabs *Pagurus bernhardus* and *P. prideaux* and the latter's associated (symbiotic) anemone *Adamsia palliata*, which had a large influence on results due to their high abundance and wide distribution throughout the SAC, epifaunal assemblages were represented by eight statistically distinct community clusters (SIMPROF: $p < 0.05$; Figure 23). The hermit crabs *P. bernhardus* and *P. prideaux* were highly abundant at all stations sampled with a beam trawl but were particularly prevalent in clusters e and g (Figure 25).

Clusters tended to occur within a single EUNIS Level 3 Habitat (Table 10; Figure 24a). Clusters c and d were associated with 'A5.1 Sublittoral coarse sediment' and were characterised by the sea urchin *Psammechinus miliaris* and scallop *Aequipecten opercularis*, with the starfish *Asterias rubens* and crab *Atelecyclus rotundatus* also among the top contributors to community similarity. Clusters f-h were associated with 'A5.2 Sublittoral sand' and were characterised by the sea potato *Echinocardium cordatum* and whelk *Nassarius reticulatus*, with the shrimp *Pontophilus* sp. common in cluster f and hydroids including *Hydrallmania falcata* and *Nemertesia* sp. common in cluster h. Cluster a was also associated with 'A5.2 Sublittoral sand' but was characterised by very low diversity, with *Pontophilus* sp. contributing to over 60% of community similarity. Cluster b (station BSSS012) was the only station associated with 'A5.4 Sublittoral mixed sediments' and was dominated by *P. miliaris*, the scallop *Pecten maximus* and ascidians. Cluster e was the only one split between habitats, 'A5.1 Sublittoral coarse sediment' and 'A5.2 Sublittoral sand', and was characterised mainly by *A. opercularis*, *P. miliaris* and the crab *Liocarcinus holsatus*.

The spatial distribution of clusters reflects the large-scale topography of the site, with clusters a and f occupying the summit and southern flank of the sandbank, cluster h found along the foot of the northern flank of the sandbank, clusters e and g located in the megaripple field on the north-western flank and clusters b-d occupying areas of relatively coarse substrate to the south and south-west of the sandbank (Figure 24b).

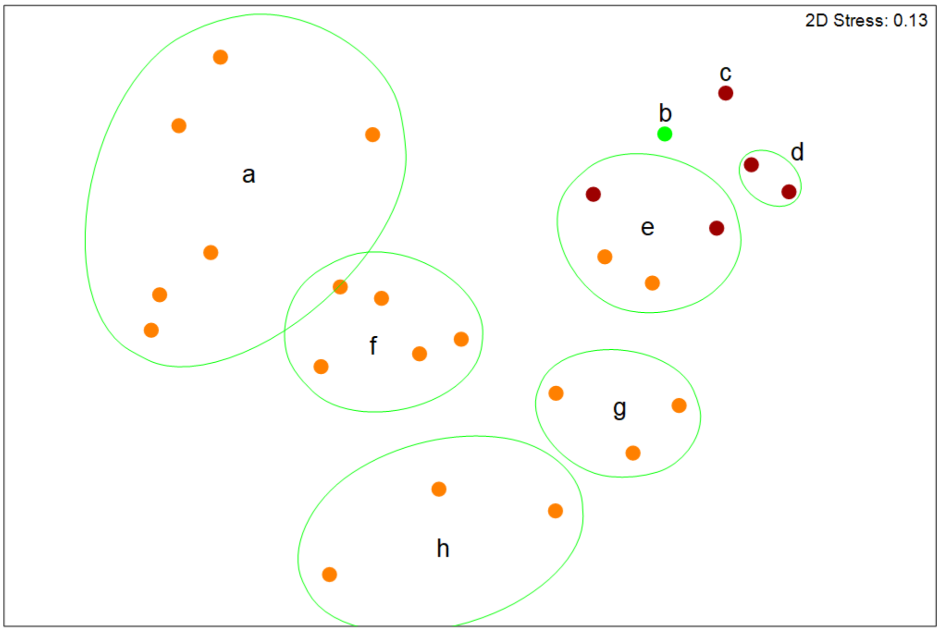

Figure 23. Non-metric multidimensional scaling ordination of epifaunal community composition, based on log_e (x+1)-transformed taxa abundances, in ‘A5.1 Sublittoral coarse sediment’ ● , ‘A5.2 Sublittoral sand’ ● and ‘A5.4 Sublittoral mixed sediments’ ● within the Bassurelle Sandbank SAC in 2017. Clusters a-h (see Table 10) of more than one station are indicated by green rings. The data presented exclude three abundant and widespread taxa (*Pagurus bernhardus*, *P. prideaux* and *Adamsia palliata*) which, when included, dominate community patterns.

Table 10. Taxa that contributed most to the internal similarity of statistically distinct epifaunal community clusters observed in the Bassurelle Sandbank SAC in 2017. Where clusters consist of just one sample, the numerically dominant taxa are listed as the main taxa. The EUNIS Level 3 Habitats (‘A5.1 Sublittoral coarse sediment’, ‘A5.2 Sublittoral sand’ and ‘A5.4 Sublittoral mixed sediments’) that clusters were associated with are shown, with the numbers in brackets indicating how many stations were located on each habitat type.

Cluster	EUNIS	Percent similarity of stations	Main taxa	Average abundance	Percent contribution to similarity	Average similarity / standard deviation
a	A5.2 (6)	49.89	*Pontophilus* sp.	41.10	66.25	6.95
			Hydroidolina	1.18	10.96	1.29
			Nassarius reticulatus	0.82	6.42	0.76
			Hydrallmania falcata	0.82	5.89	0.78
			Corystes cassivelaunus	0.77	3.73	0.47
b	A5.4 (1)	n/a	*Psammechinus miliaris*	197.34	n/a	n/a
			Pecten maximus	126.74		
			Ascidiidae	39.85		
			Pisidia longicornis	31.14		
			Mytilus edulis	19.09		
c	A5.1 (1)	n/a	*Psammechinus miliaris*	98.48	n/a	n/a
			Asterias rubens	44.15		
			Aequipecten opercularis	42.82		
			Glycymeris glycymeris	22.10		
			Dentaliidae	20.98		
d	A5.1 (2)	78.10	*Psammechinus miliaris*	78.04	10.49	n/a
			Atelecyclus rotundatus	37.86	8.58	
			Aequipecten opercularis	26.11	7.16	
			Macropodia tenuirostris	19.09	6.71	
			Glycymeris glycymeris	10.94	6.15	

Cluster	EUNIS	Percent similarity of stations	Main taxa	Average abundance	Percent contribution to similarity	Average similarity / standard deviation
e	A5.1 (2) A5.2 (2)	60.91	*Aequipecten opercularis*	20.33	12.35	11.45
			Psammechinus miliaris	19.09	11.03	4.52
			Liocarcinus holsatus	8.68	9.60	10.85
			Pontophilus sp.	10.25	9.31	5.39
			Asterias rubens	5.30	7.29	13.57
f	A5.2 (5)	63.17	*Nassarius reticulatus*	45.99	24.72	4.85
			Pontophilus sp.	21.87	18.92	2.38
			Echinocardium cordatum	4.31	9.52	6.03
			Hydroidolina	2.00	8.01	9.56
			Hydrallmania falcata	1.77	6.75	5.06
g	A5.2 (3)	67.55	*Echinocardium cordatum*	40.68	17.20	25.20
			Nassarius reticulatus	23.05	11.73	1.73
			Psammechinus miliaris	14.18	11.72	28.92
			Actiniaria	21.42	11.27	2.01
			Aequipecten opercularis	4.87	7.18	9.94
h	A5.2 (3)	48.60	*Echinocardium cordatum*	5.69	20.8	11.27
			Hydrallmania falcata	1.61	11.79	3.72
			Hydroidolina	1.29	9.93	7.57
			Nemertesia sp.	0.99	9.93	7.57
			Aequipecten opercularis	1.92	6.84	0.58

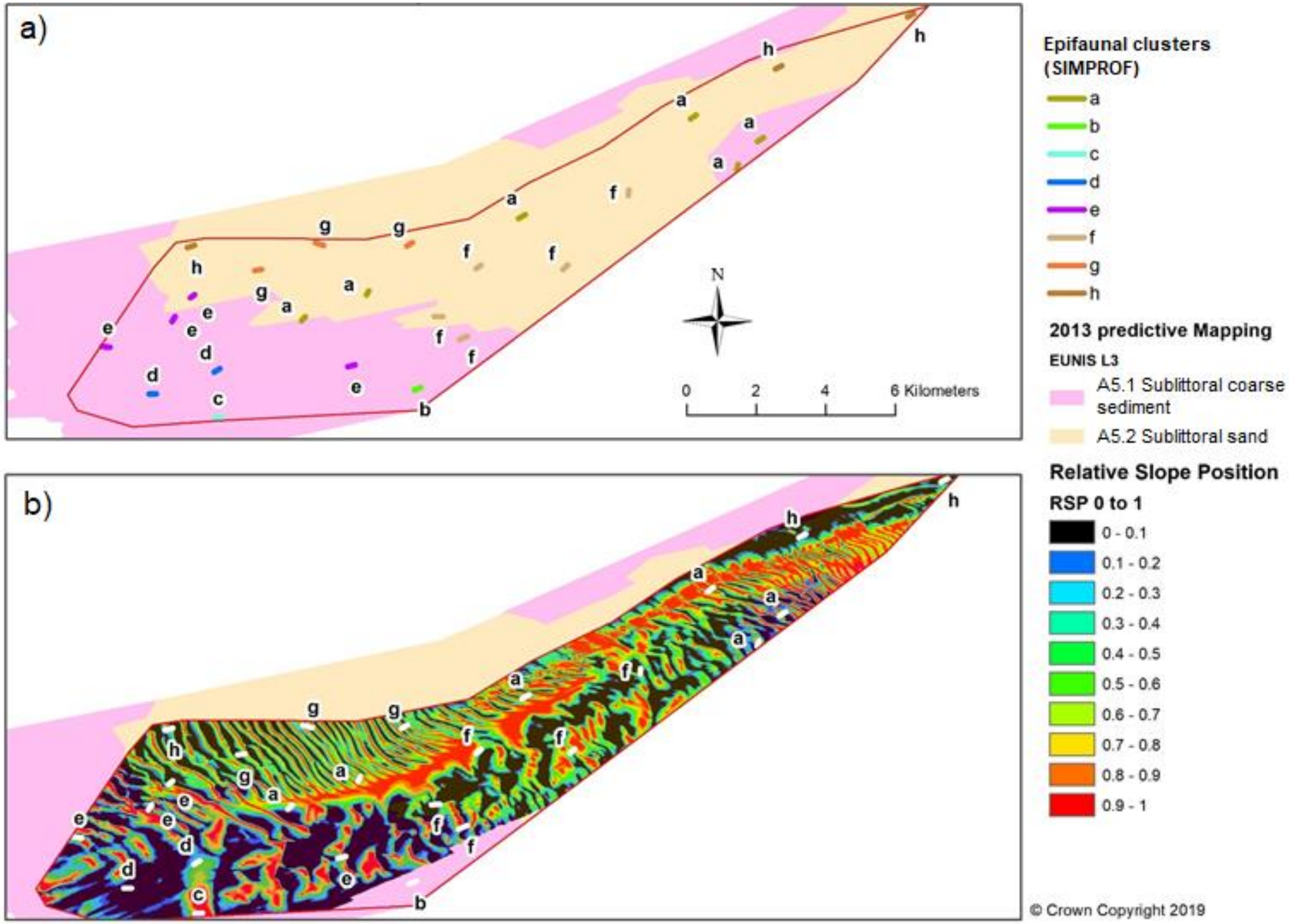

Figure 24. The spatial distribution of epifaunal community clusters within the Bassurelle Sandbank SAC in 2017. The similarity of communities from different clusters is indicated by their colour; those that are more similar in composition are more similar in colour, whereas those that are more dissimilar in composition are more dissimilar in colour. The underlying predicted habitat map in a) is based on samples collected in 2013 and the map of Relative Slope Position (RSP) in b) is based on data collected in 2014.

