The Sizewell C Project

6.3 Volume 2 Main Development Site
Chapter 22 Marine Ecology and Fisheries
Appendix 22C - Sizewell Benthic Ecology Characterisation

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Sizewell benthic ecology characterisation

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Please note that the red line boundary used in the figures within this document was amended after this document was finalised, and therefore does not reflect the boundaries in respect of which development consent has been sought in this application. However, the amendment to the red line boundary does not have any impact on the findings set out in this document and all other information remains correct.

Executive summary

EDF Energy is planning to construct a new nuclear power station to the north of Sizewell B (SZB) on the Suffolk coast. As part of the planning process for the new station, Sizewell C (SZC), EDF Energy is required to undertake an Ecological Impact Assessment (EcIA) that will assess the potential effects of the construction and operation of the station on the local marine ecology.

This report characterises the benthic fauna of the Greater Sizewell Bay area based on data collected from a series of onshore and offshore surveys implemented between 2008 and 2017. Features of the system are identified, and information is provided on their natural variability to establish a baseline for assessing impacts. These features may be ecological assemblages, functional traits, important locations (for example, centres of particularly high abundance or biomass), or they may be particular taxa. The datasets used in this report were obtained through:

- Eleven grab and trawl subtidal surveys carried out over a seven-year period with quarterly sampling in 2008 and 2011/2012, annually in June for 2009 and 2010 and in September for 2014. (Total of 890 grab samples, 295 2 m-beam trawl samples and 64 otter trawl samples);
- One survey in the shallow sublittoral area in September 2011 (40 grab samples);
- One survey in the intertidal in August 2011 (12 quadrat samples);
- 202 collection dates to estimating the numbers invertebrate impinged on cooling water screens as part of the Comprehensive Impingement Monitoring Programme at Sizewell B between February 2009 and October 2017;
- The continuous monitoring of the salinity in a coastal lagoon in Minsmere between July 2014 and May 2015;
- Two subtidal surveys with a high-resolution imaging sonar in February and June 2016 in the Coralline Crag area;
- Information gathered from a range of sources including published literature, EU and UK research council outputs, information from industry and EDF Energy's commissioned survey work in the Greater Sizewell Bay.

The use of multiple sampling methods or gears allowed a comprehensive description of the benthic fauna present in the area in terms of both infauna (organisms living in the seabed sediments) and epifauna (organisms living at the surface of the seabed). This report provides an overview of the benthic ecology of the Greater Sizewell Bay area by exploring the features of interest onshore (intertidal benthic assemblages and saline lagoon) and offshore (subtidal macrobenthos and habitats of conservation interest). The intertidal fauna of the Greater Sizewell Bay was characterised in detail in a previous report so only the important results are described here. The subtidal macrobenthos monitoring dataset is investigated in more detail by addressing a specific set of questions:

I. Are there discrete benthic communities in the Greater Sizewell Bay?

II. How is the physical environment shaping the distribution of the benthic fauna?

III. What is the natural variability of the benthic invertebrate populations?

IV. What are the dominant biological traits (i.e. morphological, behavioural, and life-history characteristics) of the benthic macrofauna?

V. Which are the key taxa, according to their socio-economic value, conservation importance or ecological role within the ecosystem and what are their spatio-temporal patterns?

Benthic fauna of the Greater Sizewell Bay:

The intertidal beaches of the area were predominantly coarse sediment with ephemeral sand veneers harbouring a reasonably broad range of sediment-dwelling organisms, but the region cannot be considered particularly diverse compared with other intertidal beaches in Europe. The beaches are very dynamic, and the proportions of surface sand change with tides and weather events. Consequently, the biology can be expected to be patchy and unstable over time, particularly in the southern half of the bay south of Thorpeness where there is no coastal sandbank to protect the shore from wave energy.

Monitoring of salinity in a Minsmere lagoon showed that the pond is brackish in nature (6 to 25 psu) showing some limited seawater input, entering the pond slowly, mostly likely via slow diffusion through the dune system that lies between the pond and the coast. The route of saltwater intrusion resulted in the conclusion that the operational risk of SZC to the Walberswick marshes waterbody from operational thermal and chemical discharges was, therefore, minimal.

Coastal vegetated shingle habitat is well represented in Suffolk where most of the shingle feature is under some form of protection. Five main sites are located within the footprint of the SZC development area with the largest site at Orfordness (508.7 ha) followed by Shingle Street (44.0 ha) and Thorpeness Haven (28.1 ha), all being in the southern part of the Greater Sizewell Bay coastline. Two smaller sites are found in the northern part of the Bay: Sizewell (10.6 ha) and Minsmere to Walberswick Heaths and Marshes (3.77 ha). This habitat is under threat due to dynamic natural coastal erosion, recreative fishing (trampling), grazer populations (e.g. rabbits) and invasive plant species.

The subtidal surveys suggest there is one overall infaunal and epifaunal community spanning most of the bay, but there is some evidence that a subset of taxa, recorded in very high abundances, have spatial affinity for specific localities within the study area, i.e. samples with higher abundance value of a given taxon are found across a restricted area within the study area. The distributions of these taxa appear to be structured in part by sediments, local morphological features and dynamic coastal processes. The epifauna data suggests that different environmental drivers, likely related to the water column, affect hyperbenthic organisms (living in the water column above the seabed). Indeed, these taxa are ubiquitous, compared to the epibenthic taxa and the infauna taxa, which show spatial affinities within the bay. Both the infauna and epifauna communities are typical in a regional context as they are part of a larger community distributed across the south of the North Sea 'infralittoral region', corresponding to the subtidal areas within 50 m depth.

Ecological indicators were applied to interpret the communities. The infauna community is naturally slightly to moderately disturbed showing a shift between April and August when erratic pulses of abundance (settlement event) are recorded, corresponding to the recruitment period. The abundant taxa found in the Greater Sizewell Bay have a high reproduction rate suggesting that infaunal populations are resilient in the dynamic environment of the Great Sizewell Bay. The hyperbenthic taxa displayed a very large increase in abundance during the summer months due to the migration patterns of several species. The epibenthic component also showed pronounced natural variability, most likely related to taxa biology, with spatial and temporal variation associated with stochastic recruitment in the dominant species**.** The dominant traits for the infaunal community at Sizewell follow similar patterns quarterly, with the dominant traits being largely consistent for the first, third and fourth quarter of the year, but shifting during the second quarter in association with natural abundance and biomass patterns. The functional traits of the epifauna community of the Greater Sizewell Bay, on the other hand, varied little over time. Both infauna and epifauna communities are characteristic of the benthic biology of the southern North Sea characterised by a few broadly adapted or recurring taxa with great reproductive power, and a large number of taxa occurring at a low frequency and in low abundance.

A series of key taxa (see Table 1) were identified for the purposes of the environmental impact assessment. A taxon is regarded as key in the ecosystem if it meets at least one of these criteria: Ecological importance (present in at least 30 % of stations and is among the taxa that contribute 90%

of the cumulative abundance); Socio-economic value (Species that are commercially exploited locally) and Conservation importance (taxa designated under a conservation status).

Two habitats of potential conservation interest have been identified in the area. The Coralline Crag deposits - located off Thorpeness - a hard substrate habitat characterised by bryozoan and mollusc debris and sometimes overlain with an ephemeral sand veneer which is locally unusual amongst the sands and gravels of the Greater Sizewell Bay. Grab samples and high-resolution acoustic images collected in the area suggest the presence of *Sabellaria spinulosa* reefs at both the inshore and offshore Coralline Crag areas. The benthic infauna living in the Sizewell-Dunwich sandbank shows low species richness and low abundances, as well as a low level of variability. However, settlement events, associated with an important increase in secondary production over the spring and summer months, have been recorded in the trough and on the flanks of the sandbank, suggesting a potential important feeding area for higher trophic levels.

The SZC construction and operational activities are expected to more than 60 years so it is important to consider and understand the possible natural shift in future baseline conditions due to natural or man-made processes, in the absence of a planned development, to predict more accurately the likely significant effects of the construction and operation activities at SZC. The main driver of change that will affect marine benthic communities and coastal habitats in the North Sea over long term is climate change and four major sources of change were identified and discussed in the context of Greater Sizewell Bay environment: (i) the distribution of benthic taxa in the southern North sea due to global warming; (ii) the possible change in hydrodynamics across the greater Sizewell Bay due to sea-level rise affecting the sandbank dynamics, (iii) the effect of the ocean acidification on the benthic taxa and (iv) the effect of the coastal-squeeze on onshore features.

Table 1: Overview of the Key benthic taxa of the Greater Sizewell Bay.

Faunal Group	Taxon	Ecological	Socio-economic	Conservation
Molluscs	*Abra alba*	✓		
	Buccinum undatum		✓	
	Ensis spp.	✓		
	Limecola balthica	✓		
	Mytilus edulis	✓	✓	
	Nucula nitidosa	✓		
	Nucula nucleus	✓		
Crabs and lobsters	*Cancer pagurus*		✓	
	Homarus gammarus		✓	
Shrimps and prawns	*Bathyporeia elegans*	✓		
	Gammarus insensibilis			✓
	Corophium volutator	✓		
	Crangon	✓	✓	
	Pandalus montagui	✓	✓	
Polychaetes	*Nephtys hombergii*	✓		
	Notomastus spp.	✓		
	Scalibregma inflatum	✓		
	Spiophanes bombyx	✓		
	Sabellaria spinulosa			✓
Echinoderms	*Ophiura ophiura*	✓		

1 Context

1.1 Purpose of the report

NNB GenCo proposes to construct and operate a new nuclear build (NNB) immediately to the north of the existing operational and decommissioned stations at Sizewell on the Suffolk coast – Sizewell C (hereafter referred to as SZC). Under the Planning Act 2008, this development, as with other nationally-significant infrastructure projects, requires a Development Consent Order (including, in the case of conservation areas, a Habitats Regulations Assessment) to be granted by the UK Government's Planning Inspectorate. The application process for this proposed power station development (hereafter the 'proposed development'), requires NNB GenCo to evaluate the impacts of the proposed station development on the marine ecosystem.

To support this process, Cefas has been commissioned since 2008 to conduct a programme of scientific studies on the marine ecosystem in the bay to form the basis of the marine ecology characterisation for the area (Figure 1). The outcome of these studies is presented through a series of reports characterising the components of the Sizewell marine ecosystem (see BEEMS Technical Reports TR346 on phytoplankton, TR315 on zooplankton, TR345 on fish and TR324 on marine mammals – see Appendix A.2). These reports support the Ecological Impact Assessment (EcIA) process by identifying the key ecological features, resources and functions of the Sizewell marine ecosystem that will then be evaluated to identify and determine how these may be affected by the proposed development.

As marine benthic invertebrates are a core component of the marine ecosystem and could potentially be exposed to impacts during the construction, operation and/or decommissioning of the proposed development, they will be included in the SZC EcIA. The present report describes the spatial distributions of the benthic taxa occurring in the Greater Sizewell Bay as well as the natural temporal and spatial variability of some structural and functional aspects of the benthic populations to form a baseline against which potential NNB impacts will be assessed.

1.2 Thematic coverage

This report characterises the distribution of the benthic invertebrate species from the onshore coastal area below mean high water springs (MHWS) to 5 km offshore. Benthic algae are not specifically addressed in the report because they are not present to any notable degree in southern East Anglian coastal waters. Coastal habitats above MHWS, such as shingle and dune plant communities, are not included in this report. Only the small saline lagoon immediately north of Minsmere sluice was considered because, although above high water, it is influenced by the marine environment (BEEMS Technical Report TR354). The larger brackish water bodies landward of the sluice (the large network of artificial lagoons known as 'The Scrape') were not considered as the ecology of these areas is beyond the remit of the BEEMS programme.

In this report only the juvenile or later stages of the benthic taxa were included. The reproductive stages of some benthic taxa (eggs and larvae) are planktonic but, for simplicity, all the plankton data were included in the zooplankton characterisation (BEEMS Technical Report TR315).

The purpose here is to identify the features of the system that should be included in the ecological assessment and provide information on their natural variability as well as the possible effect of the current activities at SZB. These features may be ecological assemblages, biological traits (i.e. characteristics of the taxa life history used to understand the structure and dynamics of ecological communities), important locations (for example, centres of particularly high abundance or biomass), or they may be key taxa in respect to their ecological, socio-economical or conservation importance.

To achieve our goals, we use data from the BEEMS characterisation surveys to address a specific set of questions:

- Are there discrete benthic communities in the Greater Sizewell Bay? (section 3.1)
- How is the physical environment shaping the distribution of the benthic fauna? (section 3.2)
- What is the natural variability of the benthic invertebrate populations? (section 3.3)
- What are the dominant biological traits (i.e. morphological, behavioural, and life-history characteristics) of the benthic macrofauna? (section 3.4)
- Which are the key taxa, according to their socio-economic value, conservation importance or ecological role within the ecosystem and what are their spatio-temporal patterns? (section 3.5)

1.3 Geographic coverage

The Greater Sizewell Bay is an open system whereby water exchanges with the wider southern North Sea. Marine disciplines considering the coastal geomorphology, water quality and ecology define the geographic area for the Environmental Impact Assessment (EIA) in subtly different ways depending on the receptor. For the purposes of the EIA, the initial reference area of the Greater Sizewell Bay extends to Walberswick in the north with the southerly extent bound by the geomorphic Coralline Crag formation at the apex of the Thorpeness headland in the south. The seaward boundary extends to the eastern flank of the Sizewell-Dunwich Bank and includes the proposed cooling water infrastructure on the east side on the bank. The landward limit of the marine study area is delineated by Mean High Water Springs (MHWS). However, the Zone of Influence (ZoI), that is the area over which a given receptor may be exposed to impacts, is species-specific and depends on the interplay between physical processes and the ecology of the species of concern including factors such as physiology, motility, and reproductive strategy.

To provide a baseline for the potential ZoI and characterise the benthic communities of the Greater Sizewell Bay relative to the wider area a wider geographic extent was surveyed. For the purpose of this report the Greater Sizewell Bay extends between headlands at Southwold to the north and Orford Ness to the south.

The seabed habitats of the Greater Sizewell Bay are shown on Figure 2. Seabed habitats were classified to EUNIS Level 5 (defined by both abiotic and biotic parameters), where possible. EUNIS Habitat Type were classified to a higher level in the hierarchy where sample information was lacking or was inconclusive. EUNIS codes: A4.138 - *Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock; A5.13 - Infralittoral coarse sediment; A5.135 - *Glycera lapidum* in impoverished infralittoral mobile gravel and sand; A5.23 - Infralittoral fine sand; A5.231 - Infralittoral mobile clean sand with sparse fauna; A5.233 - *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand; A5.261 - *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment; A5.311 - *Nephtys hombergii* and *Limecola balthica* in infralittoral sandy mud; A5.43 - Infralittoral mixed sediments. It should be noted here that following additional work implemented in 2018 and 2019 (see section 4.1), the habitat A4.138 should be reviewed in order to consider the *Sabellaria spinulosa* crust and reef habitat on exposed Coralline Crag [A4.221 Sabellaria spinulosa encrusted circalittoral rock].

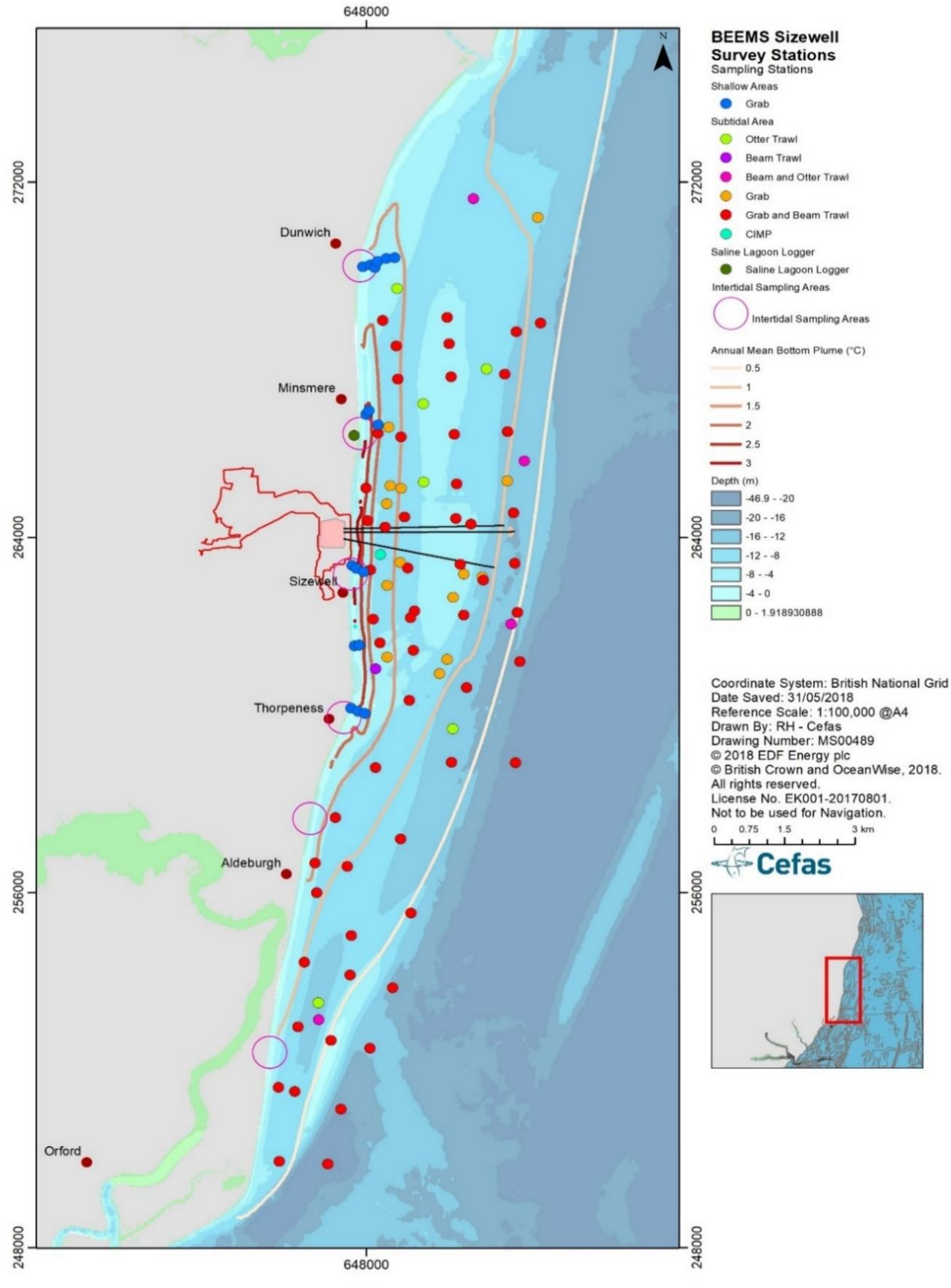

Figure 1: The BEEMS Sizewell survey stations 2008 to 2014 for each type of sampling gear. The 0.5°C contours show the distribution of thermo-plume based on the annual mean bottom temperature that was used in 2010 to re-design the monitoring area based on the maximum extent of the thermal plume across the Greater Sizewell Bay.