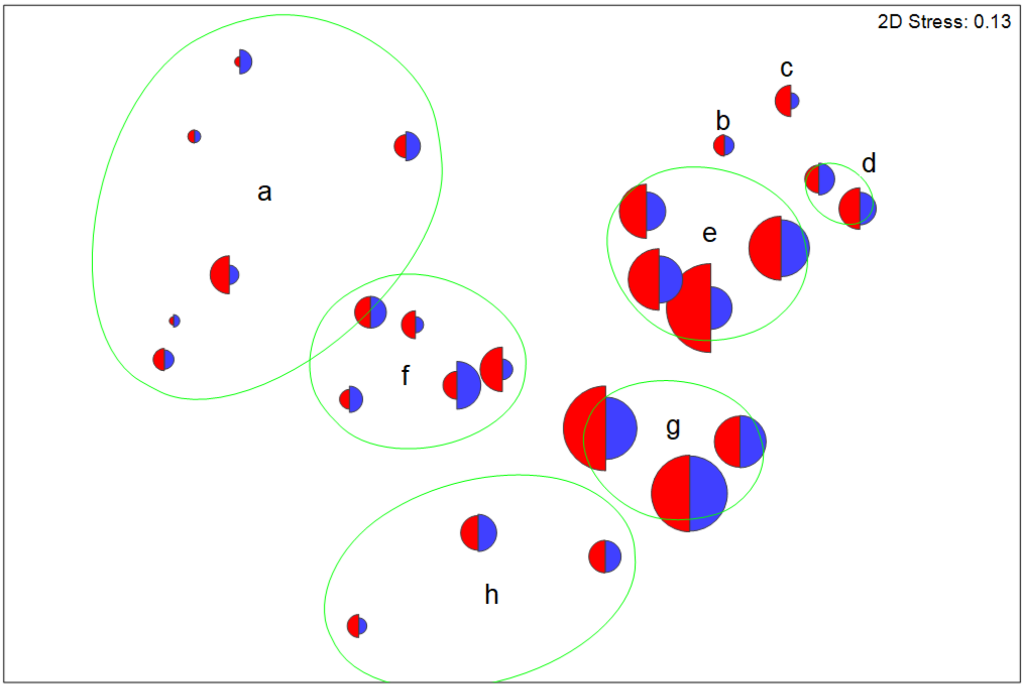

Figure 25. Non-metric multidimensional scaling ordination of epifaunal community composition, based on loge(x+1)-transformed taxa abundances, with abundances of *Pagurus bernhardus* ◖ (3-106 individuals) and *Pagurus prideaux* ◗ (2-222 individuals) overlain. Clusters a-h (see Table 10) are indicated by green rings.

Further analysis of community variation across EUNIS Level 3 Habitats (with Pagurids and *A. carciniopados* included in the dataset to reflect the level of within- and between-habitat variability for the full community) revealed statistically significant differences, with a low to moderate effect size (ANOSIM: p <0.001, global R = 0.49). For the pairwise comparisons, the highest effect size and only significant difference was between ‘A5.1 Sublittoral coarse sediment’ and ‘A5.2 Sublittoral sand’ (ANOSIM: p <0.001, R = 0.53), indicating that this difference is driving the “global” variation across habitats. However, the ability for ANOSIM to distinguish ‘A5.4 Sublittoral mixed sediments’ from other habitats will have been reduced by its low sample size (n = 1). In terms of average between-habitat similarity, ‘A5.2 Sublittoral sand’ was approximately as different from ‘A5.4 Sublittoral mixed sediments’ as it was from ‘A5.1 Sublittoral coarse sediment’ (SIMPER: 39% and 40% average similarity, respectively), whereas ‘A5.1 Sublittoral coarse sediment’ and ‘A5.4 Sublittoral mixed sediments’ were relatively similar (SIMPER: 61% average similarity).

Community variability within habitats was low compared to infauna (average similarity of 64% for ‘A5.1’ and 51% for ‘A5.2’; no average similarity for A5.4 as n =1). For ‘A5.2 Sublittoral sand’, within-habitat similarity was heavily influenced by Pagurids and *A. carciniopados* and dropped to 40% when these taxa were excluded. Note, however, that this figure is still much higher than for infauna in the same habitat (23%). For ‘A5.1 Sublittoral coarse sediment’, Pagurids and *A. carciniopados* had less influence and removing them from the dataset had little effect on within-habitat similarity (60%). The main taxa that characterised each EUNIS Level 3 Habitat are shown in Table 11.

Table 11. Taxa that contributed most to the internal similarity of epifaunal community composition in 'A5.1 Sublittoral coarse sediment' (n = 5), 'A5.2 Sublittoral sand' (n = 19) and 'A5.4 Sublittoral mixed sediments' (n = 1) within the Bassurelle Sandbank SAC in 2017.

EUNIS	Similarity	Main taxa	Average abundance	Contribution to similarity (%)	Average similarity / standard deviation
A5.1	63.57	*Pagurus prideaux*	49.4	9.85	6.40
		Psammechinus miliaris	50.9	9.69	3.56
		Aequipecten opercularis	31.5	9.22	8.46
		Pagurus bernhardus	20.5	7.21	3.76
		Asterias rubens	12.3	5.84	5.71
A5.2	50.94	*Pagurus prideaux*	28.4	19.2	3.42
		Pagurus bernhardus	16.1	16.63	3.82
		Pontophilus spp.	10.1	12.8	0.95
		Adamsia palliata	5.4	9.43	2.30
		Nassarius reticulatus	5.4	6.17	0.86
A5.4	n/a	*Aequipecten opercularis*	198	n/a	n/a
		Pontophilus spp.	127		
		Asterias rubens	40		
		Psammechinus miliaris	31		
		Ophiura albida	19		

As with infauna, all four of the univariate indices were significantly higher in 'A5.1 Sublittoral coarse sediment' than in 'A5.2 Sublittoral sand' (ANOVA: p <0.05; Figure 26; Table 17 in Annex 6). Statistical tests could not be carried out for 'A5.1 Sublittoral mixed sediments', as this habitat type was only present at one station. However, total abundance at this station was higher than the average total abundance for the other habitat types (Figure 26a), while species richness and the Margalef Index were similar to the average for 'A5.1 Sublittoral coarse sediment' (Figure 26b-c) and the Shannon Index was similar to the average for 'A5.2 Sublittoral sand' (Figure 26d).

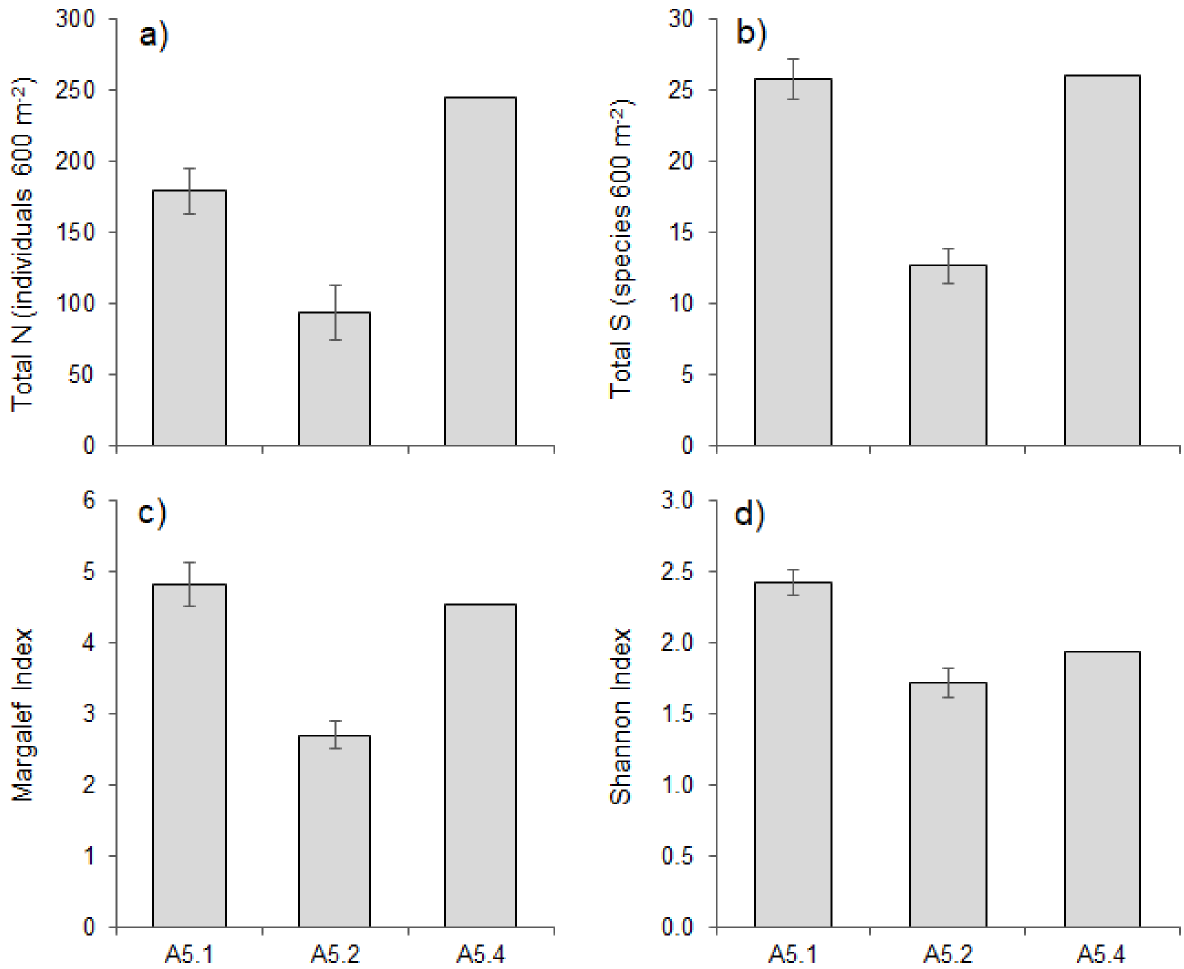

Figure 26. Mean and 95% confidence intervals of (a) total abundance, (b) total number of species (species richness), (c) Margalef Index, and (d) Shannon Index of epifauna in 'A5.1 Sublittoral coarse sediment' (n = 5) and 'A5.2 Sublittoral sand' (n = 19) and 'A5.4 Sublittoral mixed sediments' (n = 1) within the Bassurelle Sandbank in 2017.