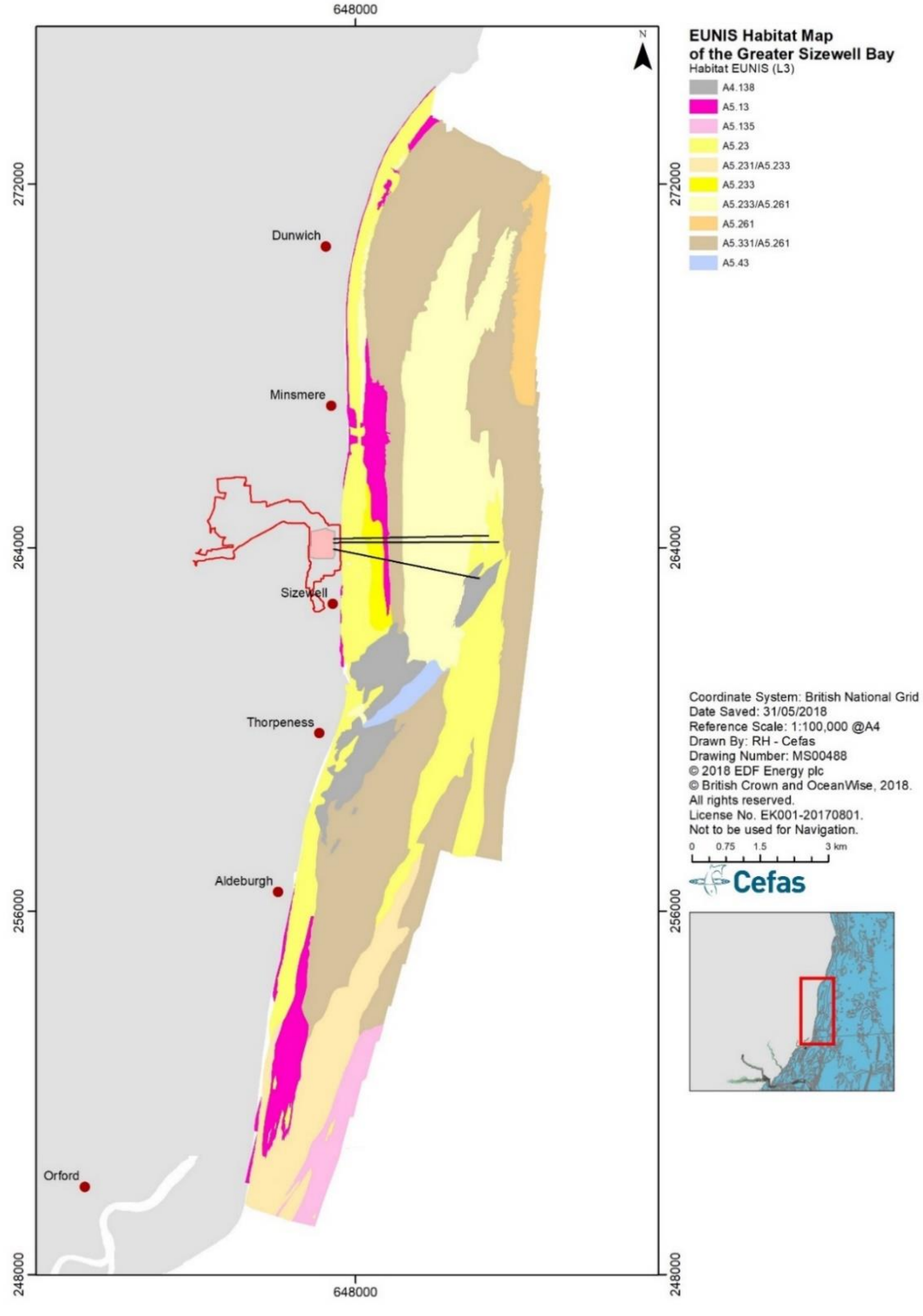

Figure 2: 2010 EUNIS habitat Map of the Greater Sizewell Bay, as mapped during late 2008 and early 2009 (from BEEMS Technical Report TR087 Ed 3). The habitat A4.138 is now considered to be *Sabellaria spinulosa* crust and reef habitat [A4.221 *Sabellaria spinulosa* encrusted circalittoral rock].

1.4 Data and information sources

The report consolidates the outputs of numerous BEEMS Technical Reports on aspects of the marine ecology of the Greater Sizewell Bay area ('feeder reports' Appendix A). Detailed survey and analysis methods are not provided, except where a new form of output has been created that does not appear in a feeder report. For brevity, the individual feeder reports are not referenced through the text. The BEEMS data have been supplemented with information from additional sources (section 1.4.3).

1.4.1 BEEMS intertidal survey

The intertidal fauna of the Greater Sizewell Bay was surveyed from the 8th to the 22nd of August 2011. Six areas were selected at approximately equal spacing along the coast between Dunwich and Orford Ness; see Figure 1), to provide coverage of the whole area and describe features of interest (e.g. Minsmere sluice and the beaches at Orford Ness). Infauna and sediments were sampled from the high and low shore at each location with quadrat surveys (0.0625 m^2 quadrat dug to a depth of 15 cm). Quadrat surveys were complemented by a qualitative habitat photography survey of the entire area to determine whether the characteristic gravel beach habitat was homogenous or whether there were pockets of finer sediments that might support different biological assemblages. Repeated quarterly or annual surveys were not considered necessary due to the nature of the assemblages (section 2.1).

1.4.2 BEEMS subtidal surveys

The subtidal data are taken from a series of BEEMS datasets covering the years 2008 to 2014 (Table 2). A list of the feeder reports is provided in Appendix A and details of the samples collected are given in Appendix B and in Figure 1. These data were gathered from a series of boat-based surveys and onshore impingement sampling. Surveys were initially designed on a quarterly basis to define taxa composition and relative distribution over the course of a year (Q1 – January to March, Q2 – April to June, Q3 – July to August and Q4 – October to December).

Three different types of grabs were used to collect soft sediment seabed in the Greater Sizewell Bay in order to maximise the quality of the samples collected. Most of the subtidal samples were collected with a 0.1 m^2 Day Grab, a popular device for the collection of marine benthos due to its simple design and the possibility of accessing undisturbed sediment through a couple of flaps disposed on the upper surface of the grab (to collect samples for sediment analysis). The Day grab does not work very well on harder coarse substrata, so the device was replaced by a 0.1m^2 Hamon grab where no sediment could be collected with the Day Grab. The Hamon grab would have been suitable for sandy and gravelly substrate but it is not recommended to use it in softer sediment samples such as mud or sandy mud due to the great weight of the device, which can cause it to sink deeply into the softer sediments. The shallow subtidal samples were collected with a small Van Veen grab with a smaller sampling surface, 0.025 m^2, a light weight device suitable for fine-medium sand that can be handled by hand from an inflatable rib in order to collect samples in very shallow water (from a couple of meter depth).

Table 2: The BEEMS Sizewell subtidal benthic invertebrate survey series up to 2014.

Year	Dates	Survey code	Quarter	No. grab stations	No. trawl stations B	No. trawl stations O	Impingement
2008	4 - 6 March	SIZE108	Q1	11 (D)	17	6	-
	2 - 5 May	SIZE208	Q2	19 (D)	18	6	
	9 - 12 September	SIZE308	Q3	20 (D)	20	6	
	23 - 26 October	SIZE408	Q4	20 (D)	20	6	
2009	16 - 20 June	SIZE209	Q2	28 (D)	21	6	Feb '09 to Jan '10
2010	17 - 22 June	SIZE510	Q2	20 (D)	19	6	Feb '10 to Jan '11
2011	17 - 24 June	SIZE511	Q2	36 (D/H)	37	10	Feb '11 to Jan '12
	12 September	SSUB111	Q3	17 (VV)	-	-	
	17-23 September	SIZE611	Q3	40 (D/H)	40	10	
	18 - 26 November	SIZE711	Q4	44 (D/H)	39	10	
2012	17 - 24 March	SIZE112	Q1	44 (D/H)	32	10	Feb '12 to Feb '13
2013	-	-	-	-	-	-	
2014	16-20 September	SIZE814	Q3	40 (D)	23	7	Apr '14 to Sep '14
2015	-		-	-	-	-	Apr '15 to Mar '16 Jun '16 to Oct '17
2016	-		-	-	-	-	
2017	-		-	-	-	-	

Note: The type of grab used for each survey is indicated in parentheses: (D) Day grab, (D/H) Day grab and Hamon grab, (VV) Van Veen grab – three replicates were sampled at each station from 2008 to 2012, only one replicate was collected in 2014. The trawl samples were obtained with a 2m-beam trawl (B) and with a commercial Otter Trawl (O), only one replicate at each station. Impingement of invertebrates on the cooling water drum screens of Sizewell B was monitored fortnightly.

1.4.2.1 Boat-based surveys

Coastal surveys were designed to characterise the invertebrate assemblages in locations representative of the Greater Sizewell Bay's seabed types. The seabed habitats were mapped during 2008 and 2009 (see BEEMS Technical Report TR087) and the benthic ecology from 2008 through to 2014 (Table 2 and Figure 1)[1]. The ecology survey grid evolved over time in response to growing understanding of both the seabed habitats and the predicted SZC thermo-chemical plume footprint.

[1] The grab and beam trawls station codes were assigned an SX prefix from 2008 - 2010, but these were revised to an SZ prefix in 2011 at NNB GenCo's request.

The grab[2] survey series comprised 88 sampling stations and a total of 890 samples (up to three replicates were collected at each station - see Appendix B.1 for details). The beam trawl series comprised of 84 stations and 295 samples (Appendix B.3) and the otter trawl[3] series included 11 stations and 65 samples (Appendix B.4 for details). The replicate grab samples were aggregated for each station for each survey and abundance and biomass values were standardised to the number of individuals per square meter[4]. Beam and otter trawl data were expressed as individuals per square kilometres, no biomass was recorded for the benthic fauna.

The surveys can be grouped by their spatial extent, as follows:

The 2008 – 2010 grid (see Appendix B): Commenced in March 2008 with a scoping survey to define sampling positions and test gears over an area from Dunwich to Thorpeness. A standard grid of 20 stations was retained for the remainder of 2008 (May, September and October) and for two further surveys, in June 2009 and June 2010. The 2 m beam trawl and the grab were successfully deployed at 17 to 20 stations depending on the survey (Table 2 lists the number of stations sampled during each survey; it wasn't always possible to obtain the full suite of 20 stations due to occasional gear damage). The surveys also included a grid of 6 commercial otter trawl stations.

The 2009 supplementary stations (Appendix B): Eight supplementary day grab and three beam trawl stations were surveyed in 2009 in addition to the standard grid defined in 2008. Indeed, after an initial review of bathymetry and backscatter data, specific areas of interest were targeted in order to improve the interpretation of the acoustic data used for the habitat maps (BEEMS Technical Report TR087).

The 2011 shallow water survey (Appendix B): The shallow sublittoral was surveyed in September 2011 to fill an information gap between the intertidal and the main subtidal benthic surveys. The area's shallows are difficult to sample due to sampling and safety considerations related to a combination of turbidity and shallow water depths. Accordingly, BEEMS adopted an approach with a hand-held Van Veen grab (0.025 m^2) deployed from the side of a soft inflatable boat with no minimum sediment volume criterion applied to maximise the chances of obtaining useful samples. Sampling was completed from Dunwich to Thorpeness; see BEEMS Technical Report TR238. The sampling design encompassed 22 stations along six transects (in the event, it was only possible to survey 20 stations).

The 2011 – 2012 grid (Appendix B): New hydrographic model runs produced towards the end of 2010 (BEEMS Technical Report TR133) indicated that the footprint of the thermal plume may extend further southwards (and slightly further northwards) than originally predicted. Therefore, the survey grid was expanded south to Orford Ness and slightly further to the north of the Bay. The survey design encompassed 40 beam trawls and grab stations (12 from the 2008 – 2010 series, 25 additional stations to the south, and 3 additional stations to the north). Ten otter trawl stations (6 from the previous grid, plus 4 additional stations) were surveyed quarterly between June 2011 and March 2012.

The 2014 grid (Appendix B): The 2014 survey was stratified by sedimentary habitat, selecting stations within the Sizewell C footprint (the originally proposed jetty, cooling water intakes, outfall and Fish Recovery and Return (FRR) infrastructure, and the predicted extent of the thermo-chemical plume). Reference locations beyond these areas were also sampled to test designs for providing targeted baseline information in areas adjacent to the Sizewell C infrastructure. The survey design

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[2] The grab type differed according to the substrate, but as this did not affect the results (comparisons were run during the late 2011 and early 2012 surveys, see BEEMS Technical Report TR201) they can safely be combined.
[3] The otter trawl is a demersal fishing gear with a 90 mm mesh net. It is not designed to catch benthic invertebrates, the taxa found in the net were accidental catches so only commercial taxa were counted during the surveys.
[4] The biomass is expressed in ash-free dry weight (AFDW, g) after conversion for wet weight using standard conversion factors (BEEMS Technical Report TR201).

encompassed 40 grab stations (including 25 positions from the 2008 – 2012 series), 23 2-m beam trawl stations (15 from previous grids), and 7 otter trawl stations (with 6 from the previous grid) surveyed in September 2014.

1.4.2.2 Onshore sampling

The Comprehensive Impingement Monitoring Programme (CIMP) was implemented at SZB from 2009 to 2017 to evaluate the effects that the abstraction of water may have on organisms in the marine environment (see BEEMS Technical Report TR120; BEEMS Technical Report TR196; BEEMS Technical Report TR215; BEEMS Technical Report TR270). Two sampling series were implemented as part of the CIMP, the first one from February 2009 to March 2013 by Pisces Conservation Ltd and the second one from April 2014 to October 2017 by Cefas.

Samples were collected approximately fortnightly from the fine-mesh (10 mm) cooling water screens in the Sizewell B forebay, to estimating numbers of fish and invertebrate taxa impinged in the cooling water system. The complete dataset comprised 202 samples of the estimated number and weight of invertebrates captured during a 24-hour period with the station pumping at full capacity. Note that the impingement data were not included in the analyses of spatial patterns in the assemblages as they are collected from only one location; they were used only to describe the temporal patterns in the key taxa retained on the drum screen. The impingement data were expressed as numbers or weights per 24 hours. The benthic invertebrates were not the priority of the CIMP and benthic species are underrepresented within the impingement record. Some relevant information can, however, be extracted from the sampling program as described in section 3.2.2 of this report.

1.4.3 The wider marine environment

The Marine Aggregate Regional Environmental Assessment for the Outer Thames Region (MAREA) [5] published by the Thames Estuary Dredging Association in 2010 (TEDA, 2010); and the Anglian Marine Aggregate Regional Environmental Assessment published by EMU Limited (2012) were used to describe the regional biological and physical environment.

Published peer reviewed and grey literature on the benthic fauna in the North Sea has also been consulted and referenced at the end of the report.

[5] http://www.marine-aggregate-rea.info/teda, consulted on the 10/12/2015.

2 Overview of the features of interest onshore

2.1 Intertidal benthic assemblages

The intertidal fauna of the Greater Sizewell Bay was characterised in BEEMS Technical Report TR237 and is not be described in detail here. Overall, the beaches of the area were predominantly coarse sediment with ephemeral sand veneers (Figure 3), appearing to contain more gravel towards the southern end of the bay. They harboured a reasonably broad range of sediment-dwelling organisms, but the region cannot be considered particularly diverse compared with other intertidal beaches in Europe. A total of 51 benthic taxa were recorded during the study (see section 1.4.1), but many taxa were found infrequently (between 9 and 21 taxa found per location). Turbellaria, juvenile gammarid amphipods, nemerteans and juvenile *Mytilus edulis* dominate the macrobenthic assemblages, comprising 94% of the total abundance. The total density of macrofauna organisms varied from about 100 to 8500 individuals per m^2 between the sampling locations and showed high natural variability in each sampling area (CV>100% - Table 3). There was little overall indication of spatially-distinct assemblages; some evidence of generally decreasing macrofauna abundance and, to a lesser extent, biomass moving from the northern to the southern half of the bay (with the exception of Orford Ness) occurred. Attached colonial fauna were restricted almost entirely to the southern gravelly locations, but there were no discernible broad-scale differences in taxon distribution or overall assemblage structure, nor any strong zonation between high and low shore (BEEMS Technical Report TR237). Despite being in an exposed location, Orford Ness was somewhat unusual in having generally higher biomass and notably higher abundance than the other survey locations (Table 3) - driven mainly by increases in *Turbellaria*, juvenile gammarids and, to a lesser extent, juvenile *Mytilus edulis*, but also by a greater frequency of attached colonial fauna.

Comparison with historical data from the SZB environmental assessment (Bamber, 1988) suggested no notable change in the fauna of the beaches over time (any differences being likely due to the larger area covered by the BEEMS survey and the use of more effective sampling techniques). Thus, the overall picture is of moderate energy shores composed of a matrix of gravel and sand, populated by patchy, low abundance and low biomass infauna assemblages more tolerant of the dynamic physical environment. Beach composition in the area is controlled by coastal processes and sediment transport pathways, with sand exchange between the beach face and nearshore longshore bars (BEEMS Technical Report TR049). The beaches are very dynamic, and the proportions of surface sand will change with tides and weather events. Consequently, the biology can be expected to be patchy and unstable over time, particularly in the southern half of the bay, south of Thorpeness, where there is no coastal sandbank to protect the shore from wave energy.

Meiofauna were also sampled in the area. Mean total abundance varied from 80 to 200 ind.10 cm^{-2} with moderate variability (CV between 70% and 140%). No north-south gradient was discernible in the meiofauna assemblage structural parameters (total abundance and taxon richness), which were more homogenous than the macrofauna.

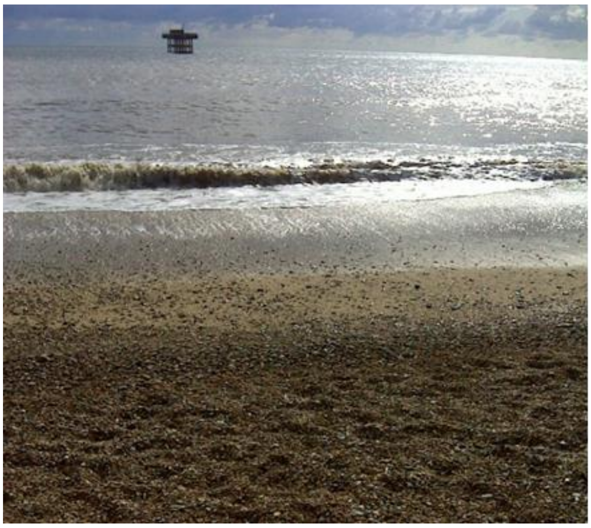

Figure 3: Sample photographs taken from the quad bike during the high-shore gravel ridge run. The shore here (Sizewell) is a mixed sand / gravel intertidal beach face, backed by a supratidal gravel ridge. Photo (a) is a seaward aspect, showing the edge of the supratidal ridge and the intertidal beach face. Photo (b) is a landward aspect showing the supratidal area and dune vegetation.

Table 3: Summary statistics on macro- and meiofauna structural parameters. For macrofauna: average total abundance is reported per square metre and taxa richness per sampling area. For meiofauna: average total abundance per 10 cm^{-2} (from BEEMS Technical Report TR237). The coefficient of variation [CV = (standard deviation) / (mean)*100] was calculated for each sampling area.

Sampling Area	Macrofauna (>0.5 mm)			Meiofauna (<0.5 mm)	
	Total abundance	CV	Richness	Total abundance	CV
Dunwich	179 ± 180 (S.D.)	101	16	182 ± 160 (S.D.)	88
Minsmere	858 ± 1588 (S.D.)	185	19	100 ± 69.2 (S.D.)	69
Sizewell	213 ± 258 (S.D.)	121	18	199 ± 283 (S.D.)	142
Thorpeness	94 ± 159 (S.D.)	169	9	148 ± 204 (S.D.)	138
Aldeburgh	136 ± 138 (S.D.)	101	18	176 ± 242 (S.D.)	138
Orford Ness	8531 ± 12046 (S.D.)	141	21	83 ± 59 (S.D.)	71

2.2 Coastal saline lagoons

Saline lagoons are natural or artificial bodies of saline water that are partially separated from the sea. They are defined by the combination of three characteristics: (i) the lagoon is isolated by a barrier beach, spit or chain of barrier islands; (ii) all or most of the water mass is retained within the system during periods of low tide in the adjacent sea; and (iii) the natural water exchange between the lagoon and the parent sea (by percolation through and/or overtopping of the barrier) is persisting so the lagoons remain saline, hyper-saline, or brackish (Barnes, 1989).

These features are relatively rare in the UK with only around 5200 ha remaining[6]. There are 188 saline lagoons in Suffolk, covering 133 hectares, which accounts for 2.6% of the UK resource. The saline lagoons are a feature of conservation importance and they are a priority Annex I habitat under

[6] http://www.suffolkbis.org.uk/ consulted on the 6th of March 2018.

the EU Habitats Directive, they are listed as a UK Biodiversity Action Plan priority habitat[7] and form part of the Walberswick Marshes water body as defined by the Water Framework Directive.

A monitoring programme was implemented to ascertain the potential for plume-water incursion into the lagoons nearest to Sizewell (at Minsmere) and to provide evidence of potential future exposure during the construction, commissioning and operational phases of the SZC development (BEEMS Technical Report TR354). Seawater can enter many of the ponds within the Minsmere RSPB[8] reserve by passing though Minsmere sluice and into Leiston Drain as part of the management of the RSPB reserve (RSPB, 2015). A small brackish pond isolated and adjacent to the coast with no direct connection to the Leiston Drain was identified for monitoring to determine if there is connectivity between the pond and the sea either via overtopping during periods of elevated tidal levels or high wave conditions or via percolation through the dune system (Figure 1 and Figure 4). This pond was selected because it was the closest pond to the sea and the only pond to lie outside of the flood protection that protects the Minsmere reserve. This pond was therefore the local waterbody most likely to exhibit marine connectivity.

Automated salinity and water temperature monitoring was undertaken between 30th July 2014 and 5th May 2015. No indications of overtopping were observed. The brackish nature of the pond water (6 to 25 psu) indicates that there is some limited seawater input into the pond and the measured changes in salinity indicate that saline water enters the pond slowly, mostly likely via slow percolation through the dune system that lies between the pond and the coast. The SZC chemical plume modelling has shown that the operational SZC TRO and hydrazine plumes will not intersect with the Minsmere coast at concentrations above the Environmental Quality Standards (EQS) and Predicted No Effect Concentrations (PNECs) respectively. Indeed, expected chemical concentrations in the marine environment will be reduced after percolation through the dune system, and the seawater reaching the saline lagoon would be expected to have concentrations below the EQS (BEEMS Technical Report TR354). The operational risk to the Walberswick marshes waterbody from these discharges has, therefore, been discounted.