3.3.3 Biotopes

Given the composition of characteristic taxa and associated sandy substrate (Table 4), infauna clusters a-d appear to be most closely matched to the biotope 'Nephtys cirrosa and Bathyporeia spp. in infralittoral sand' (SS.SSa.IFiSa.NcirBat). Infauna clusters e-j were characterised by the sea urchin *Echinocyamus pusillus* and various polychaetes, alongside the limited presence of venerid bivalves such as Dosina sp., Timoclea sp. and Chamelea sp. suggesting that the closest biotope match for these clusters is SS.SCS.CCS.MedLumVen (*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel). This is a broad biotope which has been characterised at the regional level. It is likely the infaunal communities described by cluster e-j form a local variant of this biotope, with less venerid dominance.

For epifauna, the very sparse diversity associated with clusters a and f suggest that these stations belong to the biotope 'Infralittoral mobile clean sand with sparse fauna' (SS.SSa.IFiSa.IMoSa). The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (SS.SSa.IFiSa.NcirBat) appears to be the best fit for clusters g and h, due to prevalence of the sea potato *Echinocardium cordatum* within these clusters, and the associated sandy substrate (Table 10). There was a particular prevalence of the hermit crabs *P. bernhardus* and *P. prideaux* in clusters g, in agreement with the "Occasional" noted prevalence of these species in the guidance for the biotope. The lack of *Lanice conchilega*, a characterising species for this biotope, in the trawl data could be attributed to the removal of empty *L. conchilega* tubes form the dataset, as part of the truncation process. It is likely that the 2m beam trawl is not effective at sampling *L. conchilega*; however, it can perhaps provide a meaningful indication of distribution through the presence of empty tubes.

Epifaunal clusters b-e appeared to be best matched to an undescribed local variant of SS.SCS.CCS.MedLumVen, due to the dominance of scallops (Pectenidae; *Aequipecten opercularis* and *Pecten maximus*); the echinoderm *Psammechinus milliaris* and the common starfish (*Asterias rubens*). The bivalve *Glycymeris glycymeris* (not a venerid) is also characteristic of the clusters b-e. There is a high level of local variation expected within SS.SCS.CCS.MedLumVen, and the above described epifaunal community (frequently observed in coarser parts of the English Channel) could sit within this biotope from a functional and life history perspective.

The biotopes that appeared to most closely match the observed infaunal and epifaunal communities are shown in Figure 27.

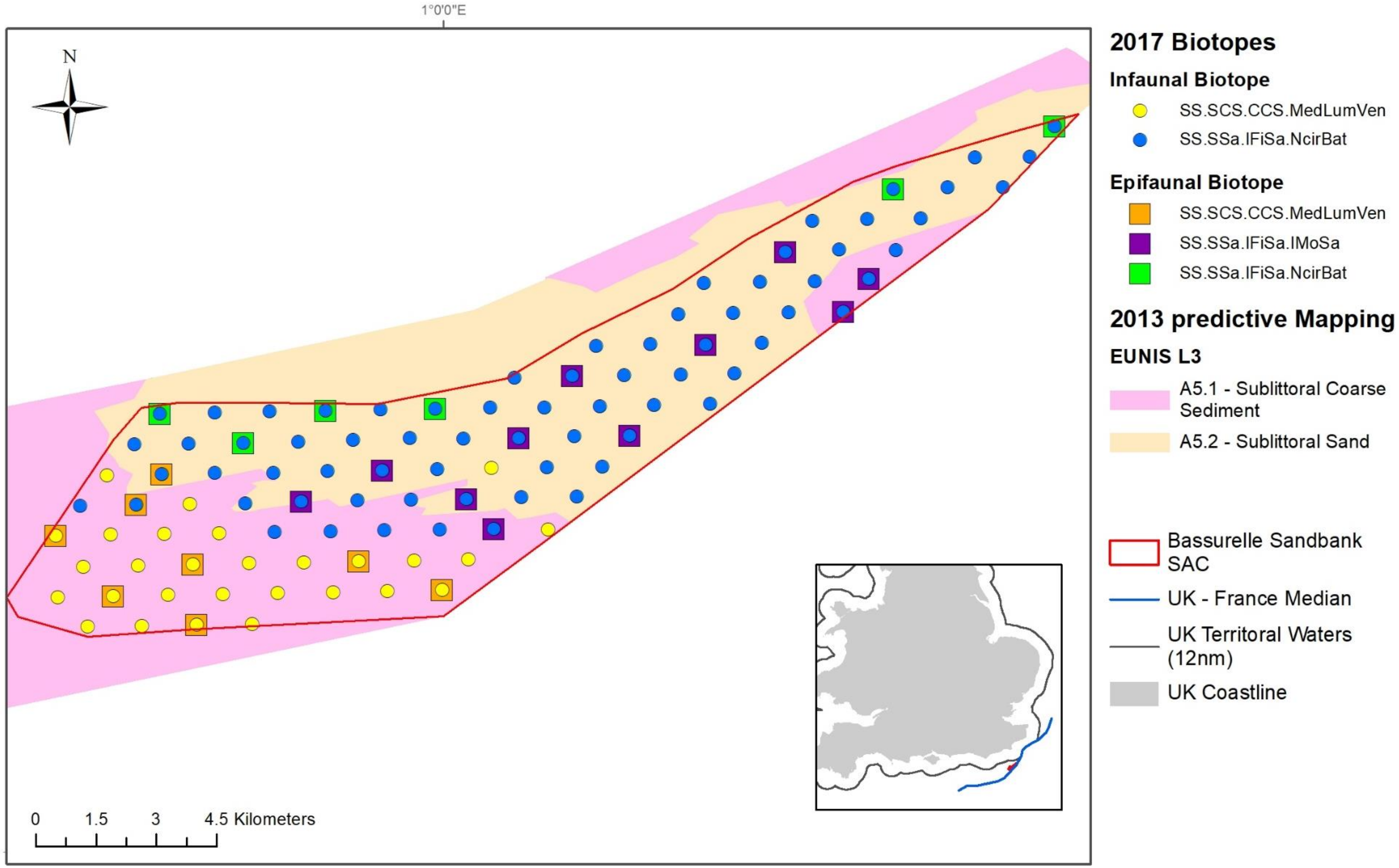

Figure 27. The spatial distribution of a) biotopes based on infaunal and epifaunal data within the Bassurelle Sandbank SAC in 2017.

3.4 Annex I Habitat: extent and distribution

The topographical extent of the sandbank, based on the 2014 MBES data, is shown along with the spatial distribution of sediment composition in Figure 28a. While there is some variation in sediment composition within the delineated topographical feature, sand is the dominant sediment component and gravel content is <30% at all stations within this area (and the rest of the site). Therefore, the sediment composition of the full area of the topographical bank, as well as the rest of the site, qualify as suitable as per the UK's interpretation of the Annex I Sandbanks definition.

Biological assemblages associated with the topographical sandbank feature are shown in Figure 28b. Communities across the majority of the sandbank (inferred from infauna and, where available, epifauna data) appeared to belong to the biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (SS.SSa.IFiSa.NcirBat). Some stations interspersed within the area dominated by this biotope were identified as 'Infralittoral mobile clean sand with sparse fauna' (SS.SSa.IFiSa.IMoSa). Both of these biotopes are characteristic of Annex I Sandbanks. Therefore, the area where they occur inside the topographical sandbank extent can be classified as 'Sandbanks which are slightly covered by seawater all the time' based on all three criteria (large-scale topography, sediment composition and biological assemblages). A distinct benthic community was observed toward the southern extent of the sandbank, where the sediment is relatively coarse. This community could not be matched to any existing biotope (either associated with sandbanks or not). However, as this community extends onto the topographical extent of the sandbank, it seems likely that it is characteristic of relatively coarse sections of sandbanks and their supporting habitat.

It was previously determined, using data collected in 2013, that the Annex I feature 'Sandbanks which are slightly covered by seawater all the time' extends to the boundary of the Bassurelle Sandbank SAC (Duncan 2016). While there is some uncertainty regarding whether the biological assemblages in the south of the site are characteristic of sandbanks, the evidence on large-scale topography, sediment composition and biota presented here is largely consistent with this conclusion.

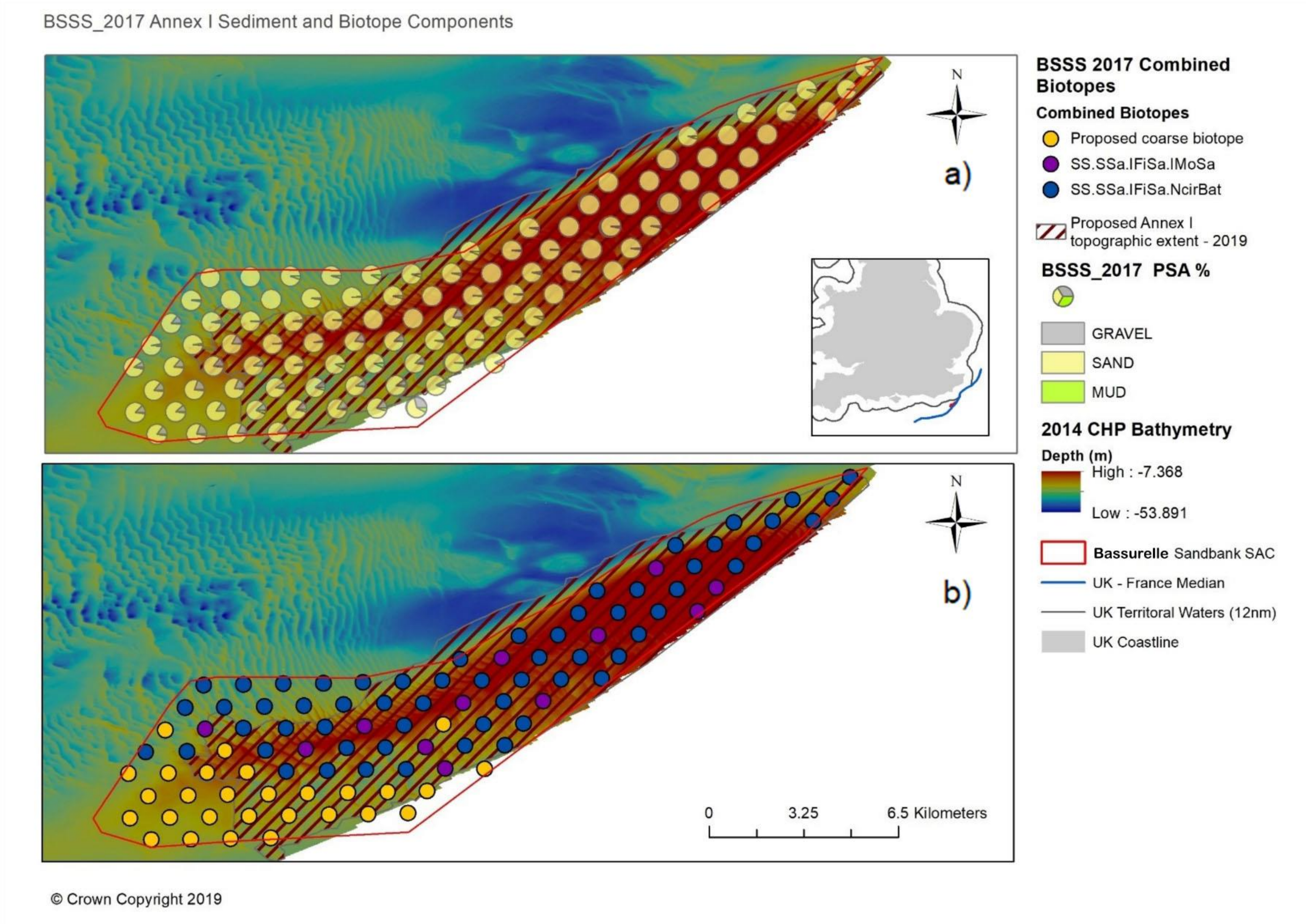

Figure 28. The topographical extent of the sandbank feature in relation to a) sediment composition and b) community biotopes within the Bassurelle Sandbank SAC in 2017.

3.5 Ecological function

Infaunal production ranged from 2 to 440KJm^{-2}y^{-1} across stations, with an average value of 75KJm^{-2}y^{-1}. Epifaunal production was an order of magnitude lower, ranging from 0.5 to 5.5KJm^{-2}y^{-1} and averaging 2.5KJm^{-2}y^{-1}. These figures provide an indication of the amount of food energy potentially available to demersal predators (e.g. commercially targeted fish species) within the SAC.

Both infaunal and epifaunal production were highest in the southwest of the site, where the substrate was predicted (and confirmed) to be relatively coarse (Figure 29). A strip of high infaunal production was also observed toward the northern tip of the site (Figure 29a). Production tended to be lowest in sandy sediment about midway between the northern and southern limits of the SAC (Figure 29). Commercially targeted fish species were mainly observed in the south of the site (Figure 29c), but otherwise were not clearly associated with variation in infaunal or epifaunal production.

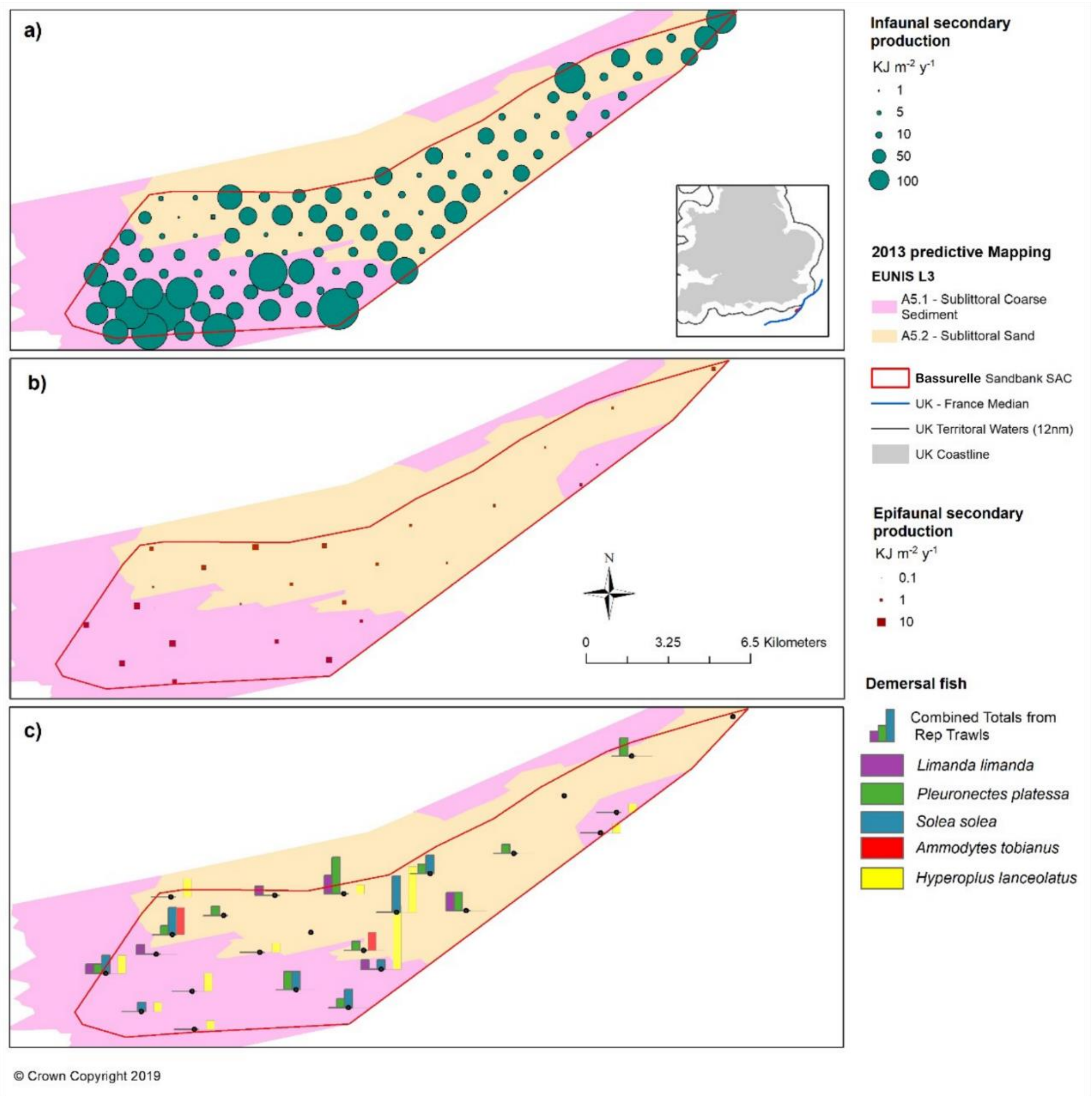

Figure 29. The spatial distribution of a) infaunal production, b) epifaunal production and c) fish relative abundances within the Bassurelle Sandbank SAC in 2017.

The fish species shown in Figure 29c – the Common Dab (*Limanda limanda*), Plaice (*Pleuronectes platessa*), Dover Sole (*Solea solea*) and two species of Sand Eel (*Hyperoplus lanceolatus* and *Ammodytes tobianus*) – all use the area for feeding and breeding (Coull *et al.* 1998; Ellis *et al.* 2010a, Ellis *et al.* 2010b; Ellis *et al.* 2012). At least one of these species was present at all but two stations (BSSS100 and BSSS089). Abundances of *H. lanceolatus* (seven individuals), *P. platessa* and *S. solea* (four individuals each) peaked near the centre of the site. Abundances of *L. limanda* and *A. tobianus* did not exceed two and three individuals, respectively.

3.6 Hydrodynamic regime

The Bassurelle Sandbank SAC is in close proximity to the Dover straits and is therefore subject to strong tidal energy across the breadth of the site, with magnitude ranging between 0.29 and 0.69ms^{-1} during peak flow at the ebb tide (particularly in the southern western section of the site) (Figure 30a). Noticeably lower magnitudes (~0.29-0.4ms^{-1}) are predicted across the majority of the site during flood tides, with a small section of the north-eastern flank of the sandbank experiencing higher magnitudes of ~0.5ms^{-1} (Figure 30b). The summit of sandbank feature is subject to notable lower tidal current magnitudes than the surrounding flanks and wider area.

Orientation of tidal currents is constant throughout the SAC during peak ebb (NE to SW) (Figure 30a). However, the direction varies slightly during peak flood from SW-NE to WSW-ENE over the summit of the sandbank (Figure 30b), likely due to the sandbank feature deflecting the predominant tidal current direction.

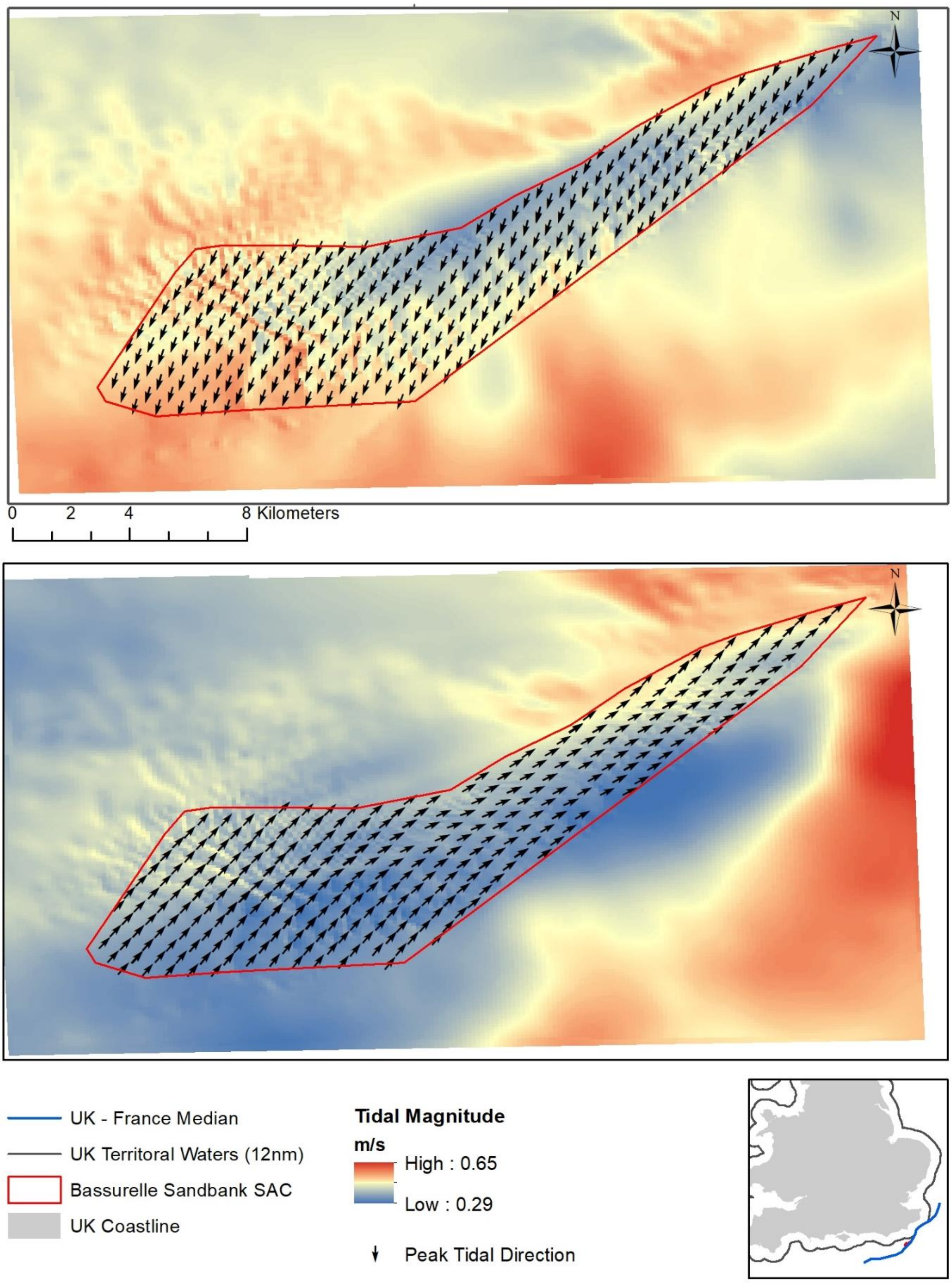

Figure 30. Tidal current velocity model for the Bassurelle Sandbank SAC.