Figure 4: Temperature and salinity logger in a saline lagoon near Minsmere.
Photo of the logger deployed in the pond near Minsmere beneath the small orange flotation marker indicated by an arrow (left) and its deployment location, approximately 50 m back from the dune crest (right).

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[7] UK Biodiversity Action Plan Priority Habitat Descriptions - Saline Lagoons: http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-48-SalineLagoons.pdf
[8] Royal Society for the Protection of Birds

2.3 Coastal vegetated shingle

Coastal shingle is defined as deposits of coarse sediment with a mixture of particle sizes ranging from 2 to 200 mm (sand to boulders). The shingle structure develops from particles being deposited at the limit of high tide. The structure becomes more permanent after storm waves throw the pebbles high up on the beach where the backwash cannot remove them. More extensive structures are formed by accumulation processes. Most of the shingle structures in Europe are bare, but highly specialised flora communities can locally grow to become a vegetated shingle habitat. The development of this ecosystem depends on the level of disturbance and mobility of shingle due to factors such as wave action, the presence or absence of fine sediment particles in the shingle matrix and the availability of moisture for the plants to grow[9].

Coastal vegetated shingle habitat is recognised as internationally important, but it is a disappearing resource due to various threats such as dynamic natural coastal erosion, recreational fishing (trampling), grazer populations (e.g. rabbits) and invasive plant species (Murdock *et al*., 2010). Britain holds approximately one third of the vegetated shingle in Europe and this habitat is well represented in Suffolk, where the majority of the shingle feature is protected by different legislation. Five main sites are located within the footprint of the SZC development area (Table 4). Two Annex I habitats protect the specialised vegetation growing on the shingle beach[8]:

- the **Annex I Habitat H1210 - Annual vegetation of drift lines** which includes two community types in the Greater Sizewell Bay area: typical community of sandy shores, with species such as such as the sea sandwort *Honckenya peploides* and shingle plants such as sea beet *Beta vulgaris ssp. Maritima*; and typical communities of shingle to saltmarsh shores, with species such as the sea beet *Beta vulgaris* ssp. *maritima* and the orache *Atriplex* spp.
- and the **Annex I habitat H1220 - Perennial vegetation of stony banks** which includes pioneer communities' type *with* sea pea *Lathyrus japonicus* and false oat-grass *Arrhenatherum elatius* grassland.

The vegetated communities are generally associated with transitional communities such as saltmarsh communities, brackish mire, swamp communities, grassland and/or heathland.

Table 4:Coastal vegetated shingle habitat along the Greater Sizewell Bay coastline. Description, extent (ha) and conservation status[10] obtained from Murdock *et al.,* (2010) and the JNCC website[11].

Sites	Location	Extent	Conservation status
Orfordness	Southward growing shingle spit which has its proximal end attached to the mainland coast at Aldeburgh.	508.7	RAMSAR, SAC (H1210 & H1220), SPA, NT, NNR
Shingle Street	Opposite the distal end of Orfordness.	44.0	RAMSAR, SSSI
Sizewell	In front of Sizewell power station.	10.6	cSAC, AONB, SSSI
Thorpeness Haven	From the southern end of Thorpeness village to the north of Aldeburgh.	28.1	AONB, RSPB reserve, SSSI
Minsmere to Walberswick Heaths and Marshes	Across the beach strandline of mixed sand and shingle.	3.77	SAC (H1210), SPA, RAMSAR, SSSI, AONB

[9] http://jncc.defra.gov.uk/ProtectedSites/SACselection/SAC_habitats.asp, consulted the 29/06/2018.
[10] RAMSAR - Convention on Wetlands of International Importance; SAC - Special Area of Conservation; cSAC candidate Special Area of Conservation, SPA – Special Protection Area, NT – National Trust; NNR - National Nature Reserve; AONB - Areas of Outstanding Natural Beauty; SSSI - Site of Special Scientific Interest; RSPB - Royal Society for the Protection of Birds Nature Reserve.
[11] Minsmere to Walberswick Heaths and Marshes – consulted on the 29/06/2018. http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0012809

3 Overview of the subtidal macrobenthos

The chapter below aims to describe the distribution of the benthic organisms in the Greater Sizewell Bay to establish the benthic receptors of ecological significance against which the sensitivity to the impact of the construction and operation of SZC power station will be assessed. To achieve this objective, a dataset comprising biological samples collected between 2008 and 2014 was used (Table 2). The highest sampling frequency was on a quarterly basis (see section 0) allowing a baseline assessment of the macrobenthic community in the Greater Sizewell Bay. Various sampling gears were used to target both groups of benthic macrofauna[12] (≥0.5 mm): (i) the organism living in the seabed sediments, sampled with different type of sediment grabs, referred below as the **infauna** and (ii) the larger organisms living at the surface of the seabed, sampled with a 2 m beam trawl, and are referred below as **epifauna** (Table 5).

Table 5: Summary data collected in the Greater Sizewell Bay over the monitoring period 2008-2014 used for the characterisation report.

Parameters	Infauna (grab samples)	Epifauna (trawl samples)
Total number of taxa (complete list in Appendix C)	301 of which: • 49 were colonial[13] • 101 were rare[14]	120 of which: • 31 were colonial • 36 were rare
Total number of individuals collected	81,116	137,389
Number of sampling stations	88	63
Number of replicate samples	890	295

[12] Macrofauna, also called macrobenthos, are the invertebrates that live on or in sediment, or attached to hard substrates which are retained on a 0.5 mm sieve.

[13] This term refers to animals living aggregated in colonies and are impossible to count to provide individual abundance value per grab. The colonial taxa were kept in the analysis and an abundance of 1 was reported.

[14] Rare taxa: taxon present at only one station over the duration of the monitoring period (2008-2014) and with abundance <0.1% of the total abundance (for the non-colonial).

3.1 Are there discrete benthic communities in the Greater Sizewell Bay?

This question is best answered using multivariate data exploration tools. Ordination is commonly used – this technique investigates patterns in species' distribution among samples. The ordination algorithm calculates the similarity of each sample to all the others based on whether they have taxa in common and whether these taxa occur in similar abundances. This step determines how similar a survey station is in its taxa complement to others across the grid. When the samples are transposed onto a 2-D or 3-D plot based on these similarities, the analyst can determine whether groupings are forming. Clear groupings indicate the presence of multiple communities. The benthic invertebrate data were ordinated using non-metric multidimensional scaling (nMDS), based on the Bray-Curtis similarity of stations after abundance data were transformed (square root) to reduce the influence of highly dominant taxa. The quality of the representation on an MDS plot is estimated by the stress value (measure of goodness-of-fit) where a stress <0.05 gives an excellent representation, <0.1 corresponds to a good ordination, <0.2 still gives a potentially useful 2-D picture but a stress value >0.3 indicates that the points are close to being arbitrarily placed in the ordination space (Clarke and Gorley, 2015).

All replicate grab samples were cumulated per station and taxa abundances were converted to square metre and averaged across surveys. Only one sample was taken with the beam-trawl for each survey so the data for each survey were converted to abundance per 1000 square metres and then averaged across surveys. The objective, in both cases, was to have one sample per station to study the spatial distribution of the infauna and epifauna taxa across the study area.

Where nMDS did not provide a good quality of representation to allow us to answer the question of whether there are discrete assemblages in the area, an alternative multivariate technique termed hierarchical cluster analysis was employed. Hierarchical cluster analysis (CLUSTER) uses the same similarity algorithm as ordination, but rather than representing the similarities on a plot, it uses them to join the samples together into groups. Samples that are the most similar cluster together first, followed by those less similar, until all are joined. The final output is a dendrogram in which the x-axis represents a sample and the y-axis the level of similarity at which they have been joined. The disadvantage of cluster analysis, compared to ordination, is that it forces samples into clusters and so can produce groupings of stations where none exist, for example if the samples align more to a gradient than a discrete group. To help overcome this limitation, a Similarity profile tests (SIMPROF) was applied to determine genuine clustering of the samples based by testing the statistical significance (5%) of species groupings (Clarke and Gorley, 2015). Cluster analysis helps to answer the question posed in the current section of this report by identifying whether the samples cluster into geographical groups. Indeed, spatially discrete groups of taxa are clear evidence of discrete communities. The taxa composition of the different clusters is examined more closely by the similarity percentages routine (SIMPER) in order to obtain a list of the taxa contributing the most by their abundance to the formation of each cluster. The software PRIMER v7 (Primer-E Ltd) was used for the analyses. Details of the specific multivariate techniques used in this report can be found in Clarke and Gorley (2015).

3.1.1 Infauna

The evidence suggests there is one overall infauna community spanning the Greater Sizewell Bay. There are, however, some indications that the highly abundant taxa have a spatial affinity, i.e. samples with a higher abundance value of a given taxon are found across a restricted area within the study area.

This conclusion is based on the following evidence:

- No clear grouping patterns have appeared on the nMDS plots (data not shown). Indeed, the nMDS procedure was not fully successful in transposing the similarities between the samples onto the ordination plot (indicated by a relatively high stress value of 0.21 for the 2-D plot and 0.15 for the 3-D plot), so one should not put too much emphasis on this as a source of evidence. For this reason, we also undertook a CLUSTER analysis of the data.

- Results of the cluster analysis are not convincing as it produced 25 significant clusters for only 86 samples, seven containing only a single sample (i.e. one station) and eight containing only two or three samples, which tells us little about overall patterns in the benthos and possibly illustrates stochastic conditions at a given location. The SIMPROF test signalled that the 18 clusters containing more than 1 sample had an average similarity (a measure of how similar the taxa complements are between the samples in a cluster) between 17 and 78% (50% on average). The composition of each cluster was analysed more closely through a SIMPER analysis.
- Out of the 200 taxa retained for the analysis (102 rare taxa were excluded), only 36 contributed highly by their abundance to the formation of the clusters (those representing 60% of cumulative abundance within a cluster are highlighted in Table 6). It appears however that an even smaller number of taxa dominated in each cluster (except for clusters u, t and c), with only one to three taxa contributing 30 to 90% of the total abundance (highlighted in bold in Table 6). Many of these highly contributing taxa are relatively common across the area, characterising clusters of two to six stations but occurring at 19 to 64 of the 86 stations sampled. Also, some of the same highly abundant taxa were dominant in multiple clusters, such as *Scalibregma inflatum* (clusters o, n, k) and *Ensis sp.* (clusters s and u). For clusters to signify discrete assemblages, one would expect different sets of taxa to dominate the clusters. These similarities in taxa composition suggest again that no discrete communities exist across the study area.
- To further describe the spatial distribution of the infauna community, the clusters were plotted onto a map of the Greater Sizewell Bay (Figure 5). Some similar clusters, which shared highly abundant taxa (see Table 6), were presented together, resulting in 12 main infaunal groups. These faunal groups suggested some spatial patterns in the abundances of taxa that characterise clusters, which are likely derived simply from irregular very strong settlement events[15] of the dominant taxa. Spatial patterns can be derived from the individual taxa maps of settlement event (Figure 6). Most of the settlement events occur in the spring (Q2) but are considered as erratic as the intensity of a settlement event (total number of individuals) varies from year to year and is even completely absent in some sampling years (Figure 6); these settlement events bring a strong heterogeneity to the dataset. Settlement events of *Notomastus*, *Scalibregma inflatum* and *Corophium volutator* occur near the proposed outfalls, whilst settlements of *Ensis* sp. and *Spiophanes bombyx* occur near the intakes (Figure 5 and Figure 6).
- There is some evidence of a more homogeneous assemblage at stations around Thorpeness and Orford Ness, to the south of the bay (see clusters v, w, t and c in Table 6). These are also distinguished by the absence of settlement events, with the exception of *Sabellaria spinulosa* at one station in the south (Figure 6).

This high number of clusters and the commonality of dominant taxa across the clusters indicates these faunal groups are an arbitrary subdivision of a natural continuum, separated based on variation in abundance of the most numerous taxa, and these clusters are therefore not ‘true’ discrete communities. The dominant taxa do, however, show some spatial affinity, i.e. samples with higher abundance value of a given taxon are found across a restricted area within the study area, particularly across the northern part of the bay.

[15] A settlement event is identified in the dataset when a very high number of individuals was recorded only in a few number of samples although the taxa is found in a high number of samples.

Table 6: List of the taxa contributing the most by their abundance to the formation of each of the cluster groups determined by the similarity percentages routine (SIMPER).
The colour intensity indicates the taxa that contribute most to the similarity within clusters, up to 90% of total contribution. The tick marks indicate whether the other taxa (low contribution) are present. The number of samples a taxon occurs in is provided in parentheses out of a possible 88 samples. Taxon in bold are highly abundant, i.e. representing up to 60 % of cumulative abundance within a cluster.

Significant clusters	**p**	**f**	**o**	**n**	**k**	**s**	**u**	**g**	**y**	**i**	**b**	**h**	**j**	**x**	**w**	**v**	**t**	**c**
% Similarity	**50**	**63**	**70**	**78**	**47**	**75**	**51**	**33**	**24**	**46**	**18**	**31**	**45**	**32**	**55**	**59**	**45**	**48**
Number of samples	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**4**	**4**	**5**	**6**	**7**	**8**	**8**	**9**	**3**	**6**
***S. bombyx* (64)**			✓	5		✓	5	65		✓		✓	8	21	10	7	15	2
***Nephtys sp.* (52)**	16		✓	✓		✓	3	✓		✓		✓	✓	39	4	3	4	✓
***B. elegans* (51)**				✓	✓	✓	4			10	73		12	20	✓	6	4	
***N. nitidosa* (49)**	23		✓	7		✓	2			✓		✓	4		10	23	✓	
***S. inflatum* (49)**		✓	62	39	90	✓	4			✓			14		4	3	6	✓
M. edulis (47)		5		✓		✓	5		✓	5			✓		3	4	5	6
***N. hombergii* (47)**	✓		✓	5		✓	✓	✓		✓			✓	✓	11	8	3	✓
S. armiger (47)						✓	✓			6		12	✓		✓	✓	6	3
***A. alba* (46)**			✓	✓		✓	✓			✓		✓		✓	7	3	4	✓
***Notomastus sp.* (46)**			11	5		✓	4			✓		54	✓		✓	✓	5	3
Nemertea (45)		✓	✓	✓		✓	3		64	✓				✓	3	✓	4	4
***Ensis sp.* (42)**			✓	✓		40	12	✓		✓			✓	✓	5	✓	3	
***N. cirrosa* (42)**				✓		✓	5		20	18			25	✓	✓	✓	✓	
***N. nucleus* (42)**	✓			3	✓	✓	✓			✓		7	✓		4	10	✓	✓
***L. balthica* (40)**	44					30	2	15		✓		✓	✓		6	✓	✓	
L. conchilega (36)			✓	✓		✓	3			✓					✓	✓	✓	✓
M. johnstoni (31)						✓	✓			✓			8		✓	✓		
Actiniaria (28)		11				✓	✓			✓					✓	✓	✓	6
M. fragilis (28)			✓	✓		✓	✓			✓		✓			✓	✓	4	2
H. gracilis (27)		✓			✓	✓	✓			✓					✓	✓	3	7
E. longissima (25)			✓	✓		✓	✓			✓					✓	✓		3
S. martinensis (25)				✓		✓	3			✓			✓		✓	✓		
S. spinulosa (24)		✓				✓	✓			✓					✓	✓		5
O. borealis (22)					✓	✓	✓			11			✓			✓	✓	
Phoronis sp. (22)		16		✓		✓	✓			✓					✓	✓		✓
***U. brevicornis* (21)**						✓	3			18				✓	✓	✓	3	
***D. monacanthus* (19)**		24				✓	✓			✓						✓		3
A. petiolatus (17)		✓				✓	✓			✓					✓	✓		4
Arenicolidae (14)						✓	9			✓					✓	✓		
A. echinata (13)						✓	✓			✓					✓	✓		2
A. squamata (13)		✓				✓	✓			✓						✓	3	4
Polycirrus sp. (12)						✓	✓			✓						✓	✓	4
Amphiuridae (11)						✓	✓			✓					✓	✓		2
Jassa sp. (9)		4				✓	✓			✓						✓		
A. spinipes (7)						✓	✓			✓						✓		2

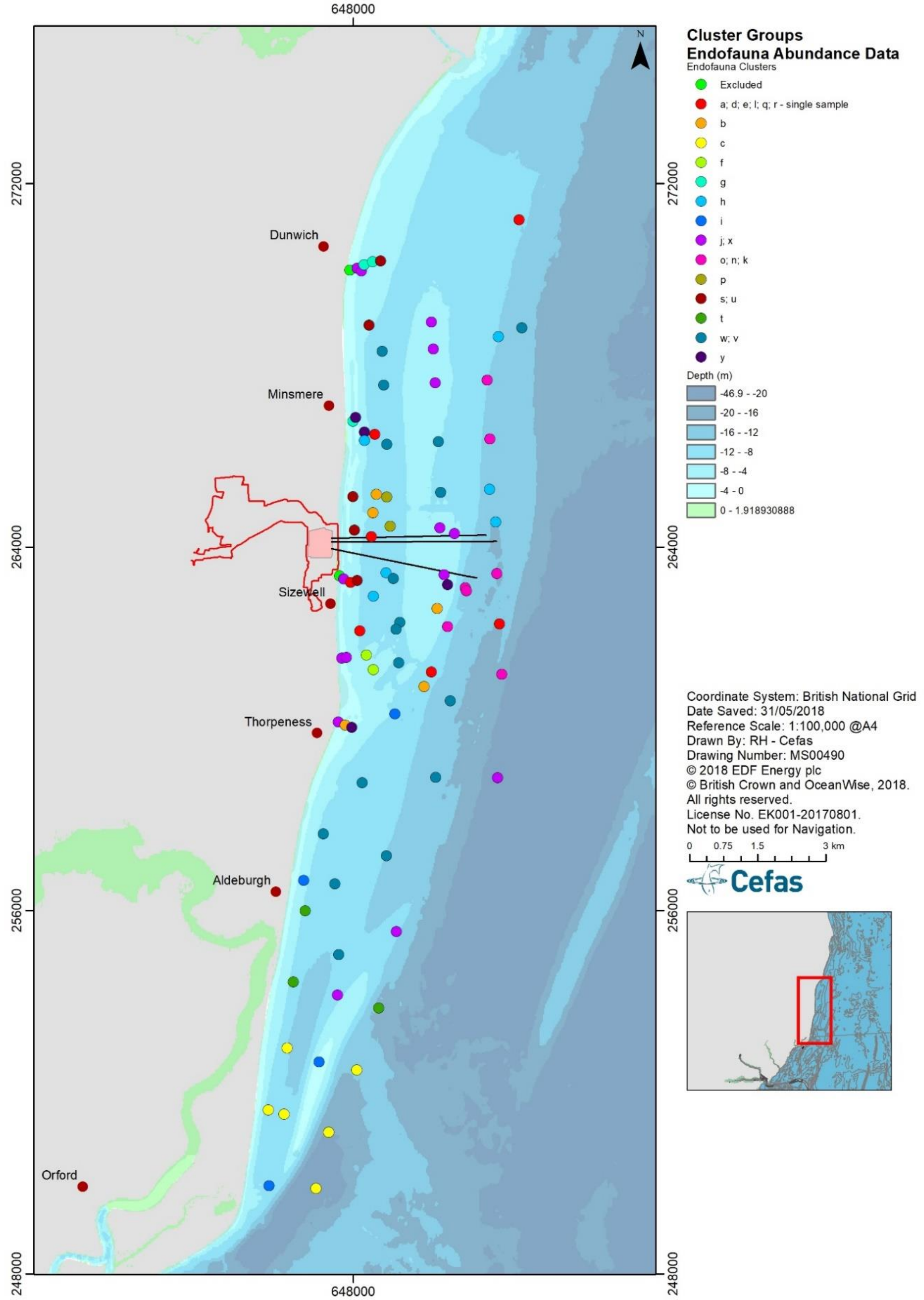
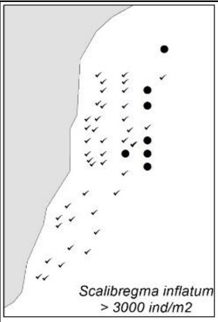
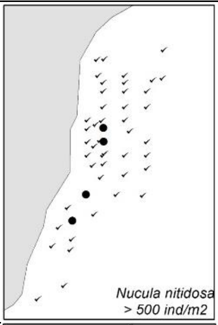


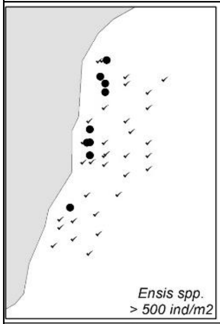
Figure 5: The distribution of the significant cluster groups based on infauna abundance data. Clusters characterised by similar highly abundant taxa have been grouped under the same symbol (see Table 6 for details).



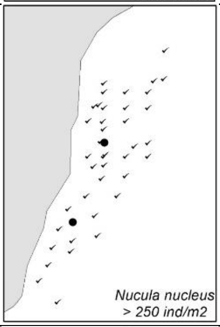
Taxa: ***Scalibregma inflatum***
Class: Polychaeta
Abundance:>3000 ind.m^{-2}:
Location: north, offshore.
Events: Absent in 2008; peak in 2009/2010 and reduced in 2011.



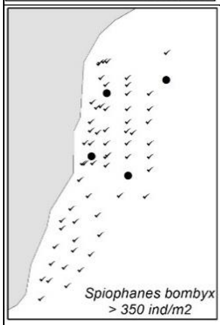
Taxa: ***Nucula nitidosa***
Class: Bivalvia
Abundance: > 500 ind.m^{-2}
Location: Three stations, parallel to the coast, facing Sizewell and Thorpeness
Events: Very high local abundance not correlated with a seasonal pattern.



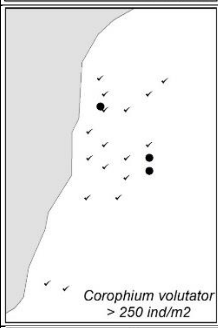
Taxa: ***Ensis spp.***
Class: Bivalvia (razor clam)
Abundance: >500 ind.m^{-2}
Location: Ten stations close to shore including three in the shallow sublittoral. Mostly north, facing Sizewell and Dunwich. One station facing Thorpeness.
Events: Recruitment peak in spring 2011.



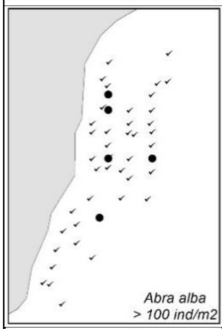
Taxa: ***Nucula nucleus***
Class: Bivalvia
Abundance: > 250 ind.m^{-2}
Location: Two stations, parallel to the coast, facing Sizewell and Thorpeness
Events: High local abundance not correlated with a seasonal pattern.



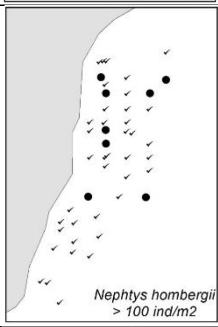
Taxa: ***Spiophanes bombyx***
Class: polychaete
Abundance: >350 in.m^{-2}
Location: Three stations inshore including one in shallow sublittoral and two offshore. North.
Events: High abundance in 2011.



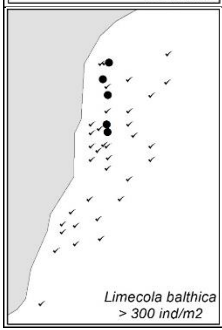
Taxa: ***Corophium volutator***
Class: Malacostraca (Amphipoda)
Abundance: >250 ind.m^{-2}
Location: Three stations, Sizewell offshore and Minsmere inshore.
Events: Peak in summer (high in 2008); Variable in spring; Lower in autumn and winter.



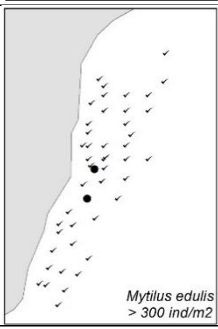
Taxa: ***Abra alba***
Class: Bivalvia
Abundance: > 100 ind.m^{-2}.
Location: Three stations inshore and one offshore
Events: High abundance in 2011.



Taxa: ***Nephtys hombergii***
Class: Polychaeta
Abundance: > 100 ind.m^{-2}
Location: five stations. Three inshore including one in shallow sublittoral and two offshore. North.
Events: Peaks occurs in 2008, 2011 and 2012 but at different station each time.

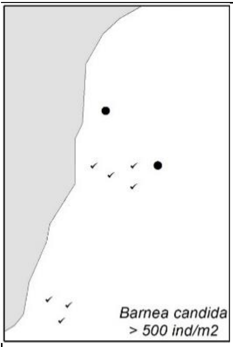


Taxa: ***Limecola balthica***
Class: Bivalvia
Abundance: > 300 ind.m^{-2}
Location: Three stations. Inshore including one station in shallow sublittoral. North, facing Dunwich.
Events: Peak in 2011.

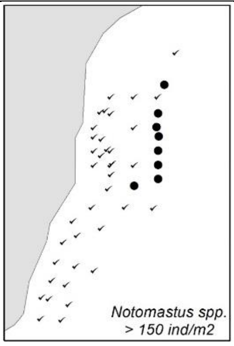


Taxa: ***Mytilus edulis***
Class: Bivalvia
Abundance: > 300 ind.m^{-2}
Location: Two stations. Inshore. Thorpeness.
Events: Peak in 2009. Reduced peak 2011 at the southern station

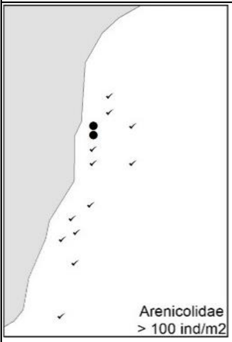
Figure 6: Location of high abundance events for the dominant taxa found in the grab samples in the Greater Sizewell Bay. High abundance events, possibly due to settlement processes, are represented by black dots where at least one occurrence at a value provided in the text was recorded. Symbols (✓) demarcate the stations were the species was found at least once but in low abundance.



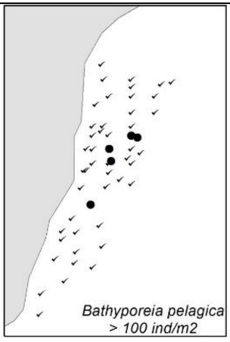
Taxa: ***Barnea candida***
Class: Bivalvia
Abundance: >500 ind.m^{-2}
Location: Two stations. Inshore facing Minsmere. Sizewell offshore
Events: Peak in 2008 (Minsmere) and peak in 2011 (Sizewell).



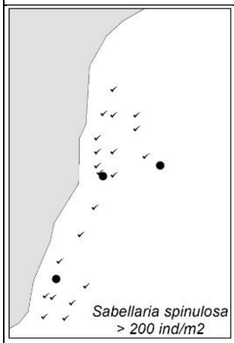
Taxa: ***Notomastus* spp.**
Class: Polychaeta
Abundance: >150 ind.m^{-2}
Location: five stations offshore
Events: Spring/summer peaks



Taxa: **Arenicolidae**
Class: Polychaeta
Abundance: >100 ind.m^{-2}
Location: two stations. Inshore facing Sizewell
Events: Peak in 2010, reduced in 2009 and 2008.



Taxa: ***Bathyporeia elegans***
Class: Malacostraca (Amphipoda)
Abundance: >100 ind.m^{-2}
Location: four stations
Events: Peak in 2012.



Taxa: ***Sabellaria spinulosa***
Class: Polychaeta
Abundance: >200 ind.m^{-2}
Location: Two stations, facing Sizewell and Orfordness.
Events: Peak in 2012 and reduced in 2011 in Orfordness. Peak in 2009 in Sizewell, not correlated with a seasonal pattern.

Figure 6 (continued).

3.1.2 Epifauna

The evidence suggests there is one overall epifauna community dominated by a few very abundant taxa which exhibit high variability across the Greater Sizewell Bay. The epifauna data indicate that different environmental drivers affect hyperbenthic[16] taxa, which are ubiquitous, compared to the epibenthic[17] taxa, which show some spatial affinity within the Bay.

This conclusion is based on the following evidence:

- The nMDS shows separation suggesting discrete communities (image not shown), indicated by a low stress value of 0.15 for the 2-D plot and 0.1 for the 3-D plot, showing possible discrete taxon assemblages in the Bay. A complementary CLUSTER analysis identified 9 significant clusters with level of similarity between 47 and 62%.

[16] Epibenthos: organisms living on top of the sediments.
[17] Hyperbenthos: organisms living just above the sediment, in the water column.

- However, the significance of each cluster is primarily based on variations in abundance of 10 common taxa within the area such as *Crangon crangon*, *Asterias rubens* and *Ophiura ophiura* (Table 7). These taxa are found at most of the sampling stations (45 to 62 stations out of 63) in high abundance. Therefore, this clearly shows that the cluster are mainly driven by a high variability in spatial distribution of the common epifauna taxa in the area and not by different taxa composition in each group. Clusters c and d, which have a very restrictive spatial extent (2 or 3 samples respectively; Figure 7), are also characterised by the absence of some less abundant taxa.
- *Crangon cragon* shows high abundance and is ubiquitous in the area. The taxon is present at 62 out of 63 sampling stations and is dominant in six of the clusters. The taxon is part of the hyperbenthic component, a group of organisms with good swimming ability and therefore more capability to move across the area, explaining its widespread distribution across the Bay. Other clusters associated mostly with epibenthic taxa which are less mobile on the seabed (crawler or sessile organisms) display some spatial patterns, such as cluster c with the sea urchin *Psammechinus miliaris,* found only in the south-east of the area and cluster b with the highest abundance of the brittle stars *Ophiura ophiura* in the north-east; or cluster e with the two bivalve species of *Nucula* sp. which is found in the north east of the bay, in shallower waters (Figure 7).

This analysis clearly shows the absence of discrete epifaunal communities across the bay with some spatial affinity of some of the epibenthic taxon (in opposition to the hyper-benthic taxa).

Table 7: List of the taxa contributing the most by their abundance to the formation of each cluster groups determined by the similarity percentages routine (SIMPER).
The colour intensity indicates the taxa that contributed most to within-cluster similarity (up to 60% of total contribution). The tick marks indicate whether the other taxa (low contribution) are present. The number of samples where a taxon occurs in is provided in parentheses (out of 63 samples).

Significant clusters	**b**	**c**	**d**	**e**	**g**	**h**	**i**
% Similarity	**62.33**	**54.3**	**47.21**	**52.45**	**57.37**	**56.46**	**59.61**
Number of samples	**3**	**2**	**3**	**8**	**22**	**3**	**20**
C. crangon (62)	✓	10.91	23.03	16.99	47.64	32.6	30.5
P. bernhardus (58)	✓	7.85		✓	✓	✓	✓
A. rubens (56)	✓	17.95	26.35	4.41	15.37		4.57
P. montagui (52)	✓	✓	9.77	✓	✓	✓	✓
C. allmanni (47)	✓	5.02		✓	✓	19.94	✓
O. ophiura (45)	77.28			18.16	✓	21.32	36.38
N. nucleus (23)	✓			11.85	✓	✓	✓
N. nitidosa (22)			✓	20.65	✓		✓
M. parva (9)			9.49	✓	✓		✓
P. miliaris (9)		23.61		✓	✓		✓

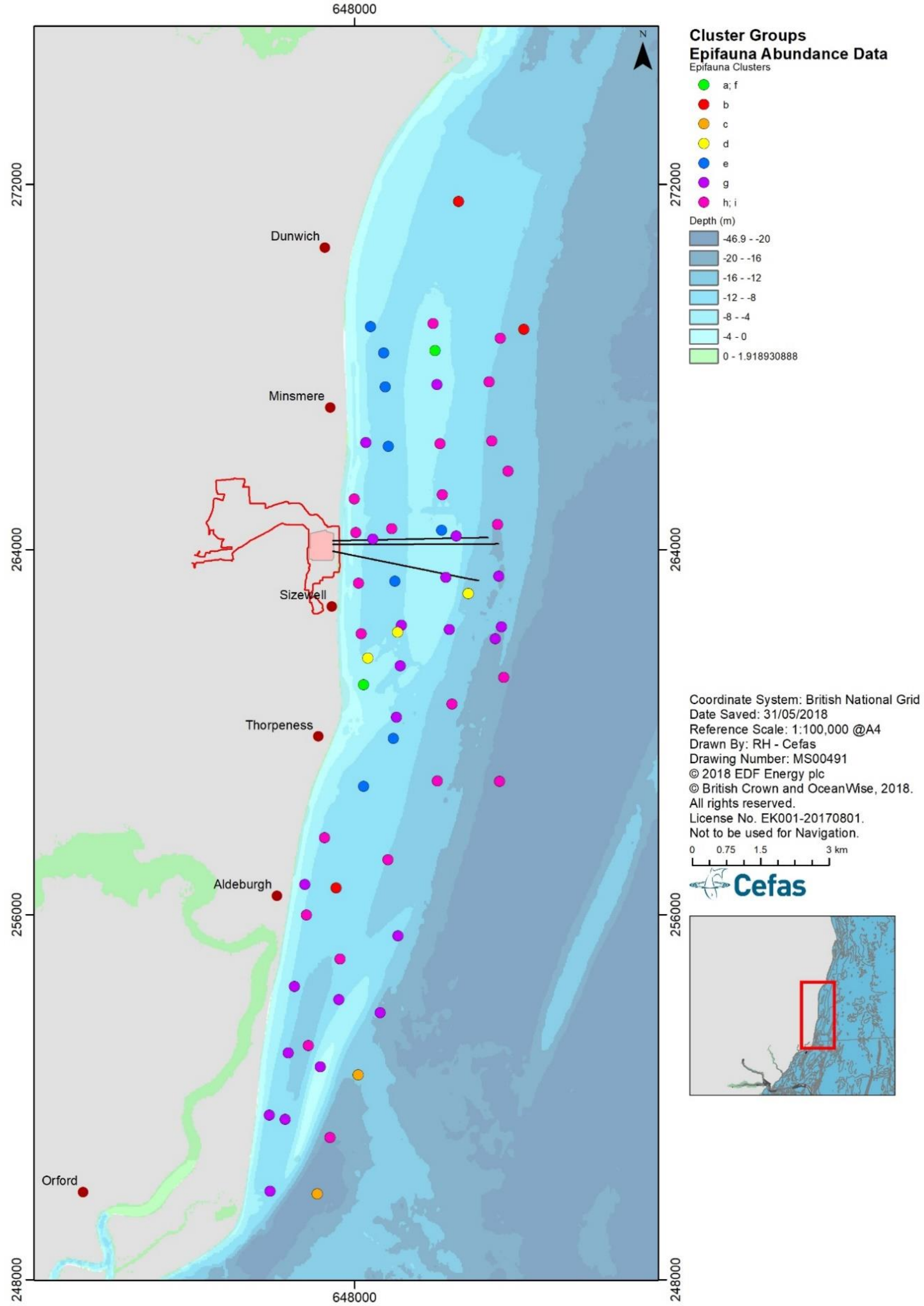


Figure 7: The distribution of the significant cluster groups based on epifauna abundance data. Clusters characterised by similar highly abundant taxa have been grouped under the same symbol (see Table 7 for details). Cluster groups a and f are comprised of a single sample.

3.2 How is the physical environment shaping the distribution of the benthic fauna?

Acoustic remote sensing (swath bathymetry and backscatter data – 2008/2009 surveys) and grab sampling (2008 to 2012) were combined within a Geographical Information System (GIS) to derive the benthic habitat maps for the greater Sizewell Bay (BEEMS Technical Report TR087 Ed3). Most of the seabed was covered by a layer of fine sand. More muddy sediments were found in the deeper area between the shoreline and the Sizewell-Dunwich (sand) Bank and coarse sediment (mixed with fine sand) was found inshore close to the shoreline. Bedrock was observed off Thorpeness extending in a north-easterly direction. In the southern part of the survey area exposed clay deposits and areas of coarse sediment occur. The distribution of these seabed characteristics has been integrated under the Level 4 EUNIS habitats maps including the following six classes:

- A4.13 - *Mixed faunal turf communities on circalittoral rock*;
- A5.13- *Infralittoral coarse sediment*;
- A5.23 - *Infralittoral fine sand*;
- A5.26 - *Circalittoral muddy sand*;
- A5.33 – *Infralittoral sandy mud,* and;
- A3.43 - *Infralittoral mixed sediments*.

The characterisation work aimed at describing benthic habitats across the bay down to EUNIS level 5 (including biological samples) (BEEMS Technical Report TR087 Ed3); however, this could not be achieved for the full area coverage at the time due to spatial information lacking or being inconclusive in some areas (Figure 2).

The correlations between the Level 4 EUNIS Habitats and the distribution of the benthic taxa in the Greater Sizewell Bay were assessed with an Analysis of Similarity (ANOSIM). The ANOSIM was used to measure the degree of similarity between fauna samples and the habitats classes to express how well the environmental information matches the community structure (Clarke and Gorley, 2015). This statistical test, run using the software PRIMER v7 (Primer-E Ltd), compares the level of variability of the biological samples between habitat against the contrasted differences among replicates within habitats.

Sediment samples were collected for each grab sampling station during the monitoring and particle size analysis[18] (PSA) was performed on the samples. These data, along with the depth of the station, were used to test which parameters best explain the distribution of the infauna within the bay based on the BEST (Bio-Env) procedure (Clarke and Gorley, 2015). In this analysis, among-sample patterns described in section 3.1.1 (infauna clusters) were matched with the environmental variables. The variables included sediment composition (percentages of Gravel, Coarse Sand, Medium Sand, Fine sand and Silt/Clay) and depth. The data was normalised data in a matrix based on Euclidian distances. The matrix was used to identify which subset of the selected variables produces a high rank correlation with the infauna clusters and, thus, appear to drive the assemblage structure. This analysis was only available for the infauna data as the area trawled for one epifauna sample covers a surface about a thousand times as large as the area of the grab used to collect the sediment samples,

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[18] The Grain/Particle size is the most fundamental property of sediment particles, affecting their entrainment, transport and deposition. Particle Size analysis is the division of the sediment sample into a number of size fractions, enabling a grain size distribution to be constructed from the weight or volume percentage of sediment in each size fraction. Grain size fraction is usually cumulated under meaningful groups for biological analysis: Gravel (grain size >2 mm); Coarse sand (0.5 mm to 2 mm); Medium Sand (0.25 mm to 500 mm); Fine sand (0.063 mm to 0.25 mm) and finally Silt/Clay fraction (>0.063 mm) (see Appendix C.4). The sediment data showed a strong skewness, so a square root transformation was applied to the data before analysis to approximate normality.

meaning that one trawl sample may contain specimens collected from more than one sediment type when areas are locally heterogenous (Basford *et al.,* 1990).

The potential impact of the SZB thermal plume on the distribution of benthic invertebrates in the Greater Sizewell Bay was investigated. The thermal uplift at the location of the sampling stations was informed from modelled data from the 25 m-resolution GETM Sizewell model. Thermal uplifts were investigated based on the mean excess temperature and the 98th percentiles excess temperature at each of the sampling stations. The sampling grid of the monitoring survey was primarily designed to characterise the spatial and temporal distribution of the benthic habitats, rather than determining the effects of uplifts from SZB. Therefore, a subset of samples was selected with only stations sampled during the second quarter analysed (Q2 surveys - SIZE208, SIZE209, SIZE510 and SIZE511 – see Table 2). However, most samples were collected at Q2 and this corresponds to the period of reproduction of most of the benthic invertebrates, which in many cases is triggered by water temperature. The potential impact of the temperature was tested at two levels. First from a simple ANOSIM analysis (Clarke and Gorley, 2015) to test, within each habitat type, whether there is a significant difference in fauna composition between area affected by a mean excess temperature within the 3°C, 2°C, 1°C thermal contours, and areas of no thermal excess (Figure 1). Then a second analysis was run on each subset of data to test the possible acute effect of the extreme temperature with a BEST (Bio-Env) analysis (Clarke and Gorley, 2015) with a series of parameters including the 98th percentile excess temperature value, the grain size fractions[17], and the depth at each sampling station. The value for the mean excess temperature and the extreme temperature are recorded in Appendix C.4.

3.2.1 Infauna

The Greater Sizewell Bay is characterised by a high content of fine sand, explaining that numerous taxa are present across the whole area. However, variations in the proportion of medium sand and silt/clay contribute to explain some spatial affinity in taxa distribution observed in the data set. Literature suggests that complementary factors such as hydrodynamics - regional regime, driven by morphologic features and weather events - induce rapid changes in sediment composition and seabed features in the Greater Sizewell Bay which would influence fauna composition on short time scales. These abiotic parameters (sediments, local morphological features, dynamic coastal processes), associated with stochastic recruitment in the dominant taxa, as well as the possible impact of temperature discharge from SZB outfall contribute to explain the patterns of spatial distribution observed in the area.

This is concluded based on the following evidence:

- The settlement event maps (Figure 6) show some spatial affinity for a subset of the most abundant taxa found in the Greater Sizewell Bay that appear to be associated with some of the seabed morphology features of the bay (Appendix C.5):
  - On the east and south flank of the Sizewell-Dunwich Bank, muddy sand sediments are moderately mobilised by tides but much more so during storms (BEEMS Technical Report TR074). The polychaetes *Scalibregma inflatum* and *Notomastus* spp. occurred in high abundances throughout much of this area in spring, while the amphipod *Corophium volutator* was highly abundant in summer but had variable abundance in spring (Figure 6).
  - West of Sizewell-Dunwich Bank is a trough, where inshore sediments alternate between sand and coarse sediment close to the shoreline, and muddy sediment in the deeper areas (BEEMS Technical Report TR074). Sediment flows, and movements are variable within the trough, as it is a pathway for sediment transport along the coast, and the sediment can be locally resuspended by waves under favourable conditions and then transported along the trough by tidal and/or storm-driven currents (BEEMS Technical Report TR105 and Technical Report TR107). Abundances are relatively high, with local pulses of bivalves; *Abra alba* and *Limecola balthica* in the north, *Nucula* spp. in the south, and *Ensis* spp. all along the trough (Figure 6).