3.7 Other OSPAR threatened and/or declining features

3.7.1 Habitats

No OSPAR Threatened and/or Declining Habitats were observed during the survey.

3.7.2 Species

The Thornback Skate (*Raja clavata*) was found in beam trawl samples at two stations. Both records were from the narrow northern strip of the site (Figure 31). No OSPAR Threatened and/or Declining Species were observed in the relatively coarse area in the south of the site.

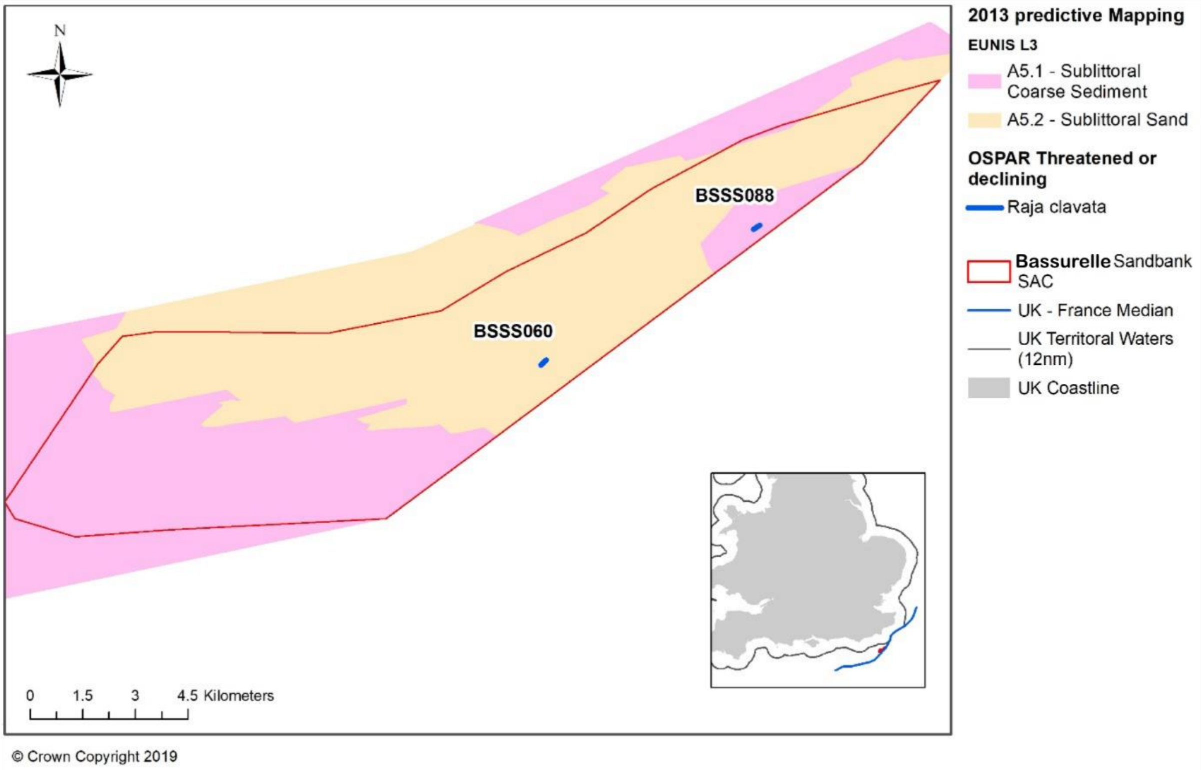

Figure 31. Stations where the OSPAR Threatened and/or Declining Species *Raja clavata* was found in beam trawl samples during a survey of the Bassurelle Sandbank SAC in 2017.

3.8 Non-indigenous species

The only NIS identified was the Slipper Limpet *Crepidula fornicata*. This species was found in beam trawl samples and its distribution was limited to the SW of the site, associated with an area of coarser sediment (Figure 32).

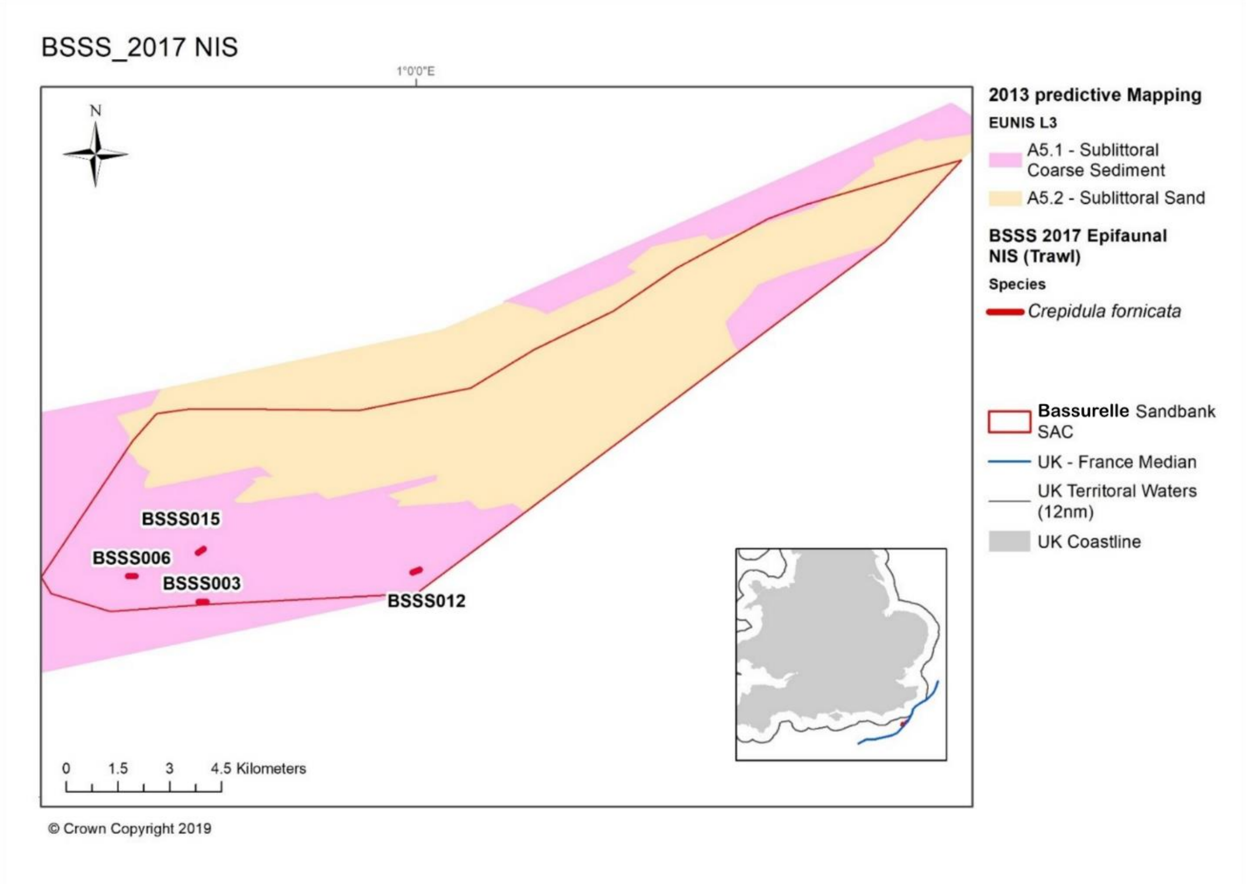

Figure 32. The spatial distribution of non-indigenous species within the Bassurelle Sandbank SAC in 2017.

3.9 Marine litter

Litter found in grab samples did not match up to specific items using MSFD litter codes. Small pieces of plastic were observed at three stations running across much of the length of the site and were recorded as the broad category ‘A. Plastic’, while at one station in the south of the site paint flakes were observed in a grab sample and recorded as ‘A14. Other’ (Figure 33). Litter was found in 14 trawls conducted at 11 stations. However, as items of litter were generally not described, MSFD litter codes usually could not be applied to the data. A single occurrence of litter, ‘F2. Rope’, was noted for a beam trawl conducted at station BSSS061. While litter was recorded throughout much of the site, most observations were made in the SW (Figure 33).

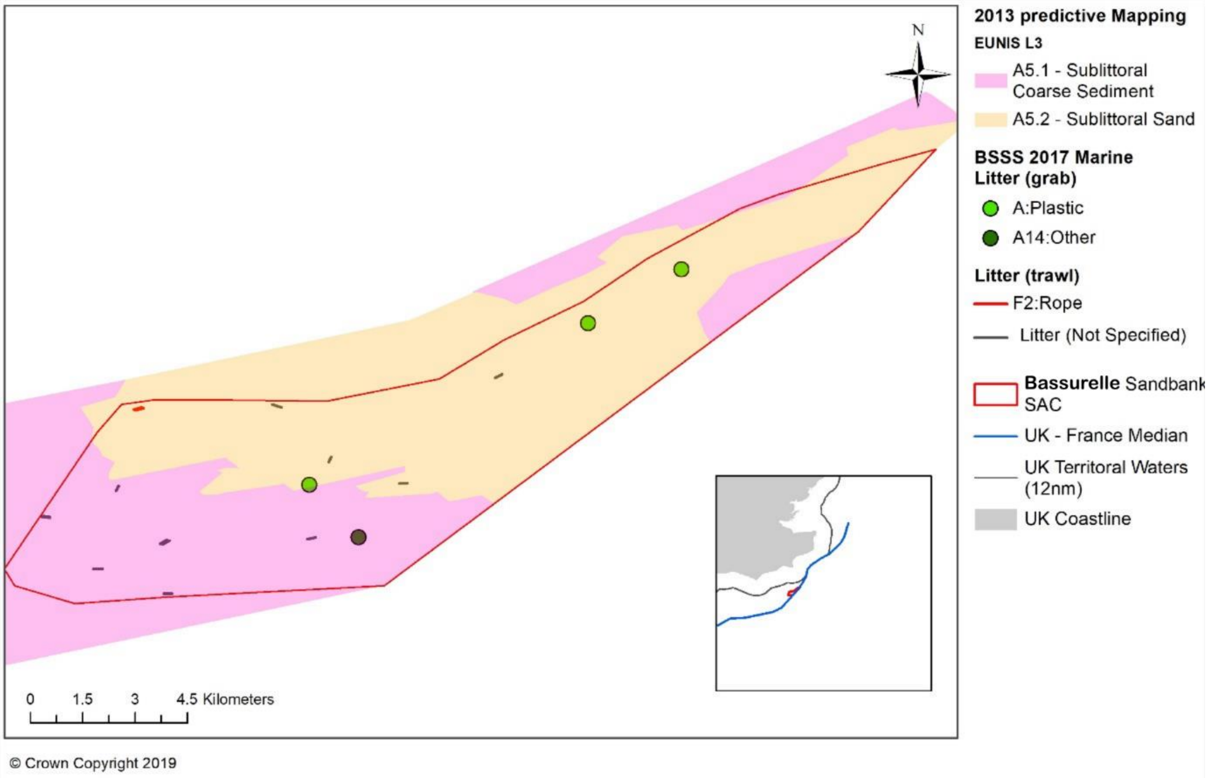

Figure 33. The spatial distribution of marine litter within the Bassurelle Sandbank SAC in 2017.