- A deeper part of the trough running parallel to the coast from Sizewell northwards has been reported previously as presenting a distinctive fauna associated with fine accumulated organic material (Irving, 1998; EMU Limited, 2012). This corresponds to some of the supplementary stations sampled by BEEMS in 2009 (see section 1.4.2.1), with three dominant taxa - the amphipod *Dyopedos monacanthus*, the phoronid *Phoronis* spp. and the bivalve *Mytilus edulis*.
- Both sides of the Aldeburgh Ridge (in the south of the area) are covered with coarse sediment where evidence of a more homogeneous assemblage was found, along with high abundances of *Sabellaria spinulosa* (exact location and images of the *S. spinulosa* fragments found in the grabs are shown in Appendix C.6).

- The sediment composition (percentage of gravel, coarse sand, medium sand, fine sand and silt/clay) was tested against the infauna clusters (section 3.1.1) to explore the relationship between the distribution of the benthic fauna across the area and the seabed sediments. The coefficient of correlation of the BEST (Bio-Env) test was low (ρ= 0.45, p< = 0.01); the best environmental variable explaining the distribution of the biological clusters were proportion of medium sand and the proportion of mud (silt/clay) (Table 8). Most of the area is characterised by fine sand (see Appendix C.4) so it is not surprising that the other sediment fractions best explained the spatial changes observed in the infaunal community.
- As described above (section 3.2), the EUNIS Level 4 habitat integrates the information from both the morphology and the sediment composition. An analysis of similarity showed significant differences in infaunal taxa composition across EUNIS Level 4 habitats in the Greater Sizewell Bay (One-way ANOSIM, Global R = 0. 23, p-value = 0.01). The low R value in the analysis of similarity indicates however a weak correlation between distribution of the fauna and the EUNIS Level 4 habitats, which can be related with the fact that only one community is present in the area and the local differences may support higher settlement events for some taxa. Also, boundaries between Level 4 habitats should also be taken with caution as the regional hydrodynamic regime and weather influences governing deposition and/or mobilisation of substrata can lead to slight modification of the sediment composition and more significantly affect the morphology of the sand bank over short periods of time. For example, a westward movement of > 10 m to the western side of the sand bank occurred between September and December 2009) (BEEMS Technical Report TR087 Ed3).
- The mean excess temperature due to the SZB thermal plume currently discharged (since 1990s) did not affect the distribution of the benthic assemblage within each habitat type. Indeed, the R coefficient of the ANOSIM analysis is close to 0 (Table 9) indicating a similar level of similarities between and within groups of stations affected by mean excess temperature of 0, 1, 2 or 3°C (Clarke and Gorley, 2014). The BEST analysis aimed at testing the combination of continuous variables that best explains the patterns in the biological data: grain size fractions, depth and the 98th percentile excess temperature. Temperature (98th percentile) may have been a significant contributing factor explaining the distribution of the benthic assemblages in one of the four habitats studied (A5.26/A5.33), as well as in shallow sublittoral (Table 9). It was however always in combination with sediment fractions composition and therefore it can't be concluded that the temperature affects the distribution of the benthic assemblages. It is, therefore, impossible to dissociate its effects from the influence of natural changes in the environment occurring in the Greater Sizewell Bay.

The link between the distribution of the benthic taxa and the seabed characteristics is moderate; however, it is important to point out here the difference in temporal resolution between the infaunal dataset, which is based on a compilation of samples from twelve surveys implemented at a quarterly frequency and spanning over a 7-year period (Table 5), whilst the data used to produce the EUNIS 4 Habitat maps are based on surveys implemented between 2008 and 2009. The review of previous work in the Greater Sizewell Bay on sediment transport suggest that surface sediments (fine sand and silt/clay) are governed by the regional hydrodynamic regime and the influence of the weather (e.g. storm surges) can hence be transported rapidly across the area. This process induces the deposition and/or mobilisation of substrata leading to slight modification of sediment composition over time and therefore changes in the colonising fauna (BEEMS Technical Report TR087 Ed3 and

BEEMS Technical Report TR107). It was also noted during the acoustic surveys that an area of megaripple can turn featureless over a few months and that the inner flank of the Sizewell-Dunwich Bank shows a steady trend of landward migration (BEEMS Technical Report TR058 and BEEMS Technical Report TR107). The seabed surface sedimentary characteristics are naturally variable and may therefore have not been captured in the current Greater Sizewell Bay EUNIS 4 Habitat map. Further observations made between the map of the settlement events suggest that the spatial affinity of some taxa could be related to seabed morphology features. For instance, the flanks and the trough associated with the Sizewell-Dunwich Bank (north part of the area) and the Aldeburgh Ridge (south part of the area) are areas of high recruitment. Finally, temperature increase associated with the thermal discharge at SZB may have an influence on the distribution of the benthic community in one of the four habitats studied and in the shallow sublittoral however its effects are impossible to dissociate form the spatially variable environment encountered in the Great Sizewell Bay.

Table 8: Correlation coefficients of the BEST (Bio-Env) analysis for infauna and environmental variables.
The results are displayed according to the combinations of variables that ‘best explains’ the patterns in the biological data.

Nb variable	BEST coefficient (ρ)	Correlation variable
2	0.452	Medium Sand, Silt/Clay
1	0.427	Medium Sand
3	0.395	Medium Sand, Silt/Clay, depth

Table 9: Correlation coefficients of the ANOSIM analysis and for the BEST (Bio-Env) analysis for infauna community within each EUNIS Level 4 habitats and for the shallow sublittoral areas.
The ANOSIM aims at testing the differences between faunal assemblages influenced by different values of mean excess temperature. The BEST analysis aims to identify the combination of continuous variable that best explains the patterns in the biological data: grain size fractions, depth and the 98th percentile excess temperature (98th PET). The analysis could not be performed in habitats represented by three samples or less. The tests results highlighted in bold show significant results.

Habitat (Nb station)	ANOSIM analysis	BEST analysis	
		Test	Correlation variable
A4.13 (6) *Mixed faunal turf communities on circalittoral rock*	R= 0 p > 0.05	ρ = 0.650 p > 0.05	Silt/Clay, 98th PET
A5.13 (3) *Infralittoral coarse sediment*	NA	NA	NA
A5.23 (26) *Infralittoral fine sand*	R= -0.05 p > 0.05	**ρ = 0.444 p = 0.01**	Gravel, Fine sand, Silt/Clay, depth.
A5.26/A5.33 (16) *Circalittoral muddy sand/ Infralittoral sandy mud*	R= -0.028 p > 0.05	**ρ = 0.592 p = 0.01**	Medium sand, Fine sand, Silt/Clay, Depth, 98th PET
A5.43 (1) *Infralittoral mixed sediments*	NA	NA	NA
Shallow sublittoral	R= -0.008 P > 0.05	**ρ = 0.460 p = 0.02**	Gravel, Coarse sand, Silt/Clay, 98th PET

3.2.2 Epifauna

The factors driving the distribution of the epifauna across the bay are difficult to identify as a high proportion of the taxa are part of the hyperbenthic compartment, which may be associated to parameters associated to the water column more so than sediment characteristics. Sediment and morphological features partly explain the distribution of the epibenthic taxa.

This conclusion is based on the following evidence:

- An analysis of similarity showed significant differences in epifaunal taxa composition across EUNIS Level 4 habitats in the Greater Sizewell Bay (One-way ANOSIM, Global R = 0. 279, p-value = 0.01). The R value is low, indicating a weak correlation, which could be related to the possible difficulty to delineate EUNIS habitat map boundaries for trawl samples (see section 3.2.1). Alternatively, it may be partly related to the fact that numerous individuals collected in the trawl samples are hyper-benthic taxa and are therefore not affected strongly by seabed features but more likely but features from the water column.
- Depth is often regarded as important driver to explain epifauna distribution in a given area (Basford *et al.,* 1990). An analysis of similarity was performed on the epifauna sample to test the importance of the depth range (4 m depth classes, see Appendix C.4), but the results shows that there was no significant correlation between depth range and the distribution of the epifauna taxa (One-way ANOSIM, Global R = -0.004, p-value > 0.05).
- There is no significant effect of the SZB temperature discharge on the distribution of the epifauna assemblages in the Greater Sizewell Bay (Table 10).

The epifauna community analysis (section 3.1.2) suggested that the overall spatial distribution patterns may be attenuated due to the presence of a high number of hyper-benthic individuals. Their distribution may be driven by parameters associated with the water column such as suspended sediment, the temperature or water currents, which are not presented in this report but are described in other characterisation reports on water quality monitoring and plankton (respectively BEEMS Technical Report TR314 and BEEMS Technical Report TR346). The weak correlation between the epifauna community structure and the Level 4 EUNIS Habitats suggests, however, that the sediment composition and the morphological features (integrated in EUNIS Level 4 habitat) are at least contributory factors explaining the distribution of the epibenthic taxa.

Table 10: Correlation coefficients of the ANOSIM analysis and for the BEST (Bio-Env) analysis for infauna community within each EUNIS Level 4 habitats and for the shallow sublittoral areas.
The ANOSIM aims at testing the differences between faunal assemblages influenced by different values of mean excess temperature. The BEST analysis aims to identify the combination of continuous variable that best explains the patterns in the biological data: grain size fractions, depth and the 98th percentile excess temperature (98th PET). The analysis could not be performed in habitats represented by three samples or less.

Habitat (Nb station)	ANOSIM analysis	BEST analysis	
		coefficient	Corr. variable
A4.13 (3) *Mixed faunal turf communities on circalittoral rock*	NA	NA	NA
A5.13 (3) *Infralittoral coarse sediment*	NA	NA	NA
A5.23 (26) *Infralittoral fine sand*	R= 0.048 p > 0.05	ρ = 0.055 p > 0.05	Depth, 98th PET
A5.26/A5.33 (14) *Circalittoral muddy sand/ Infralittoral sandy mud*	R= 0.134 p > 0.05	ρ = 0.023 p > 0.05	Depth
A5.43 (1) *Infralittoral mixed sediments*	NA	NA	NA

3.3 What is the natural variability of the benthic invertebrate populations?

This section aims to explore the 'natural' temporal variability of the subtidal benthic fauna (spatial patters have been described in the previous sections). Variation in parameters associated to the structure and diversity of the fauna community is investigated to establish natural baseline variability in the absence of the development at SZC. The natural variation here is different from 'pristine condition' as the site is currently influenced by anthropogenic activities in the region, including the operational activities of SZB.

Analyses in this section were performed at the replicate level (*i.e*. for each grab/trawl sample) to fully explore the natural variability in the Greater Sizewell Bay community. Results are presented at the highest sampling resolution, *i.e.* quarterly (Q1 – January to March, Q2 – April to June, Q3 – July to August and Q4 – October to December), which corresponds roughly to the seasonal changes (respectively winter, spring, summer and autumn). In order to explore the natural variation further, results are also presented on a series of maps to show spatial differences in seasonal dynamics across the area.

Descriptive analyses are based on total number of individuals (**total abundance**), **total biomass** (when available) and total number of taxa (**richness**) to provide a quantitative assessment of the benthic community within the study area. Some ecological indicators listed below have also been calculated to understand the dynamics of the benthic community in the Greater Sizewell Bay:

i. **Shannon Diversity (H')** index is a quantitative measure of biodiversity based on the relationship between the number of taxa found in each sample and their regularity (or evenness); *i.e.* how abundance is distributed between taxa. As a reference, $H<0.5$ is considered as a low value of diversity and $H \sim 4.5$ is a value found for large and diverse samples (Frontier *et al.,* 2008).

ii. **Pielou's eveness index (J')** is a measure of the regularity between taxa, it considers how evenly distributed the numbers of each taxon are (Frontier *et al.,* 2008). The index assumes a value between 0 and 1, with 1 being complete evenness (i.e. each taxon has the same number of individuals).

iii. **Infaunal Quality Index (IQI)** is a multi-metric index expressing the ecological health of benthic macroinvertebrate (infauna) assemblages. The metric encompasses a high amount of information on how macroinvertebrate assemblage changes within the marine environment as its calculation relies on selected metrics: taxa number, the AZTI Marine Biotic Index (AMBI, a measure of sensitivity to disturbance) and Simpson's evenness (a measure of the distribution of individuals across the different taxa). The IQI incorporates each metric as a ratio of the observed value to that expected under reference conditions (Appendix C.7). The index operates on a scale of zero to one: zero reflecting ecological quality under extreme anthropogenic disturbance and one representing ecological quality where anthropogenic disturbance is absent or negligible (Phillips *et al.,* 2014). The IQI is recommended indicator to assess the ecological status of the macrobenthic invertebrate and infaunal assemblages of sediment habitats in UK coastal and transitional water bodies was calculated to support the requirements of the Water Framework Directive (WFD - 2000/60/EC).

The normality and homoscedasticity of the distribution for all the structural parameters and ecological indicators were assessed to determine the type of statistical tests to be performed on the data sets. Non-parametric tests had to be performed to test the differences between quarters. Kruskall-Wallis tests were used, and the temporal changes were assessed using a multiple comparisons procedure. Data analysis was carried out in R 3.4.3 (R Core Team, 2017). The shallow sublittoral stations were sampled at only one survey, so these stations are not included in the analysis. The values for the different indicators are shown in Table 11 for a general comparison with the subtidal data. The coefficient of variation has been calculated for each indicator and for each quarter [CV = (standard deviation) / (mean)*100].

3.3.1 Infauna

Overall, the Greater Sizewell Bay infauna assemblages are not discretely separated into bio-sedimentary communities and form part of a larger infralittoral community distributed across the south of the North Sea 'infralittoral region', corresponding to subtidal areas within 50 m depth. The ecological indicators show that the community is naturally slightly to moderately perturbed. The highest variability in community indices was observed between April and August, corresponding to the recruitment period, when richness, abundance and biomass showed significantly higher values compared to the rest of the year. The most abundant taxa found in the Greater Sizewell Bay are common in the North Sea infralittoral region and have a high reproduction rate, indicating that infaunal populations are likely resilient to the dynamic environment of the Bay.

This conclusion is based on the following evidence:

- The average number of taxa per grab is low and varies little between quarters (6 to 8 taxa/grab between the third and the 4th quarter, Table 11; however, as the species-accumulation curves show, the overall richness for the area is much higher for the second and third quarters of the year than in the first and fourth quarters (Figure 8). The species-accumulation curves are steeper for Q2 and Q3, showing that the number of taxa is still rising even after a cumulated 290 and 213 replicates, respectively. Several taxa are therefore only caught in the grab sample between April and August (either taxa are absent or juvenile and not retained in the 0.5 mm sieve).
- There were significantly higher abundances in second and third quarter of the year (665 to 1846 ind.m^{-2}) compared to the first and fourth quarter (351 to 401 ind.m^{-2}). Biomass was significantly higher during the second quarter of the year than in other quarters (36.4 g.m^{-2} compared to 16.7 - 27.8 g.m^{-2} for the rest of the year) (Table 11). One taxon, the polychaete *Scalibregma inflatum*, made up 40% of the total abundance and was found in 30% of the replicate grab samples (see Appendix C.1).
- The relationship between abundance and biomass (ABC plots – Figure 8) implies a moderate level of disturbance in the benthic infauna community in the Greater Sizewell Bay for the first, third and fourth quarter (biomass curve equal or slightly above the abundance curve), whilst it appears highly disturbed in the second quarter (abundance curve below the biomass curve). This indicates that during the recruitment season (usually spring) between April and June (Q2), a high proportion of R-strategy individuals (smaller and short-lived organisms with a rapid reproduction and growth rate) occur, which is often found in unstable environments. This is confirmed by the diversity indicators showing a community with a significantly lower Shannon diversity and evenness during the second quarter, and also the fact that some taxa are only observed in during April and August (Table 11 and Figure 8). The IQI values have been added to Table 11 only as complementary information to describe the current state of disturbance of the community as the reference values used have not been estimated to indicate 'pristine condition'. According to the WFD Ecological Quality Ratios scale (EQRs), the Greater Sizewell Bay community is classified as a moderate to good status benthic community under moderate to slight disturbance (Phillips *et al.,* 2014).
- The coefficient of variation (CV) is a measure of relative natural variability for the benthic infaunal community for each quarter (Table 11). The CV values are high overall for all the structural parameters, with 65% for species richness, 200 to 230% for abundance and 230 to 650% for biomass. Values are relatively high for the ecological indicators, with 50% variability for Shannon Diversity, 25 to 45% for Pielou's evenness and about 15% for the IQI.

- The taxa that are remarkable in terms of abundance and occurrence are those taxa that make up 90% of cumulative abundance, present at > 30% of stations. These taxa include: the polychaetes *Scalibregma inflatum*, *Spiophanes bombyx, Nephtys hombergii* and *Notomastus spp.;* the bivalves *Nucula nitidosa, Nucula nucleus, Ensis spp., Limecola balthica, Abra alba* and *Mytilus edulis;* and the amphipods *Corophium volutator* and *Bathyporeia elegans* (Appendix C.1). All these taxa showed settlement events (Figure 6), bringing a strong spatial and temporal heterogeneity in the data set. This heterogeneity is reflected by a high number of distinguishable infauna assemblages identified by the cluster analysis (see section 3.1.1), most of them characterised by a small number of taxa (more than a third of the groups contained only a single sample showing strong discrete differences in sample composition across the area and another third had 90% of the abundance represented by less than four taxa). Most of the settlement events occurred during the spring (Figure 6), the season presenting the highest values and the highest variability in number of taxa and in abundance (Table 11), however the settlement events were considered as erratic as they were not recurrent every year. For example, the abundance of the polychaete *S. inflatum* was very high in 2009 and 2010 but reduced in 2011 and was in very low abundance in 2008 (no settlement event recorded).
- Maps of taxon richness, total abundance and biomass reveal a complicated picture, although some patterns are discernible (Figure 9, Figure 10 and Figure 11). For instance, there is an underlying trend of increasing richness value toward the south of the Greater Sizewell Bay. Abundance is highest and most variable at the most inshore and offshore stations in the north part of the sampling area. This latter observation is consistent with the location of the settlement events shown in Figure 6. Further stations with high abundance, but relatively low intra- and inter-annual variability, are located around Aldeburgh. Abundance seems to be the lowest in the shallow offshore areas, associated with the crest of the sandbanks. Patterns in biomass follow roughly the same patterns observed for abundance (Figure 10 and Figure 11).

Table 11: Summary statistics on structural parameters and ecological indicators of diversity for each quarter of the year.
Values are means ± standard deviation, CV is also provided. The significance of the difference between quarters was tested with a Kruskall-Wallis test (KW) and the results of the multiple comparison are shown by a colour code: highest values in red and lowest value in yellow, no colour represents non- significant differences. SSSUB: shallow sublittoral data. The difference between IQI_{WFD} and IQI_{SZ} are detailed in Appendix C.7.

Survey quarter	Structure			Diversity			
	Richness	Abundance	Biomass	Shannon	Evenness	IQI_{WFD}	IQI_{SZ}
Q1	7.1 ± 0.7 CV = 68%	401 ± 121 CV = 197%	32.6 ± 29.2 CV = 584%	1.3 ± 0.1 CV = 44%	0.79 ± 0.03 CV = 26%	0.72 ± 0.02 CV = 10%	0.81 ± 0.02 CV = 10%
Q2	8.0 ± 0.6 CV = 65%	1846 ± 495 CV = 233%	38.4 ± 11.1 CV = 251%	1.2 ± 0.1 CV = 56%	0.64 ± 0.03 CV = 44%	0.66 ± 0.02 CV = 14%	0.75 ± 0.02 CV = 14%
Q3	8.4 ± 0.7 CV = 63%	665 ± 200 CV = 224%	16.9 ± 4.7 CV = 208%	1.4 ± 0.1 CV = 47%	0.74 ± 0.03 CV = 30%	0.68 ± 0.02 CV = 15%	0.76 ± 0.02 CV = 14%
Q4	6.4 ± 0.6 CV = 66%	351 ± 119 CV = 234%	12.8 ± 5.5 CV = 297	1.2 ± 0.1 CV = 47%	0.79 ± 0.03 CV = 25%	0.69 ± 0.02 CV = 12%	0.77 ± 0.02 CV = 12%
KW test (df = 3)	X^2 = 23.262 P = 3.562^{-05}	X^2 = 43.483, P = 1.943^{-09}	X^2 = 30.518 P = 1.074^{-06}	X^2 = 14.441, P = 0.002362	X^2 = 48.976 P = 1.32^{-10}	X^2 = 15.177 P = 0.001671	X^2 = 14.5, P = 0.002298
Survey quarter	Structure			Diversity			
	Richness	Abundance	Biomass	Shannon	Evenness	IQI_{WFD}	IQI_{SZ}
Q3 (SSUB)	2.8 ± 0.6 CV = 71%	438 ± 210 CV = 155%	11.3 ± 7.5 CV = 213%	0.6 ± 0.2 CV = 94%	0.82 ± 0.09 CV = 28%	0.56 ± 0.07 CV = 27%	0.64 ± 0.08 CV = 26%

The benthic infauna is of low diversity and the mean density per square metre is similar to that of the wider region (circa 500 – 1500 ind.m^{-2}; see Kroncke *et al.,* 2011). Duineveld *et al.* (1991) describe the benthic biology of the southern North Sea as characterised by a few broadly adapted or recurring taxa with great reproductive power, and a large number of taxa occurring at a low frequency and in low abundance. These characteristics also fit with the description of the benthic community in the Greater Sizewell Bay, where a few core taxa - representing only 4 % of those occurring in the area - are dominant and almost 35 % of the taxa are spatially rare. This information as well as the information gathered in section 3.2.1 shows that the community in the Greater Sizewell Bay is typical of the ‘infralittoral Region’ corresponding to the area in the south of the North Sea within the 50 m depth contour.

North Sea infauna assemblages are separated into three regions roughly defined by the 50 m and 100 m depth contours (Glémarec, 1973; Duineveld *et al.,* 1991; Ducrotoy *et al.,* 2000; Kroncke et al., 2011). The seabed within the 50 m contour includes most of the shallow areas around the east coast of England, France, Belgium, the Netherlands and Germany, as well as the Southern and German Bight and the Dogger Bank and the Oyster Grounds. These areas are characterised by vertically mixed water (EMU Limited, 2012) and, like most of the southern North Sea, are mainly composed of fine sand and coarse sediments (UK Sea Map, http://jncc.defra.gov.uk/ukseamap, consulted on the 10/12/2015). The assemblages in this region reflect the mobile nature of the sediment, they are generally accepted as impoverished (Connor *et al.,* 2004, EMU Limited, 2012) and characterised by a dominance of robust fauna, particularly polychaetes (e.g., *Nephtys spp.* and *Lanice spp.*; Connor *et al*., 2004) and amphipods (e.g., *Bathyporeia* spp.). The stress exerted by tidal currents and storm waves strongly influences the assemblages and the benthic organisms are adapted to the macro-scale movements of fine sand that induce smothering and scouring of the seabed (Duineveld *et al.,* 1991; Zühlke and Reise, 1994; EMU Limited, 2012). The Sizewell coast is located on the western fringe of this wide infralittoral region and the area is dominated mainly by fine sand interspersed with some coarse sediment, bedrock, clay and mud (see section 3.2.1).

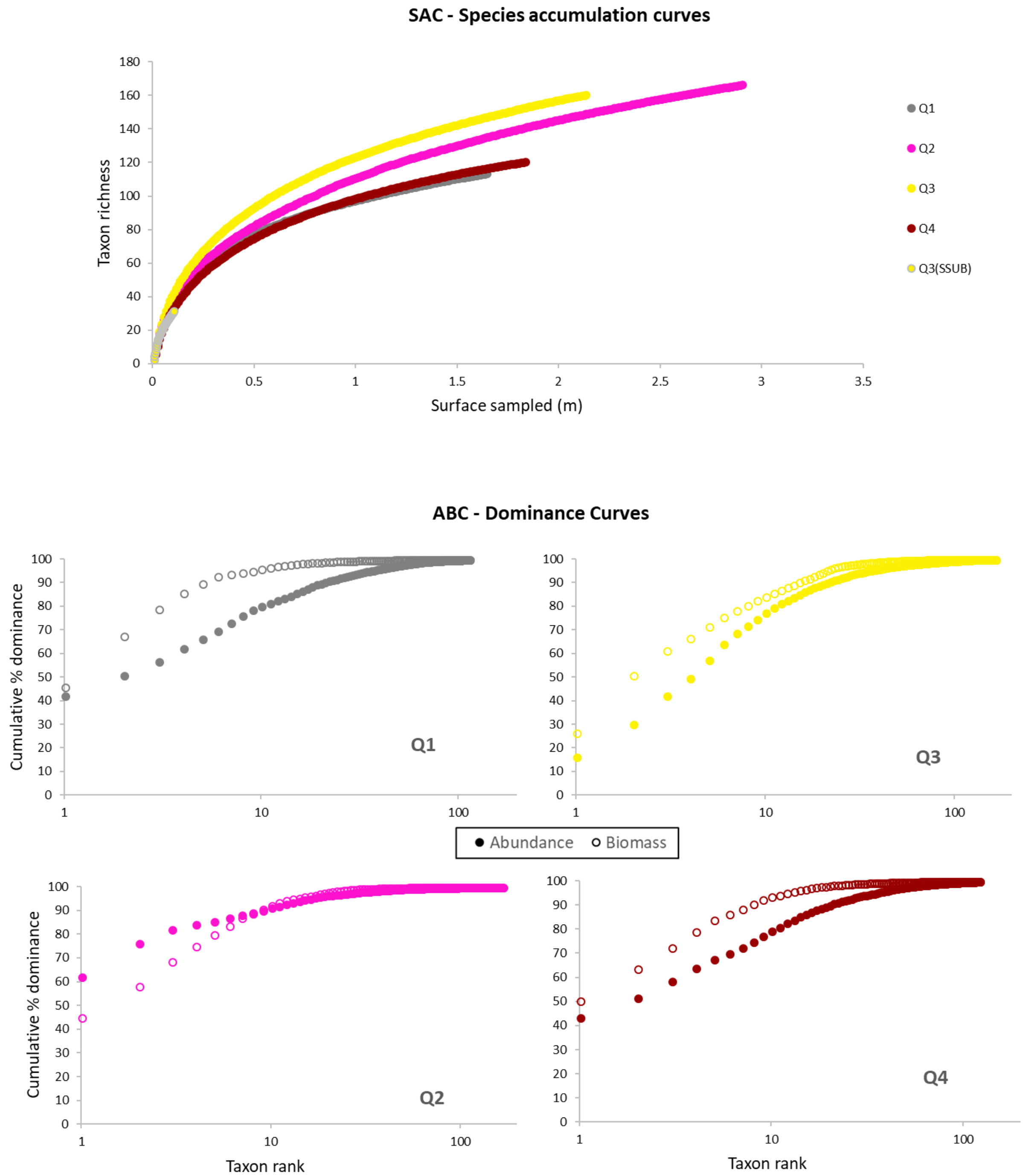

Figure 8: Species accumulation curves (SAC) and Abundance Biomass curves (ABC).
SACs show the mean cumulative number of taxa encountered in incrementally aggregated samples over 999 randomised permutations of the sample aggregation (PRIMER v.7). ABCs plot the cumulative dominance in biomass and taxa abundance against a log taxa rank.

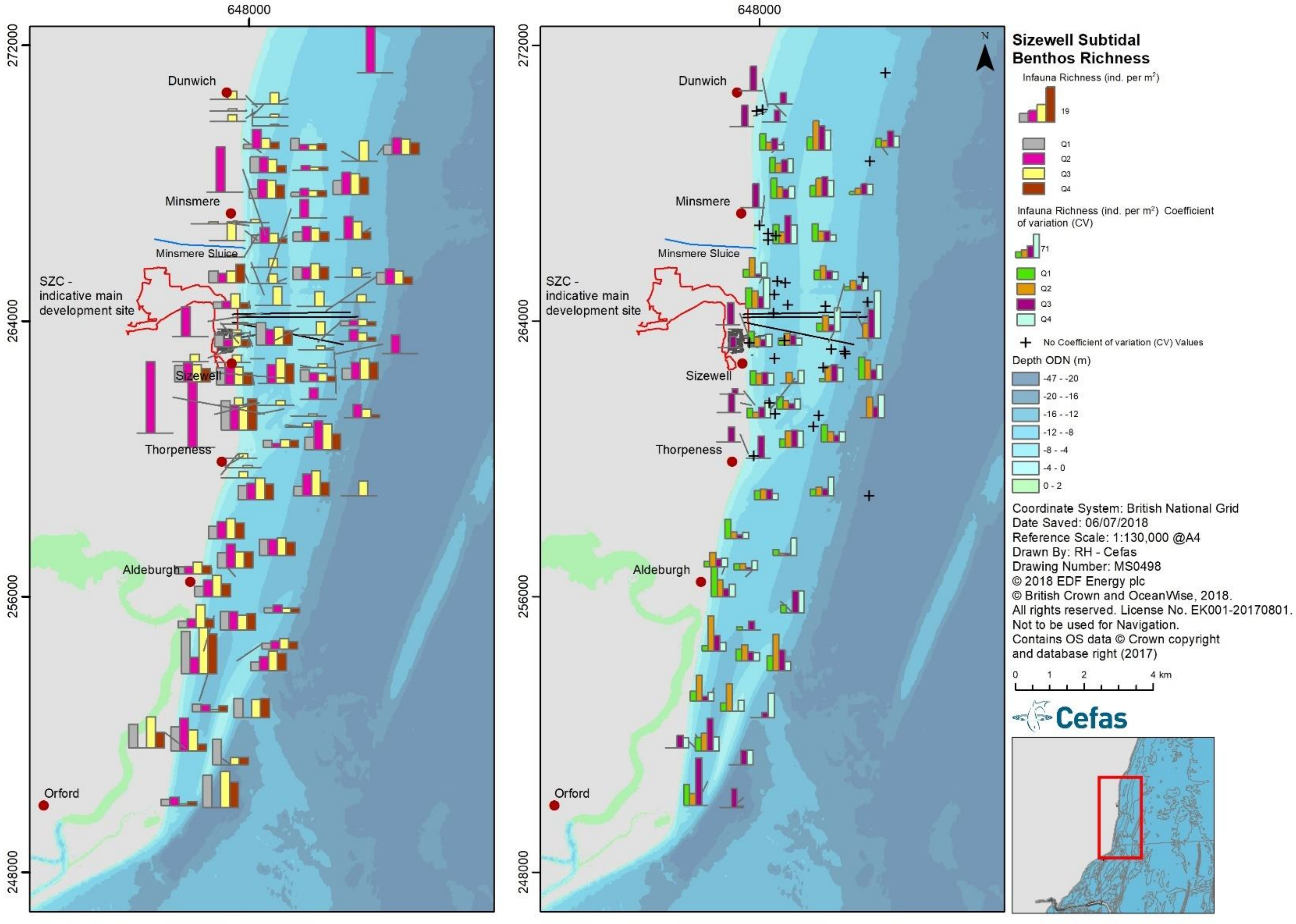

Figure 9: Relative quarterly variation of the mean infauna taxa richness per grab (left) and coefficient of variation (right) for each sampling station in the Greater Sizewell Bay.

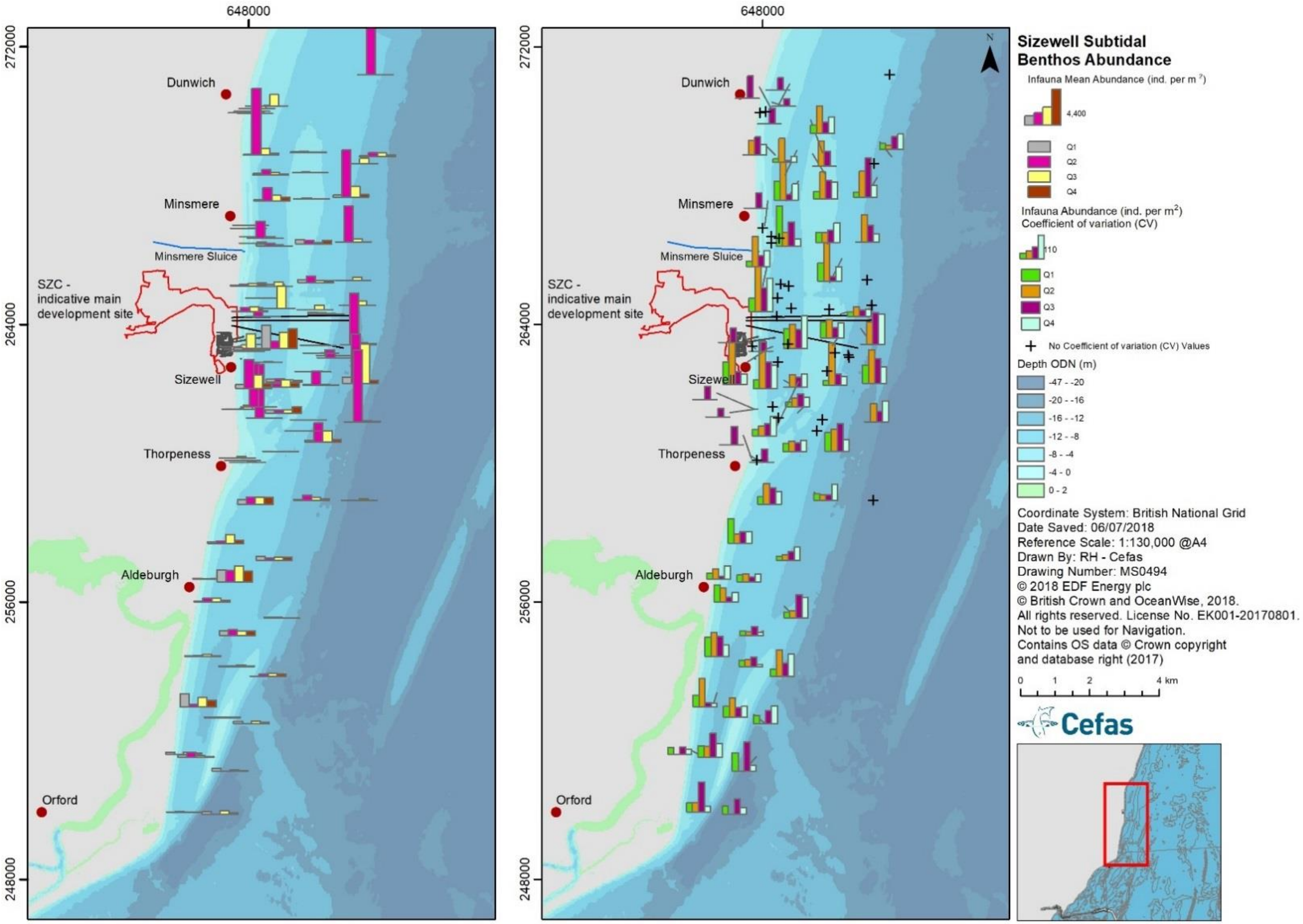

Figure 10: Relative quarterly variation of the infauna mean abundances (left) and coefficient of variation (left) for each grab sampling station in the Greater Sizewell Bay.

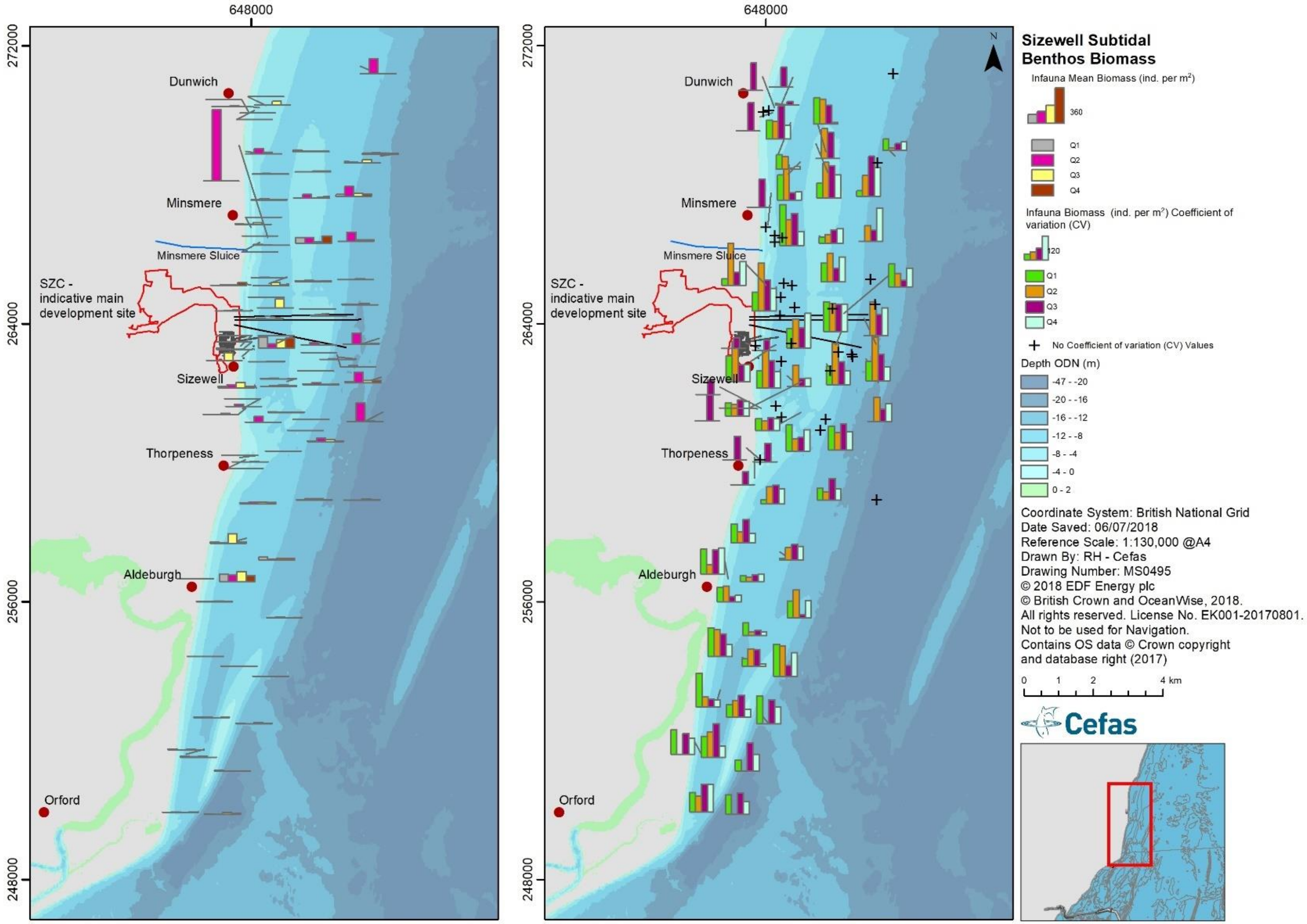

Figure 11: Relative quarterly variation of the mean infauna biomass for each grab sampling station in the Greater Sizewell Bay (left) and coefficient of variation (right).

3.3.2 Epifauna

The epifauna assemblages observed in the Greater Sizewell Bay are typical of the southern North Sea with the hyperbenthic component displaying a very high increase in abundance during the summer months. This phenomenon is consistent with the inshore migration patterns of several taxa during the summer. The epibenthic component also shows important natural variability, more likely to be related to the biological factors (food availability, predation) and physical factors (passive migration, temperature) with spatial and temporal variation associated with stochastic recruitment in the dominant taxa.

This conclusion is based on the following evidence:

- There are no significant differences between taxon richness between survey quarters, with approximately 8 taxa per 2 m-beam trawl sample (Table 12 and Figure 12), whilst the mean total abundance is significantly higher during the third quarter of the year compared to the first quarter with 1110 ind.1000 m^{-2} and 332 ind.1000 m^{-2} respectively.
- The taxa that are remarkable in terms of abundance and occurrence are those taxa that make up 90% of cumulative abundance, present at > 30% of stations. These taxa are the brittle star *Ophiura ophiura*; the shrimp *Crangon crangon*; and the bivalves *Nucula nitidosa* and *Nucula nucleus* (Appendix C.2). These were identified as part of the most dominant taxa driving spatial variation in the assemblages across the survey area (section 3.1.2) but they also appear to undergo major seasonal changes with a large increase in abundance in the second and third quarter, particularly in the northern part of the area (Figure 13 to Figure 16).
- Counts in the trawl samples for abundant epibenthic taxa such as *Ophiura ophiura* and *Nucula spp* can be very different from one year to another. For example, there was an average of 267 *Ophiura ophiura* individuals per station in 2008, 777 in 2011 and over 2,000 in 2014. This inter-annual variation can be associated to a variety of biological and physical factors such as food availability (Reiss *et al.,* 2004; Neumann *et al.,* 2009), passive migration during storm events (Armonies, 2000), or a response to coastal temperature anomalies inducing differential mortality from taxon-specific resistance and resilience capacities (particularly for echinoderms such as *Ophiura ophiura*, *Ophiura albida* or *Psammechinus miliaris*; Reiss *et al.,* 2004, Neumann *et al.,* 2009), and knock-on effects of predators such as *Asterias rubens* and *Liocarcinus holsatus* (Neumann *et al.,* 2009). Alternatively, they may simply be a function of stochastic recruitment in the area.
- As identified in section 3.1.2, the epifauna community in the Greater Sizewell Bay has two major components: the epibenthic and the hyperbenthic taxa (section 3.1.2). The results from the Comprehensive Impingement Monitoring Programme (CIMP) are a good indicator of the temporal changes taking place in the latter component. All benthic invertebrate taxa found impinged on the SZC drum screens were also found in the grab or the trawl samples collected in the Greater Sizewell Bay between 2008 and 2014. Mean total abundance and biomass of the taxa impinged on the Sizewell B screens varied on a quarterly basis (Figure 17), with higher abundance and biomass during the third quarter and, to a lesser extent, during the fourth quarter of the year. Four main taxa contributed to this seasonal increase: the shrimps *Crangon crangon* and *Pandalus montagui*, the prawn *Palaemon serratus* and the swimming crab *Liocarcinus holsatus*. These changes are likely due to the active migration of some hyperbenthic taxa. This phenomenon is well known for the species *Crangon crangon* which migrates to nearshore waters during the warmest months and back to offshore waters during the autumn (Boddeke, 1976; Reiss *et al.*, 2004). *Liocarcinus holsatus* also shows inshore and offshore migration in late autumn; however, the mechanism underlying these migrations is unclear and did not appear to be triggered by temperature alone (Venema and Creutzberg, 1973). This phenomenon is reflected in the data from the impingement and the beam trawl data with a peak of abundance at the end of the summer (Q3) and a decrease before winter (Q1).
- Only three invertebrate taxa were collected in the commercial otter trawl, the edible crab *Cancer pagurus,* the lobster *Homarus Gammarus* and the velvet crab *Necora puber.* Their abundance was low and varied little between quarters (Table 13).