4 Discussion

This monitoring report has achieved objectives 1–4 and 6–8 (see section 1.4.3). Report objective 5 – a comparison epifaunal assemblages sampled by a beam trawl and a camera sledge – could not be completed, as water turbidity severely impacted the quality of video footage/still images and the resulting taxonomic data. This nevertheless confirms the risk of using seafloor imagery as the sole method of surveying epifaunal communities. The following sections discuss the evidence pertaining to the report objectives and provide monitoring recommendations for the designated Annex I Habitat feature, thus achieving objective 9.

4.1 Large-scale topography and physical structure

The availability of MBES bathymetry data collected as part of the UKHO CHP in 2014, covering nearly 100% of the SAC, allowed a more complete assessment of the large-scale topography than was possible with the partial cover data collected during the habitat verification survey in 2013 (Barrio-Froján *et al.* 2017). Using these data, delineation of the underlying topographical extent of the sandbank (report objective 1; see section 1.4.3, Table 2) showed no meaningful difference compared to the boundaries drawn in 2013.

Detailed investigation of the underlying topographical bank extent, using high-resolution 2014 (CHP) MBES data indicates no change or revision of this feature is required, and supports the 2016 JNCC decision to extend the feature 'Annex I Sandbanks which are slightly covered by seawater all the time' to the boundary of the SAC, as supporting habitat.

Besides being used to assess the topographical extent of the sandbank (report objective 1; see section 1.4.3, Table 2 and for discussion of results, section 4.3), analysis of these data at 10m resolution has shed light on the extent and topography of the very large megaripple features present within the site. These features, orientated transverse to the predominant tidal currents, overlie the NW flank of the sandbank. They are associated with areas of higher tidal magnitude, indicating a tidal origin. The association of these features with sandbanks is well documented in other regions (e.g. the Norfolk and Flemish sandbank systems), with heights and wavelengths of the order of 1 and 10m, respectively (Sanay *et al.* 2007). The heights of the megaripple features described by Sanay *et al.* (2007) match with our observations, however the wavelengths of megaripples associated with Bassurelle Sandbank appear to be greater (between 50 and 200m).

Analysis of high-resolution (1.5m) 2014 MBES bathymetry to reveal the fine-scale topography of the site (report objective 1; see section 1.4.3 and Table 2) has shown that within the wavelength of large megaripples there are smaller sand wave bedforms with height of ~0.5m and wavelengths of ~10m. The presence of these bedforms is indicative of a moderate to high energy bottom current (tidally driven, as they are orientated transversely to the predominant ebb and flow directions). It would be expected that the PSD of sediment forming these within-feature sand waves (i.e. small ripples within the troughs of megaripples) would tend toward finer grain sizes. The 2017 monitoring survey was not designed to investigate this aspect of fine-scale topography; however, inspection of PSD data collected in 2017 from the limited stations located within the megaripple troughs (based on 2014 high-resolution MBES data) suggests that this is the case (Figure 28a).

Report objectives 1 and 3 involved assessing spatial patterns in sediment composition and comparing to those observed in 2013 (see section 1.4.3 and Table 2). Sediment composition in 2017 broadly corresponded to 2013 observations throughout the site, both in terms of EUNIS Level 3 Habitats (Figure 13) and the relative contents of gravel, sand and mud

(Figure 14). Sand was the dominant sediment component at all stations, as is to be expected for a sandbank. However, there was a clear trend toward coarser sediments in the south of the site, reflected by an increase in gravel content and a shift from 'A5.2 Sublittoral sand' to 'A5.1 Sublittoral coarse sediment'. In both 2013 and 2017, only one station had sediment samples classified as 'A5.4 Sublittoral mixed sediments'. These stations were in the southeast of the SAC on both occasions, suggesting that a relatively muddy patch of sediment has been present within this area for the five-year study period. Extending the analyses conducted for the 2013 site report, sand was sub-divided (fine, medium and coarse) and analysed to gain a greater understanding of how the dominant sediment component varies spatially within the SAC. Mirroring patterns in gravel content, coarse sand became increasingly dominant moving north to south, whereas fine sand showed the opposite pattern and medium sand peaked around the mid-point between the northern and southern limits of the site. While it appears that gravel content captures the overall spatial pattern in sediment composition reasonably well in this case, the distinct spatial patterns in different sand fractions highlight how aspects of a feature's physical structure could go unnoticed by aggregating sediment data at a low resolution.

Assessment of sediment composition on a smaller (within-station) spatial scale (report objective 2; see section 1.4.3) revealed very little variability from sample to sample. At the ten stations where replicate grab samples were collected, the contents of sand and all three of its sub-fractions were remarkably consistent, with just two stations showing high variability for coarse sand and one showing medium variability for fine sand (Figure 12). Moreover, medium-high variability (25-100% of the mean) in these sand fractions at these stations was associated with low mean values (1-2% for coarse sand, 7% for fine sand) and, therefore, constitutes only a small change in their percent contribution to overall sand content. Given the low within-station variability in sediment composition at the Bassurelle Sandbank SAC, the collection of a single sediment sample per station would appear sufficient for characterising the physical habitat in most cases. However, it should also be noted that at one station in the southeast of the site, the EUNIS Level 3 Habitat was classified as 'A5.1 Sublittoral coarse sediment' based on two sediment samples and 'A5.4 Sublittoral mixed sediments' based on the other three (Figure 10b). Therefore, although variation in sediment composition is minor across replicates, this can be the difference between classification as one habitat or another when the PSD is close to the boundary between habitats.

4.2 Biological structure

Aside from the assessment of physical structure, report objective 1 also involved assessing the biological structure of benthic assemblages (see section 1.4.3 and Table 2). The main taxa that characterised communities (biotopes) within the SAC are typical of clean sand, including the polychaete *Nephtys cirrosa*, amphipod *Bathyporeia* spp. and sea potato *Echinocardium cordatum* (Budd 2005; Hill 2008; Hayward & Ryland 2017). In addition to being biotope-defining (see section 3.3.3), these species provide a source of food to demersal fish – particularly flatfish – that use the area (Pinnegar 2014) and may therefore be important contributors to commercial fishery production in the region. As such, they may be suitable focus points for future monitoring of biological condition. Unsurprisingly, given their habitat preferences, these species mainly occurred within the topographical extent of the sandbank. In the area south of the sandbank (the far south of the SAC), where the sediment is relatively coarse, a different benthic community characterised by two sea urchins, *Echinocyamus pusillus* and *Psammechinus miliaris*, the Queen Scallop *Aequipecten opercularis* and a diverse polychaete species was observed. These species are typical of relatively coarse and/or mixed sediments (Carter 2008; Jackson 2008; Lumbis 2008) but could not be matched to an existing biotope. It may therefore be appropriate for a new biotope to be classified to represent this assemblage, based upon beam trawl data. *E. pusillus*, *P. miliaris* and *A. opercularis* are also known prey of flatfish, thus potentially playing an important food-provisioning role in the region and, thus, providing suitable foci for condition monitoring (Pinnegar 2014). The same can be said of the hermit crabs (*Pagurus bernhardus* and *P. prideaux*), which were present throughout the site but were most abundant in the megaripple field to the northwest of the sandbank.

Characterisation of biological structure to achieve report objective 1 clearly benefited from the collection of both infaunal and epifaunal samples, using a mini-Hamon Grab and beam trawl, respectively. Of the key taxa listed above, some were found almost exclusively in grab samples (*N. cirrosa*, *Bathyporeia* spp. and *Echinocyamus pusillus*) while others were found mainly in trawl samples (*P. miliaris*, *A. opercularis*, *P. bernhardus* and *P. prideaux*). Therefore, if any of these populations are to be monitored in the future then the appropriate sampling gear must be selected and if all are to be monitored then both gears should be used. Moreover, the availability of data from both sources led to different biotopes being assigned than would have been assigned using data from a single source. For example, the absence (or rarity) of a key biotope-defining species, *E. cordatum*, saw some stations that were classified as '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (SS.SSa.IFiSa.NcirBat) based on infaunal samples reclassified as 'Infralittoral mobile clean sand with sparse fauna' (SS.SSa.IFiSa.IMoSa) when beam trawl samples were integrated. Likewise, the rarity of a biotope-defining infaunal taxon, *Ensis*, in grab samples saw the classification of biotope '*Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand' (SS.SSa.IMuSa.EcorEns) based on beam trawl samples reclassified as SS.SSa.IFiSa.NcirBat. Therefore, sampling with both gears allowed a more complete assessment of community composition.

In contrast to the low within-station variability in sediment composition (report objective 2; see section 1.4.3), the same analysis for infaunal communities revealed at least intermediate levels of variability (i.e. CV from 25-49%) for total abundance across a wide range of stations (Figure 19a). This suggests that a single sample cannot be relied upon to indicate the total abundance of a station to a high degree of accuracy. Half the stations with replicate samples also had intermediate variability in species richness (Figure 19b). However, correlations of the number of species in one sample with the number in five samples and with an estimate of the total number of species (*Smax*) revealed reasonably strong relationships (R^2 = 0.85 and 0.74, respectively; Figure 20), providing some reassurance that a single sample may give a reasonable indication of the relative infaunal diversity of a station. Perhaps more noteworthy, however, is that within-station variability was particularly low (CV <25%) at all stations for the Margalef and Shannon Indices (Figure 19c-d). This suggests that, of the four univariate biological indices considered, these two may be the most useful for monitoring biological condition if a single grab sample is to be collected per station. Indeed, within-habitat variability was lowest for the Margalef and Shannon Indices, regardless of whether one or five replicates were used, implying more statistical power to detect change over time if monitoring is focused on EUNIS Level 3 Habitats. Moreover, there is some evidence that the Margalef Index is a good general indicator of physical, organic and chemical disturbance, as it as a relatively strong relationship with environmental drivers compared to other commonly used indices (van Loon *et al.* 2018). Therefore, this index appears to be particularly promising. With respect to community composition, increasing replication reduced the level of within-habitat variability, thus increasing power to detect habitat-level temporal change. However, samples from the same station tended to cluster together (with few exceptions; see Figure 18), suggesting that a single sample is likely to provide a reasonable indication of a station's infaunal community composition compared to that of other stations. Therefore, a single sample per station may be sufficient for assigning biotopes and tracking changes to the spatial distribution of biotopes, but not for monitoring potentially subtle temporal changes in community composition.