The epifauna of the Greater Sizewell Bay comprises one overall assemblage with the presence of widespread taxa which are typical of the shallow part of the southern North Sea (within the 50 m depth contour - Glémarec, 1973; Duineveld *et al.,* 1991; Ducrotoy *et al.,* 2000; Kroncke *et al.,* 2011) and taxon abundances around of the same order of magnitude as those of a similar benthic assemblage in the German Bight (Reiss *et al.,* 2004). Thus, this assemblage appears typical of the southern North Sea. Temporal changes observed for the dominant hyperbenthic taxa are related to annual inshore/offshore migration movement. Regarding the changes observed in the epibenthic taxa, these are more likely related to an interaction of physical environment (passive migration, temperature) and biological factors (food, predation, recruitment) affecting the populations locally.

Table 12: Summary statistics of structural and diversity indices calculated from the epifauna data collected in the 2 m-beam trawls for each quarter of the year.
Values are means ± standard deviation, CV is also provided. The significance of the difference between quarters was tested with a Kruskall-Wallis test (KW) and the results of the multiple comparison are shown by a colour code: highest values in red and lowest value in yellow, no colour represents non- significant differences.

Survey quarter	Structure		Diversity	
	Richness	Total abundance	Shannon	Evenness
Q1	8.0 ± 0.9 CV = 44%	332 ± 243 CV = 281%	1.2 ± 0.1 CV = 37%	0.62 ± 0.05 CV = 32%
Q2	8.6 ± 1.1 CV = 63%	824 ± 468 CV = 285%	1 ± 0.1 CV = 62%	0.47 ± 0.04 CV = 47%
Q3	8.2 ± 0.9 CV = 51%	1110 ± 958 CV = 399%	1.0 ± 0.1 CV = 48%	0.48 ± 0.04 CV = 39%
Q4	7.5 ± 1.0 CV = 52%	180 ± 56 CV = 122%	1.1 ± 0.1 CV = 48%	0.60 ± 0.05 CV = 29%
KW **(df=3)**	X^2 = 1.1403, P = 0.7673	X^2 = 40.229, P = 9.527^{-09}	X^2 = 16.231, P = 0.001017	X^2 = 27.982, P = 3.663^{-06}

Table 13: Average abundance of the three benthic taxa found in the commercial otter trawl for each quarter of the year.

Survey quarter	*Cancer pagurus*	*Homarus gammarus*	*Necora puber*
Q1	14 ± 10	6 ± 8	-
Q2	5 ± 3	3 ± 1	-
Q3	9 ± 4	2 ± 0	5 ± 5
Q4	11 ± 6	6 ± 4	-

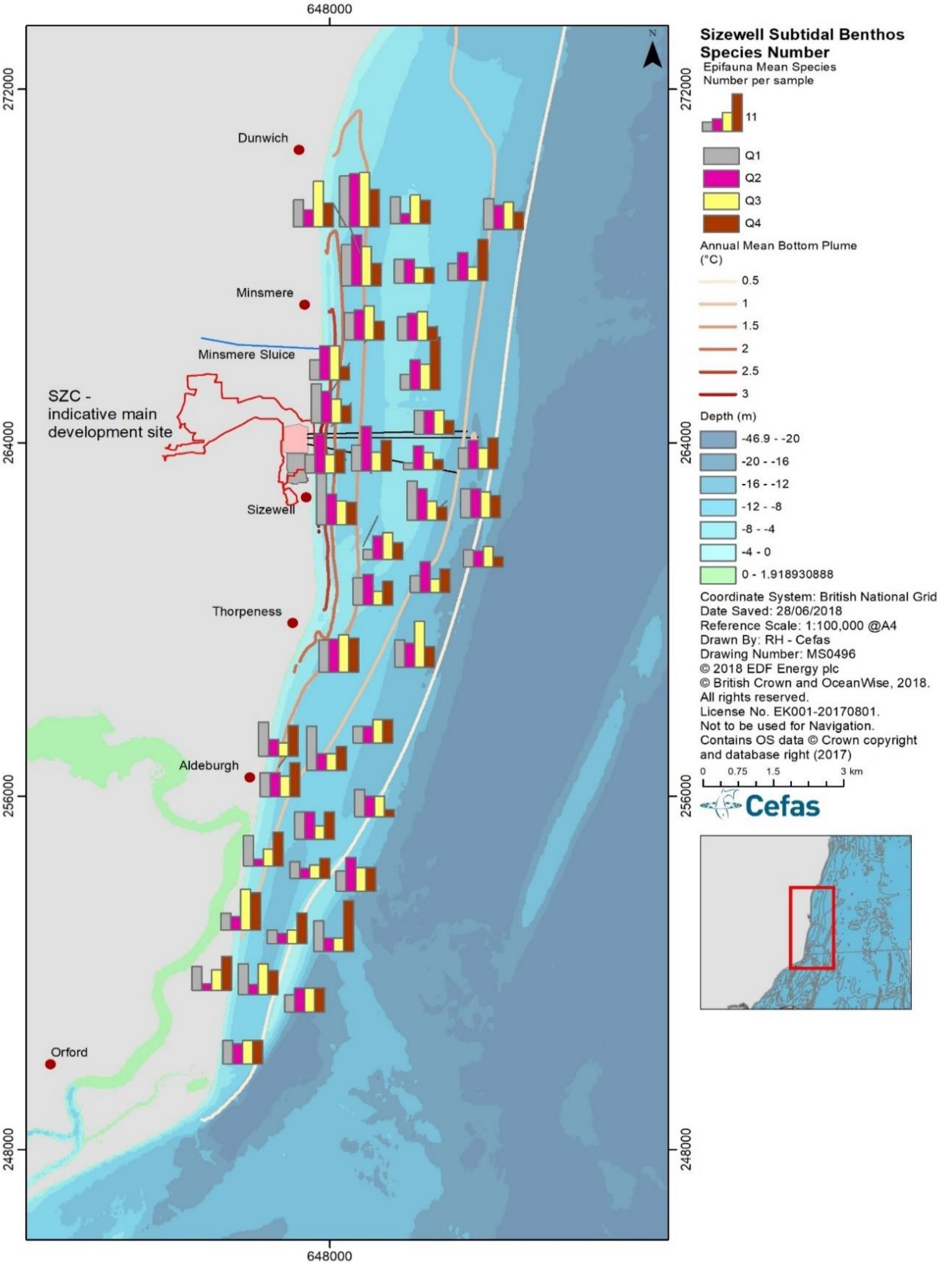

Figure 12: Relative quarterly variation of the epifauna mean taxa richness for each trawl sampling station in the Greater Sizewell Bay.

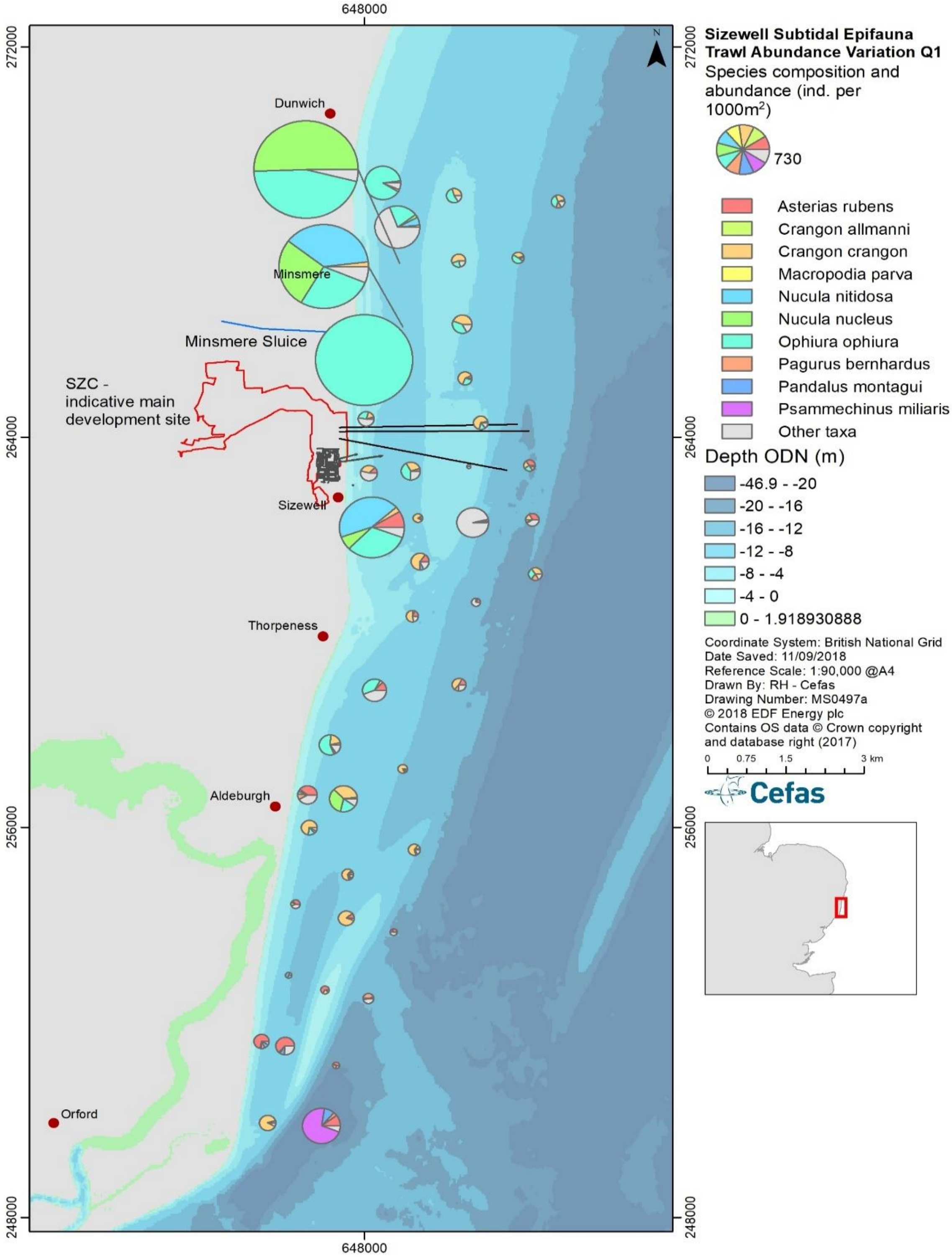

Figure 13: Mean abundance the epifauna taxa in the Greater Sizewell Bay at Q1 – January to March. The pie charts indicate the relative proportions of the most abundant taxa.

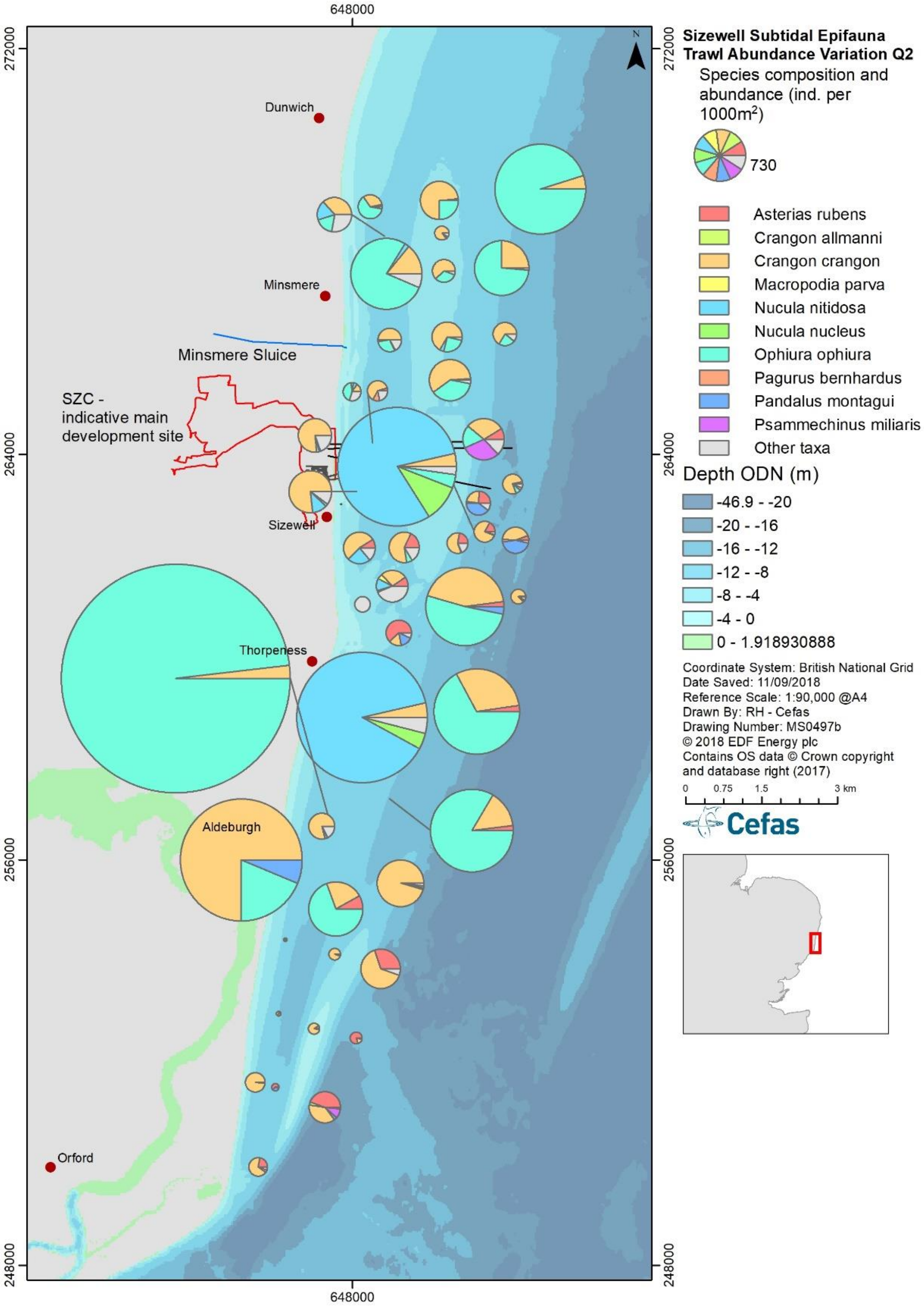

Figure 14: Mean abundance the epifauna taxa in the Greater Sizewell Bay at Q2 – April to June. The pie charts indicate the relative proportions of the most abundant taxa

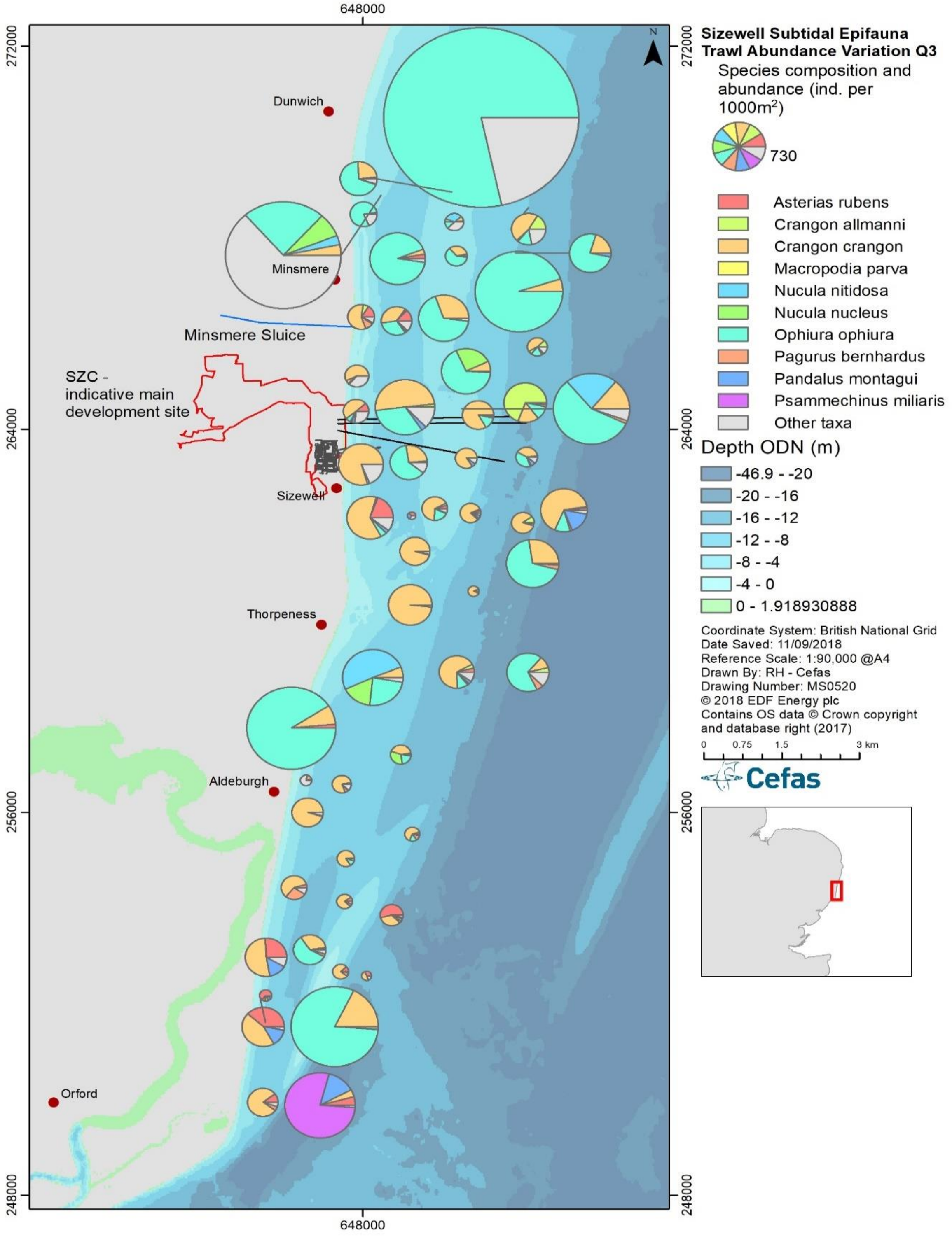

Figure 15: Mean abundance the epifauna taxa in the Greater Sizewell Bay at Q3 – July to August. The pie charts indicate the relative proportions of the most abundant taxa.