One of the objectives of this report was to assess temporal change in infaunal communities, by comparing 2017 data to data collected for the habitat verification survey in 2013 (report objective 3; see section 1.4.3). Statistically significant change in community composition was observed for both ‘A5.1 Sublittoral coarse sediment’ and ‘A5.2 Sublittoral sand’. However, the amount of change was minor, particularly in ‘A5.2 Sublittoral sand’ (see Figure 21), and the populations of most key infaunal taxa highlighted above either remained stable or increased over time (Table 8). In ‘A5.1 Sublittoral coarse sediment’, some taxa were recorded only in 2013 and others only in 2017 (Table 9), but no changes to station-level faunal density or diversity were observed (Figure 22), suggesting a possible turnover in community composition over time. In ‘A5.2 Sublittoral sand’, all taxa that contributed up to 70% of temporal variation were recorded in both years, but station-level density and diversity increased over time, suggesting a possible spatial expansion of populations within the SAC. As the 2013 and 2017 surveys were conducted at different times of the year (the latter two months later than the former), it is possible that temporal differences reflect seasonal variation. Nevertheless, if the differences do reflect genuine long-term change, they are not clearly indicative of any drastic changes to ecological condition in either of the two habitats. However, possibly worth noting is a 65% reduction in the average abundance of *E. cordatum* in ‘A5.2 Sublittoral sand’ between 2013 and 2017 (Table 8). This species characterised communities associated with ‘A5.2 Sublittoral sand’ in 2017 based on beam trawl data, so is clearly still a significant component of the biota. Nevertheless, the apparent decline in population size observed in grab sample data suggests that this key species may have been negatively impacted. Indeed, *E. cordatum* is fragile and long-lived (~ten years) and is therefore sensitive to physical disturbances, such as trawling and dredging (Eleftheriou & Robertson 1992; Bergman & van Santbrink 2000). This report has not assessed changes in fishing activities or other physical disturbances within the site between 2013 and 2017, so it is not possible to say whether they could plausibly have caused the decline in *E. cordatum* abundance. Further investigation into the causes of this population decline would help to determine whether *E. cordatum* could be used to monitor the impact of fishing activities within the site and guide SAC management measures.

4.3 Ecological function

Analysis of secondary production, to explore the potential for the SAC to provide nutrition for demersal fish (report objective 1; see section 1.4.3, Table 2), indicated that infauna produced more biomass than epifauna by an order of magnitude. A similar ratio has been observed elsewhere in UK subtidal ecosystems (CEFAS 2012). While this difference is substantial, the degree to which infauna and epifauna act as sources of food to demersal predators will depend on the specific prey items present in each component of the benthos and may vary across predator species. Stomach content records indicate that both infaunal and epifaunal species within the SAC, including characteristic taxa, are significant components of the diet of commercially targeted fish species in the area (Pinnegar 2014). For example, *Echinocardium cordatum*, a burrower of surficial sediments, is a major prey of the European Plaice (*Pleuronectes platessa*), epifaunal Pagurids (e.g. *Pagurus bernhardus*) are major prey of the Common Dab (*Limanda limanda*) and species belonging to the genus *Nephtys*, an infaunal polychaete, are major prey of the Dover Sole (*Solea solea*), *P. platessa* and *L. limanda*. It may therefore be beneficial for future monitoring to consider production in both components of the benthos. If any specific fish species are of concern, then a more targeted approach could be taken whereby production is calculated for species (infaunal and/or epifaunal) known to be important components of their diets.

Spatially, there was no clear association between infaunal or epifaunal production and the distribution of demersal fish species (Figure 29). The flatfish noted above were more common in the southern than the northern section of the site but did not appear to be concentrated in the area of high production in the far south. This may be attributable to habitat preferences, as all three species tend to prefer sandy substrates. Nevertheless, the lack of a clear association between fish distribution and areas of high benthic production suggests that food might not be limited within the site. It must also be noted, however, that these fish are mobile organisms and, therefore, their absence from an area of high productivity at a single point in time does not imply that they are not using this area as a source of food.

4.4 Hydrodynamic regime

Supporting processes were assessed with respect to hydrodynamics (report objective 6; see section 1.4.3, Table 2), which is an important determinant of sandbank topography, sediment composition and ecology. The main axis of the Bassurelle sandbanks is orientated a few degrees (10°–15° at peak flood, 0º-5º at peak ebb) anticlockwise with respect to the principal direction of the tidal currents. This is in keeping with previous work undertaken on northern hemisphere sandbanks (Sanay *et al.* 2007). The model indicates higher tidal energy around the flanks of the sandbank feature, not the summit, indicating that the bank is diverting flow to the flanks in normal conditions. However, this is not reflected in the composition of epifauna, with a sparser community of scour-resistant taxa found at stations near the summit, not the flanks. It is possible that sporadic changes in tidal flow intensity, or an increase in wave energy at the summit not captured by the tidal hydrodynamic model, explain this counter-intuitive observation.

4.5 Other OSPAR threatened and/or declining features

4.5.1 Habitats

Inspection of mini-Hamon Grab and beam trawl datasets for species indicative of OSPAR Threatened and/or Declining Habitats (report objective 7; see section 1.4.3) did not reveal any such features.

4.5.2 Species

Inspection of mini-Hamon Grab and beam trawl datasets for OSPAR Threatened and/or Declining Species (report objective 7; see section 1.4.3) identified the Thornback Ray (*Raja clavata*) as the only relevant species. Pagurids and *Nephtys* spp. are among the major prey items of this species (Pinnegar 2014). It is therefore possible that *R. clavata* uses the site for feeding. The species is often found over a variety of habitat types, including the sandy and gravelly sediment present within the Bassurelle Sandbank SAC (Snowden 2008). Commercially, it is the most important species of ray in the UK (Snowden 2008).

4.6 Non-indigenous species

NIS were recorded to satisfy requirements of the MSFD (report objective 8; see section 1.4.3). The only NIS observed was the Slipper Limpet (*Crepidula fornicata*), which was found in beam trawls samples collected from the relatively coarse area in the south of the site. This species is common in the English Channel and is often found living attached to stones (Rayment 2008). Therefore, neither its presence nor spatial distribution within the site are unexpected.

4.7 Marine litter

Items of marine litter were recorded to satisfy requirements of the MSFD (report objective 8; see section 1.4.3). While items were observed throughout most the site, they were more common in the southwest (Figure 33). This may reflect the historic distribution of human activities within the SAC but may also be influenced by hydrodynamics.

5 Recommendations for Future Monitoring

The Bassurelle Sandbank SAC is designated to protect a single Annex I Habitat 'Sandbanks which are slightly covered by seawater all the time'. Distinct faunal communities inhabit the two EUNIS Level 3 Habitats within the SAC, 'A5.2 Sublittoral sand' and 'A5.1 Sublittoral coarse sediment', the former occupying northern areas of the site and the latter occupying southern areas. More subtle variation in faunal communities is observed in relation to sandbank topography and even less variation is observed at a fine (within-station) spatial scale. Given the physical and biological structure of the site, the following recommendations are made:

5.1 Operational and survey strategy

- Future surveys should continue to monitor large-scale topography, sediment composition and associated biological assemblages throughout the site. This will be essential for tracking changes to the extent and distribution of the topographical sandbank and allow the broadest assessment of physical and biological structure.
- Given the failure of seafloor imagery to produce useable epifaunal data, future surveys which look to investigate sandbank features should not use underwater video sampling.
- The mini-Hamon Grab and 2m beam trawl provided complementary information needed to accurately assess biological structure. These two gears should therefore continue to be used in tandem for monitoring.
- If future surveys aim to monitor changes to community composition and diversity with precision, then replicate samples should continue to be collected at a fixed set of stations that are representative of the habitats at the site. Accounting for within-station variability and removing "noise" caused by broadscale spatial variability will result in higher statistical power to detect potentially subtle temporal changes. If monitoring is to focus only on broad spatio-temporal variation in assemblages and biotopes, then collection of a single sample per station across many stations appears to be a suitable approach.
- Future surveys should be conducted at the same time of year (May), otherwise it will not be possible to determine whether any observed changes are due to seasonal cycles or reflect broader-term change.
- Items of litter should be described in the field according to MSFD litter codes to help determine the sources of litter at the site and allow more detailed marine litter monitoring. Items of litter found in grab samples tended to be small fragments of plastic, which does not currently constitute an MSFD litter sub-category (see Annex 5). A new sub-category of 'A. Plastic' (e.g. 'Fragment') may therefore be useful.

5.2 Analysis and interpretation

- Given that benthic communities can be clearly divided according to the EUNIS Level 3 Habitat they inhabit, this seems an appropriate level at which to group biological data collected throughout the site for monitoring.
- The key species identified in this report are both biotope-defining and functionally important (as a source of food for demersal fish). These species may therefore be suitable focus points for monitoring.
- The possible use of *Echinocardium cordatum* and/or any other fragile species at the site should be further considered as possible indicators of physical disturbance. Trait-based approaches (e.g. focusing on community-wide expression of traits that determine sensitivity) may also prove useful in this regard.

- The Margalef Index may be suitable for monitoring changes to infaunal diversity, as it exhibits low within-station variability (i.e. can be accurately estimated from a single sample per station) and appears to be a good general indicator physical, organic and chemical disturbance (van Loon *et al.* 2018). Its low within-station variability makes it particularly suitable for monitoring if only one sample is collected per station.
- The database of fish stomach contents (Pinnegar 2014) could be used to cross-check all infaunal and epifaunal species against the stomach content records of commercially targeted fish species that use the area, to help identify ‘key and influential species’ for monitoring (report objective 1; see section 1.4.3, Table 2). Production by these species alone may provide greater insight into the role of the SAC in providing food for commercially targeted species.
- Although the sampling strategy for this survey was not designed to explore pressure-state relationships, consideration of temporal changes in human activities (e.g. vessel monitoring system (VMS)-derived abrasion for fishing vessels) could provide useful contextual information and steer further analyses of temporal changes in biological assemblages.
- For fixed stations sampled with replication, statistical models could be created to test whether change over time is consistent across stations (i.e. test the ‘station’ and ‘time’ interaction). This would help to identify whether any desirable or undesirable changes are occurring in localised areas of the SAC. Generalised additive models (GAMs) may be particularly useful for monitoring change over time, as they do not require assumptions about the shape of temporal trends but rather fit the appropriate temporal trend to the data.
- The hydrodynamic model could be adjusted to incorporate a wave component in conjunction with the tidal component. This would allow a more complete assessment of hydrodynamics.
- Further work should investigate the setting of topographical thresholds for sandbank definition using RSP. It is proposed in MPAs where full multibeam data is available, the topographical extent is not based upon the slope threshold, as this is very difficult to determine when large megaripple features (features commonly associated with sandbanks) add noise to the data. It is instead proposed that the topographical extent be defined as the area:
    - from the summit (RSP =1) to the point where the RSP is value is equal to 0.1, but only where there is a continuous line of values exceeding 0.1; and
    - where the summit is shallower the 20m MSL; and
    - where PSD indicates <30% gravel content.

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Annex 1. 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 Bassurelle Sandbank SAC 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 recorded above the genus level were removed from the dataset when lower taxonomic levels of the same group were recorded to avoid having to reduce the taxonomic resolution of records.
- 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 Bassurelle Sandbank SAC, if ‘juvenile’ records were recorded at the same taxonomic level as ‘adult’ records then the two records were combined, whereas if juveniles were recorded at a higher taxonomic level than adults then the ‘juvenile’ records were removed to avoid having to reduce the taxonomic resolution of the ‘adult’ records.
- Records of meiofauna (i.e., nematodes) were removed.
- Records of fish species were removed.

Annex 2. Epifauna Data Truncation

The 2017 epifauna (trawl) data were truncated for statistical analysis, with due consideration of each truncation in terms of taxon abundance and implications for the dataset (see below). Truncation actions are colour coded as per the key given below.

Epifaunal truncation action key

Step	Colour and Taxa	Rationale
1	Fish, Substrate or highly abundant fauna – e.g. Paguridae	Remove for separate analysis (fish) and non-analysable detritus from trawl
2	e.g. Ebalia sp.	Truncate all to Genus / highest taxon
2	Very high-resolution taxa (e.g. Bryozoa)	Removed -high generality and overlapping nature of classification including juveniles
3	Colonial taxa identified	Noted for review

All epifaunal taxa recorded in 2017, highlighted by truncation action type

Taxa	Comment
Abra sp.	
Actiniaria	
Adamsia carciniopados	Removed - highly abundant and widespread
Aeolidia papillosa	
Aequipecten opercularis	
Agonus cataphractus	Removed - Fish
Alcyonidium diaphanum	
Alcyonium digitatum	
Ammodytes tobianus	Removed - Fish
Anapagurus laevis	
Anseropoda placenta	
Aphrodita aculeata	
Arcopagia crassa	
Arnoglossus laterna	Removed - Fish
Ascidiidae	
Aspitrigla cuculus	Removed - Fish
Astacilla longicornis	
Asterias rubens	
Atelecyclus rotundatus	
Bela powisiana	
Bryozoan	Removed- taxonomic resolution too high
Buccinum undatum	
Buglossidium luteum	Removed - Fish
Callionymus lyra	Truncated - Calionymus sp. Removed - Fish
Callionymus maculatus	Truncated - Calionymus sp. Removed - Fish
Callionymus sp.	Removed - Fish
Calliostoma sp.	

Taxa	Comment
Calliostoma zizyphinum	Truncate to Calliostoma sp
Calliostoma zizyphinum?	Truncate to Calliostoma sp
Chelidonichthys lucerna	Removed - Fish
Cirripedia	
Clausinella fasciata	
Corystes cassivelaunus	
Crangon allmani	
Crangon crangon	
Crepidula fornicata	
Dead maerl	Removed - substrate
Dentalidae	
Diplecogaster bimaculata	Removed - Fish
Dosinia sp.	
Ebalia cranchii	Truncate to Ebalia sp
Ebalia granulosa	Truncate to Ebalia sp
Ebalia nux	Truncate to Ebalia sp
Ebalia sp.	
Ebalia tuberosa	Truncate to Ebalia sp
Ebalia tumefacta	Truncate to Ebalia sp
Echiichthys vipera	Removed - Fish
Echinocardium cordatum	
Eggs (Buccinum)	Removed - eggs
Eggs (Hinia)	Removed - eggs
Eggs (indet.)	Removed - eggs
Eggs (Polinices)	Removed - eggs
Eggs (rays/sharks)	Removed - eggs
Ensis sp.?	Removed - uncertain
Epizoanthus sp.	Distinct from "Actiniaria"
Eurynome aspera	
Eurynome spinosa	
Euspira catena	
Euspira nitida	
Galathea intermedia	Truncate to Galathea sp.
Galathea sp.	
Gastropod	Removed- taxonomic resolution too high
Glycymeris glycymeris	
Gobiidae	Removed - Fish
Hinia reticulata	
Hyas coarctatus	
Hydractinia echinata	
Hydrallmania falcata	
Hydroids	Removed- taxonomic resolution too high
Hyperoplus lanceolatus	Removed - Fish
Inachus dorsettensis	Truncate to Galathea sp.
Inachus sp.	

Taxa	Comment
Laevicardium crassum	
Ligia oceania	
Limanda limanda	Removed - Fish
Liocarcinus depurator	
Liocarcinus holsatus	
Liocarcinus marmoreus	
Liocarcinus pusillus	
Litter	Removed - substrate
Lutraria sp.	
Macroalgae	Removed- taxonomic resolution too high
Macropodia rostrata	
Macropodia tenuirostris	
Maja squinado	
Microchirus variegatus	Removed - Fish
Mytilus edulis	
Nemertesia antennina	Truncate to Nemertesia sp.
Nemertesia ramosa	Truncate to Nemertesia sp.
Nemertesia sp.	
Nucula hanleyi	
Nucula nucleus	
Ophiocten affinis	
Ophiothrix fragilus	
Ophiura albida	
Ophiura ophiura	
Paguridae *juv.*	Removed- taxonomic resolution too high
Pagurus bernhardus	Removed - highly abundant and widespread
Pagurus prideaux	Removed - highly abundant and widespread
Pagurus sp.	Removed- uncertain ID
Pecten maximus	
Pegusa lascaris	Removed - Fish
Phaxas pellucidus	
Phaxas pellucidus	
Pisidia longicornis	
Platyhelminthes	
Pleuronectes platessa	Removed - Fish
Polititapes rhomboides	
Polychaete	
Pontophilus sp.	
Porifera	
Processa sp.	
Psammechinus miliaris	
Raja clavata	Removed - Fish
Raphitoma purpurea	
Sepiola atlantica	Removed - Fish
Shell and Rocks etc	Removed - Fish

Taxa	Comment
Sipunculid	Removed - Fish
Solea solea	Removed - Fish
Spisula sp.	
Spisula subtruncata	
Suberites sp.	Truncate to Porifera
Tellinidae	
Thracia sp.	
Timoclea ovata	
Trisopterus luscus	Removed - Fish
Trisopterus minutus	Removed - Fish
Tubes (Chaetopterus)	Removed - tubes
Tubes (Lanice)	Removed - tubes
Tubes (Polychaetes)	Removed - tubes
Xanthidae	

Annex 3. Analysis Sandbank Extent and Bedforms

The extent of the underlying topographical sandbank feature was assessed using the 0.5º slope threshold and expert judgment. MBES data were analysed at a 10m resolution to aid in removing noise inherent with large sand wave features within the site. To aid in extracting the slope threshold signal associated with the sandbank (and not the megaripples), a Slope-Aspect map was then created. This map reclassified the derived aspect data from the MBES into nine classes, the numeric value of the class of interest was 80 (equating to an aspect of between 292.5 and 337.49º – the apparent orientation of the northern flank of the sandbank). The same reclassification was undertaken on the slope data, classing all cells with a slope of >0.5º as the numeric value 2. These reclassified slope and aspect raster images were then summed, meaning that any cell of value 82 was considered representative of the northern flank extent. Profiles were then run transversely along the length of the megaripples to ascertain the overall slope of these features and, thus, derive the location of the 0.5º threshold manually (*sensu* Barrio-Froján *et al.* 2017).

Following the delineation of sandbank extent, MBES data were used to assess the distribution of large-scale bedforms within the site, at 10m resolution, using a derivative called RSP, calculated using the SAGA package within QGIS 3.2. RSP is indicative of the relative position of any cell from the lowest cell which water from the cell in question could flow to. It is represented as a proportion above the lowest point (i.e. 0), with a value of 1 indicating a top of a ridge.

Annex 4. Non-indigenous Species Lists

Table 12. Taxa listed as non-indigenous species (present and horizon) which have been selected for assessment of Good Environmental Status in GB waters under MSFD Descriptor 2 (Stebbing *et al.* 2014).

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

Table 13. Additional taxa listed as non-indigenous species in the JNCC 'Non-native marine species in British waters: a review and directory' report by Eno *et al.* (1997) which have not been selected for assessment of Good Environmental Status in GB waters under MSFD.

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

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

Annex 5. 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*5cm = 25cm²
B: ≤ 10*10cm = 100cm²
C: ≤ 20*20cm = 400cm²
D: ≤ 50*50cm = 2500cm²
E: ≤ 100*100cm = 10000cm²
F: ≥ 100*100cm = 10000cm²

Annex 6. ANOVA results

Table 14. Differences in univariate indices of infaunal assemblages between 'A5.1 Subtidal coarse sediment' and 'A5.2 Subtidal sand'. The sum of squares (s.s.) is shown along with the residual sum of squares in brackets. F and *p* are presented. All differences were statistically significant (i.e. $p \geq 0.05$).

Index	s.s. (residual)	F	*p*
$\log_e$ (total abundance + 1)	28.6 (57.5)	48.9	<0.001
$\log_e$ (species richness + 1)	29.3 (21.7)	132.2	<0.001
$\log_e$ (Margalef Index + 1)	13.7 (8.7)	154.0	<0.001
Shannon Index	33.6 (22.9)	144.0	<0.001

Table 15. Differences in univariate indices of infaunal assemblages associated with 'A5.1 Subtidal coarse sediment' between 2013 and 2017. The sum of squares (s.s.) is shown along with the residual sum of squares in brackets. F and *p* are presented. There were not statistically significant differences (i.e. $p \geq 0.05$).

Index	s.s. (residual)	F	*p*
Total abundance	292 (129229)	0.1	0.736
Species richness	116 (15307)	0.4	0.537
Margalef Index	8.3 (459.8)	0.9	0.343
Shannon Index	1.0 (17.5)	3.0	0.087

Table 16. Differences in univariate indices of infaunal assemblages associated with 'A5.2 Subtidal sand' between 2013 and 2017. The sum of squares (s.s.) is shown along with the residual sum of squares in brackets. F and *p* are presented. All differences were statistically significant (i.e. $p \geq 0.05$).

Index	s.s. (residual)	F	*p*
$\log_e$ (total abundance + 1)	9.6 (74.6)	15.0	<0.001
$\log_e$ (species richness + 1)	3.9 (28.3)	16.0	<0.001
$\log_e$ (Margalef Index + 1)	1.3 (12.1)	12.3	<0.001
Shannon Index	2.0 (33.9)	7.0	0.009

Table 17. Differences in univariate indices of epifaunal assemblages between 'A5.1 Subtidal coarse sediment' and 'A5.2 Subtidal sand'. The sum of squares (s.s.) is shown along with the residual sum of squares in brackets. F and *p* are presented. All differences were statistically significant (i.e. $p \geq 0.05$).

Index	s.s. (residual)	F	*p*
Total abundance	46349 (129343)	3.9	0.034
Species richness	794.8 (525.2)	16.6	<0.001
Margalef Index	19.6 (14.8)	14.6	<0.001
Shannon Index	2.0 (3.6)	6.0	0.008

Annex 7. Tables and Figures

7.1 Tables

7.2 Figures

Annex 8. Acknowledgement

Bassurelle Sandbank
Special Area of Conservation (SAC)
Monitoring Report 2017

Marine Protected Areas (MPA) Monitoring Programme

Contract Reference: MB0129

Report Number: 19

Version 4

July 2020

Marine Protected Areas Survey Coordination & Evidence Delivery Group

This work was delivered by Cefas and JNCC on behalf of the Marine Protected Areas Survey Coordination & Evidence Delivery Group (MPAG) and sponsored by Defra. MPAG was established in November 2012 and continued until March 2020. MPAG, was originally established to deliver evidence for Marine Conservation Zones (MCZs) recommended for designation. In 2016, the programme of work was refocused towards delivering the evolving requirements for Marine Protected Area (MPA) data and evidence gathering to inform the assessment of the condition of designated sites and features by SNCBs, in order to inform Secretary of State reporting to Parliament. MPAG was primarily comprised of members from Defra and its delivery bodies which have MPA evidence and monitoring budgets and/or survey capability. Members included representatives from Defra, JNCC, Natural England, Cefas, the Environment Agency, the Inshore Fisheries Conservation Authorities (IFCAs) and the Marine Management Organisation (MMO)).

Since 2010, offshore MPA surveys and associated reporting have been delivered by JNCC and Cefas through a JNCC\Cefas Partnership Agreement (which remained the vehicle for delivering the offshore survey work funded by MPAG between 2012 and 2020).

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