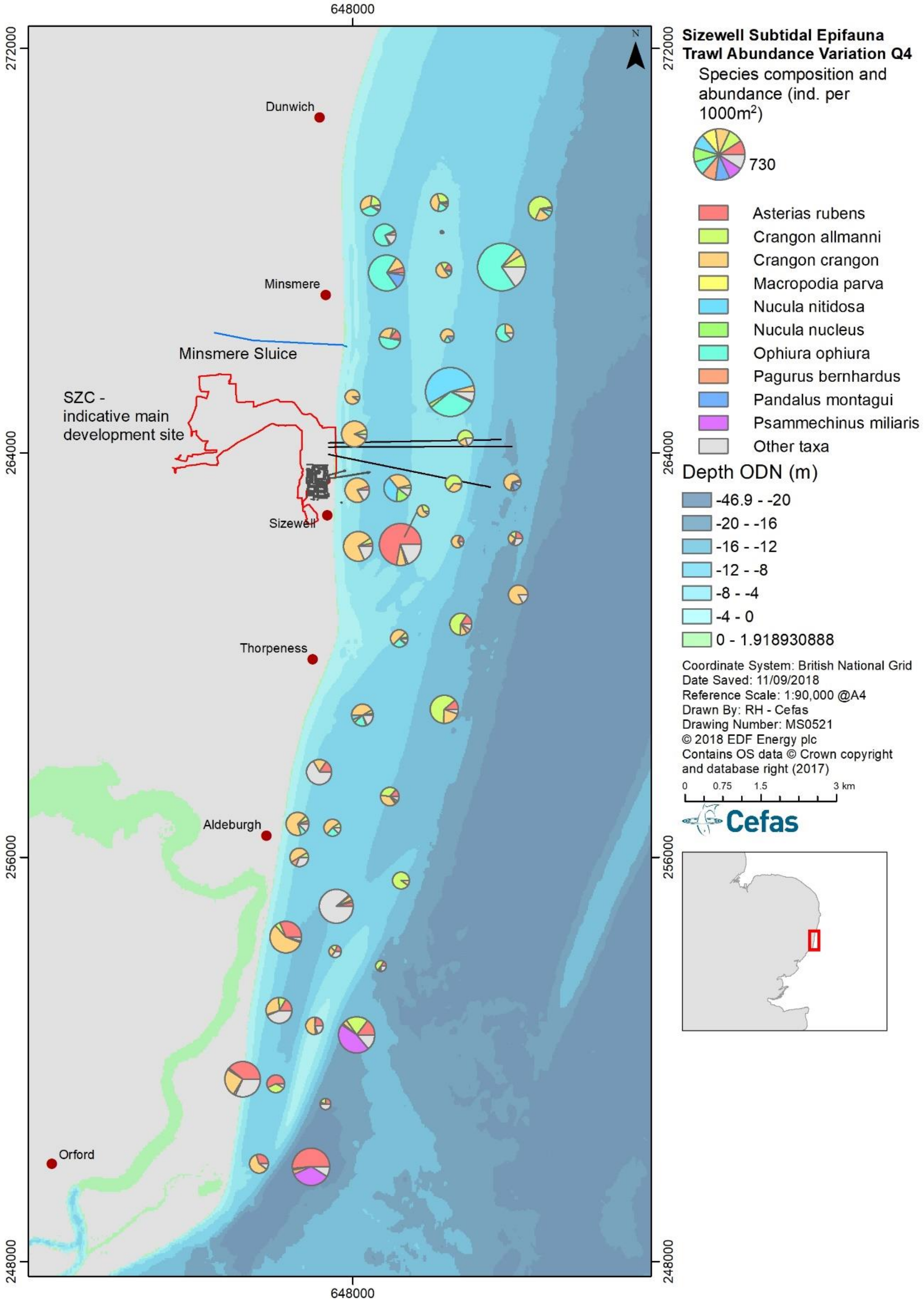

Figure 16: Mean abundance the epifauna taxa in the Greater Sizewell Bay at Q4 – October to December. The pie charts indicate the relative proportions of the most abundant taxa.

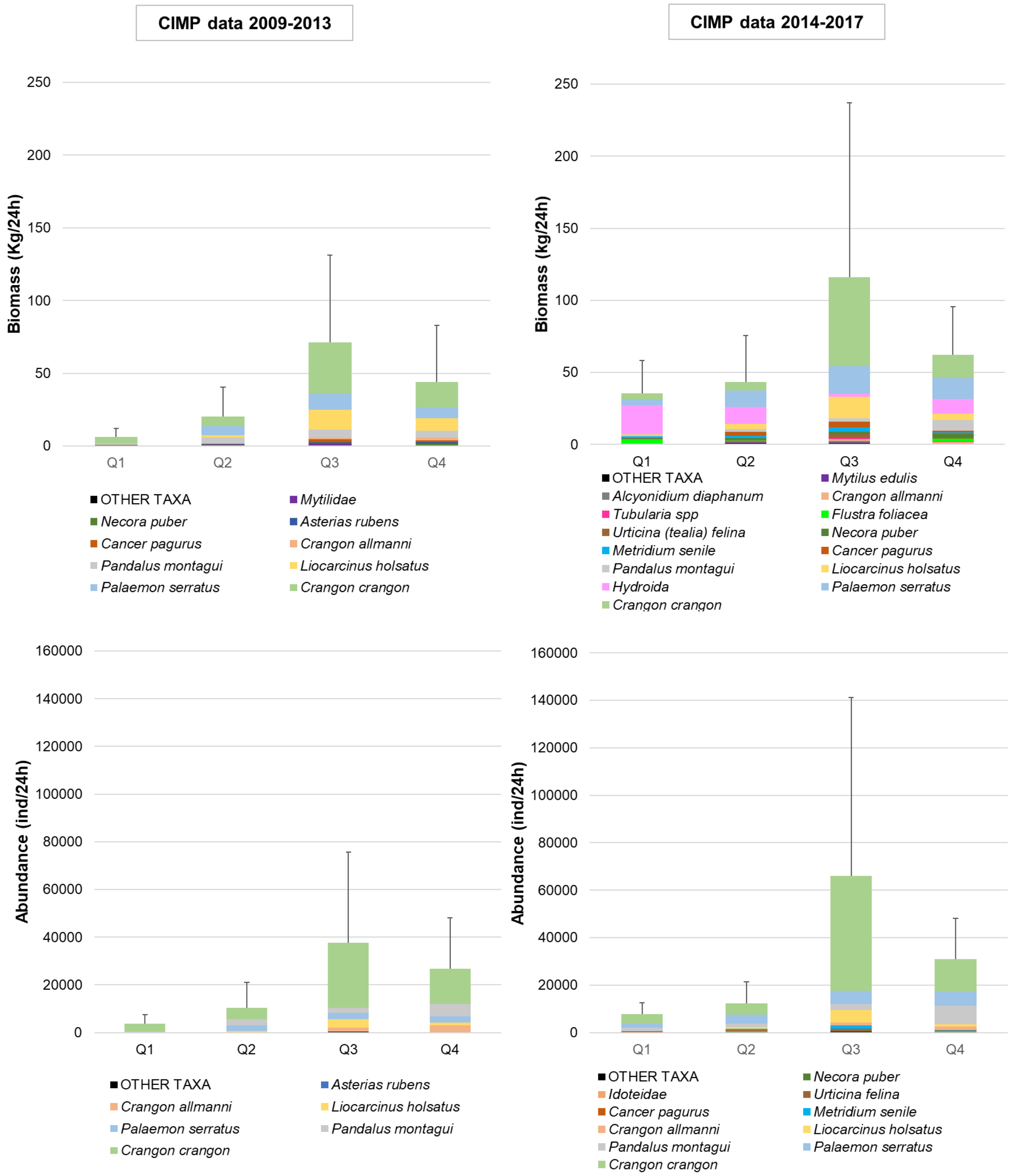

Figure 17: Average biomass and abundance of the invertebrate taxa collected on drum screens during the Comprehensive Impingement Monitoring Programme for each quarter of the year.
On the left are the results from the CIMP between 2009 and 2013 and on the right the data from 2014 to 2017. The quarter corresponds to: Q1 – January to March, Q2 – April to June, Q3 – July to August and Q4 – October to December.

3.4 What are the dominant biological traits of the benthic macrofauna?

Biological Traits Analysis (BTA) assesses variation in the morphological, behavioural, and life-history traits expressed within a benthic fauna community. Biological traits can be used to understand why different taxonomic entities (e.g, species, genus) occur in similar habitats, as organism performances (or fitness) result from common adaptations to environmental forces indirectly affecting growth, reproduction and survival (Violle, 2007 and Beauchard *et al.,* 2017). In view of this, changes in the patterns of trait expression within assemblages - in terms of changes in the relative abundance/biomass of taxa exhibiting the traits - can be used to indicate the effects of human impacts on ecosystem functioning (Bremner *et al.,* 2006). The use of biological traits as a management tool to understand the changes in benthic communities exposed to anthropogenic perturbation is considered as a complementary approach to traditional methods such as ecological indices based on diversity metrics (Cooper *et al.,* 2008). The approach with BTA has also been recognised as less sensitive to seasonal variability or sampling effort (Charvet *et al.,* 1998), or to taxonomic resolution level (Doledec *et al.,* 2000, Gayraud *et al.,* 2003). In accordance with the Marine Evidence-based Sensitivity Assessments (MarESA) proposed by Tillin *et al.,* (2010), full recovery following an impact does not necessitate every species to return to pre-impact level condition or abundance, but that the community is structurally and functionally synonymous (Tyler-Walters *et al.,* 2017). In this respect, BTA has the potential to be a powerful supporting tool for investigating the effects of development activities on the functioning of the benthic community.

A catalogue of functional traits has been compiled by Cefas for a selection of northern benthic taxa at the taxonomic level of the genus (Eggleton et al., 2011, Eggleton et al., 2012, Bolam et al., 2017). The selected traits (see Table 14) are all "Response traits" meaning that they determine taxon performance under different kinds of natural and anthropogenic environmental variability (Beauchard *et al.,* 2017). The information used for this characterisation exercise was based on a simple use of the quantitative data collected in the trait database by attributing a median trait value for each taxon (or genus), so each taxa/genus are ascribed a single score for each trait (Beauchard *et al.,* 2017). This genus/trait matrix was then multiplied with the taxa abundance and/or biomass (when available) data from the grab and trawl samples to obtain a final data matrix with the trait composition (i.e. the abundance/biomass of each trait modality) for each sample. These data were then aggregated (averaged) to assess the changes in the relative proportion of the different modalities of each trait over a year.

3.4.1 Infauna

Overall, the dominant traits for the infaunal community in the Greater Sizewell Bay follow similar quarterly trends with comparable dominant traits for the first, third and fourth quarter of the year. During the second quarter of the year a shift in functional traits occurs, which is associated with natural abundance and biomass patterns described previously in the report. The same functional traits were dominant regardless of whether calculations were based on abundance or on biomass data.

The functional characteristics of the community are shown in Figure 18 and Figure 19 and summarised below:

- Free living and Burrow-dwelling organisms living between the surface and 10 cm in the sediment are dominant. The infauna is mostly sessile or burrowers with a smaller proportion of taxa moving horizontally on the seabed (crawler, climber or creeper). Taxa are predominantly surface or subsurface deposit feeders, actively bioturbating the sediment by surface deposition and diffusive mixing.
- Most of the taxa are relatively long lived (3 to 10 years) and of relatively small size ranges (<10 mm and 21 to 100 mm). Finally, the community is characterised by taxa with planktotrophic development and produce eggs that are released in the water column, an important trait showing a high resilience capacity for the widely distributed community across the Greater Sizewell Sea and in the wider Southern North infralittoral region.
- There is a shift in the second quarter of the year, associated with a higher proportion of deeper burrow-dwelling organisms (6 to 10 cm). These taxa are shorter lived (1-2 years) of medium size with a soft morphology. Their larval development is lecithotrophic, producing eggs that stay on the seabed during development. This increase is mostly related to the peak of abundance and biomass of the polychaete *Scalibregma inflatum* (see section 3.3.1).

3.4.2 Epifauna

The functional traits of the epifauna community of the Greater Sizewell Bay vary little over time.

The functional characteristics of the epifauna community are shown in Figure 20 and summarised below:

- A great majority of the taxa are free living, living mostly above the seabed (hyperbenthic) but also within the few first centimetres of the sediment, consequently, they mostly create surface deposition but also diffusive mixing bioturbation in much lower proportion. The epifaunal organisms are mostly predators, a small proportion of individuals are subsurface and surface deposit feeders.
- Most organisms move horizontally on the seabed (crawling, climbing or creeping), and a lesser proportion are swimmers or sessile. Almost all the organisms have an exoskeleton made of chitin or calcium carbonate. They have a long-life span (3 to 10 years) and display a wide range of sizes from a 10 mm up to 500 mm.
- Finally, the vast majority of the community has planktotrophic larval development and produces eggs by sexual reproduction that are released into the water column.

Table 14: Biological traits selected for the study of the functional characteristics of the benthic infauna and epifauna community in the Greater Sizewell Bay.
The trait catalogue was compiled by Cefas (Eggleton et al., 2011, Eggleton et al., 2012, Bolam et al., 2017). See Appendix C.8 for the definition and functional significance of each trait.

Traits	Modalities	Traits	Modalities
Living habit	Tube-dwelling Burrow-dwelling Free-living Crevice/hole/under stone Epi/endo zoic/phytic Attached to substratum	**Morphology**	Soft Tunic Exoskeleton Crustose Cushion Stalked
Sediment position	Surface Infauna: 0-5cm Infauna: 6-10cm Infauna: >10cm	**Mobility**	Sessile Swim Crawl/creep/climb Burrower
Bioturbators	Diffusive mixing Surface deposition Upward Conveyor Downwards conveyer None	**Longevity**	<1 year 1-2 years 3-10 years >10 year
Feeding mode	Suspension Surface Deposit Subsurface deposit Scavenger/Opportunist Predator Parasite	**Size range**	<10 mm 11-20 mm 21-100 mm 101-200 mm 201-500 mm >500 mm
Larval Development strategy	Planktotrophic Lecithotrophic Direct	**Egg development location**	Asexual/Budding Sexual shed eggs- pelagic Sexual shed eggs- benthic Sexual brood eggs

Figure 18: Dominant biological trait modalities for each quarter based on the infauna abundance data from the grab samples.

Figure 19: Dominant biological trait modalities for each quarter based on the infauna biomass data from the grab samples.

Figure 20: Dominant biological trait modalities for each quarter based on the epifauna abundance data from the 2 m-beam trawl samples.

3.5 Which are the key benthic taxa in Sizewell Bay?

3.5.1 Selection process

For the purposes of the Environmental Impact Assessment and to allow us to focus the assessment on the ecological features of greatest importance key taxa are selected based on their ecological, socio-economic, and/or conservation important within the Greater Sizewell Bay. A taxon is regarded as key in the ecosystem if it meets at least one of the following criteria:

- **Ecological importance**: If a taxon is common - present in at least 30 % of stations (*n* = 88 for grabs, *n* = 63 for beam trawls) – and also abundant – if it is among the taxa that contribute towards 90 % of the cumulative abundance in grabs, beam trawls or impingement monitoring - we consider it to be ecologically important. We also consider bioengineers (e.g. reef-, patch- or aggregation-forming taxon) to be ecologically important for enhancing biodiversity if they are also common or abundant.
- **Socio-economic value**: Taxon that are commercially exploited locally or of interest for recreational fisheries. Details of the local commercial and recreational fisheries is provided in BEEMS Technical Report TR123 Ed2.
- **Conservation**: Over the past thirty years, numerous lists of conservation status have been produced: Red Lists for threatened species, Biodiversity Action Plan Priority Lists (BAP lists for taxa identified as priorities for conservation action), Natural Environment and Rural Communities (NERC) lists for biodiversity, species listed under European Directives, species listed on the Schedules of the Wildlife & Countryside Act, together with lists of rare and scarce species. To assess the conservation status of the Sizewell taxa, we used the "species designations" spreadsheet collated by the Joint Nature Conservation Committee (JNCC, http://jncc.defra.gov.uk/page-3408, consulted in September 2018). This collation has been built largely from the same components used for the Species of Conservation Concern listing produced as a part of the UK Biodiversity Action Plan (UK BAP) process in 1999–2000.

3.5.2 Key benthic taxa

The key taxa and the selection criteria are summarised in Table 15. Each species is then described and detailed in the following sections, sorted by taxonomic groups, providing details on:

- **Scientific name** and common name along with an image;
- **Criteria of selection** (see section 3.5.1), with a detail of the type of fauna for the taxa of ecological importance ('I' for infauna and 'E' for Epifauna);
- **Habitat information** and biology of the taxa;
- **Abundance** found in the Greater Sizewell Bay and temporal (bar plots) and spatial (maps) natural variability in the Greater Sizewell Bay (Figure 21 to Figure 60). Some of the taxa were recorded in both grab and trawl survey gears so in that case, both abundance data are shown in the bar plot section, where the data source is also discriminated by a colour code showing the sampling grid: OG for the original grid – 2008 to 2010, EG for Extended grid, 2011 to 2012 and SS for the 2011 shallow sublittoral data); and the survey quarter (Q1 – January to March, Q2 – April to June, Q3 – July to August and Q4 – October to December). The coefficient of variation (on maps) has been calculated for each indicator and for each quarter [CV = (standard deviation) / (mean)*100]. The CV range corresponds to a low CV (>25%), medium CV (26 to 75%), high CV (76 to 125%) and very high CV (125 to 325%). 'NO CV' indicates that no replication data were available at that station, so the natural variation could not be estimated.

The biological traits of the key benthic taxa are presented in Appendix C.9.

Note that the 2014 data were excluded from the summary as the sampling grid was based on a different design (see section 1.4.2.1 and Table 2) and thus would have complicated the interpretation of the figures. The data collected in 2014 were analysed in the BEEMS Technical Report TR338.

Table 15: Key benthic taxa of the Greater Sizewell Bay.

Conservation designations; W = Wildlife and Countryside Act (1981), H = Habitats Directive (1992), B = UK Biodiversity Action Plan, R = UK Red List species, N = Natural Environment and Rural Communities Act (2006). CIMP = comprehensive impingement monitoring programme. Details of the local commercial fisheries is provided in BEEMS Technical Report TR123.

Taxon	Socio-economic	Conservation	Ecological						Comments
			Common grab	Abundant grab	Common trawl	Abundant trawl	Abundant CIMP	Bioengineer	
Abra alba									
Bathyporeia elegans									
Buccinum undatum	YES								In grab and trawl
Cancer pagurus	YES								In trawls
Corophium volutator									
Crangon crangon	YES								
Ensis spp.									
Gammarus insensibilis		W, B, R, N							In trawl
Homarus gammarus	YES								In trawls
Limecola balthica									
Mytilus edulis	YES								In grab, trawl, CIMP[19]
Nephtys hombergii									
Notomastus spp.									
Nucula nitidosa									
Nucula nucleus									
Ophiura ophiura									
Pandalus montagui	YES								
Sabellaria spinulosa		H, N, B (when in reef formations)							In grab and trawl. Additional acoustic surveys.
Scalibregma inflatum									
Spiophanes bombyx									

[19] Recorded in the CIMP as both *Mytilus edulis* and Mytilidae – as no other Mytilidae species have been recorded in the BEEMS surveys, we postulate the Mytilidae records to be *M. edulis*.

3.5.3 Molluscs

3.5.3.1 *Abra alba*

Abra alba, the white furrow shell

Taxon of ecological importance (I)

Photo © Cefas

Abra alba is a bivalve usually found in inshore muddy fine sand or mud substrates. The taxon is widespread around the British Isles. Abundance in the Greater Sizewell Bay was relatively low for the species, as it can reach densities over a thousand individuals per square metre in favourable habitats (Budd, 2007). It was found throughout the year (Figure 21) and all over the study area (Figure 22), but temporal variability was high to very high at most of the stations. The highest abundances were observed between June and October (second and third quarter of the year). Only a few individuals were found in the shallow sublittoral samples between Thorpeness and Sizewell.

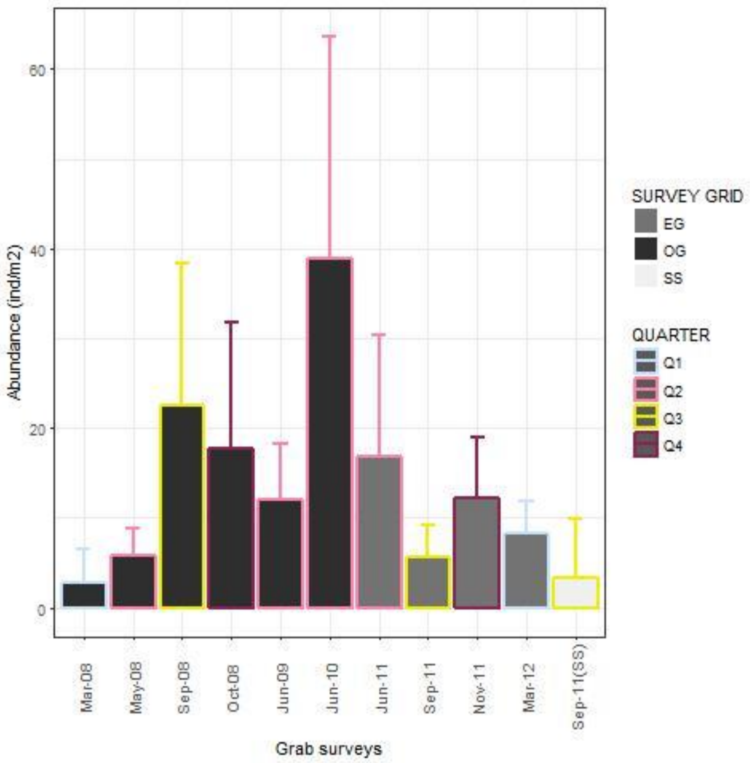

Figure 21: Temporal variation in the abundance (mean ± 95 % C.I.) of *Abra alba*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

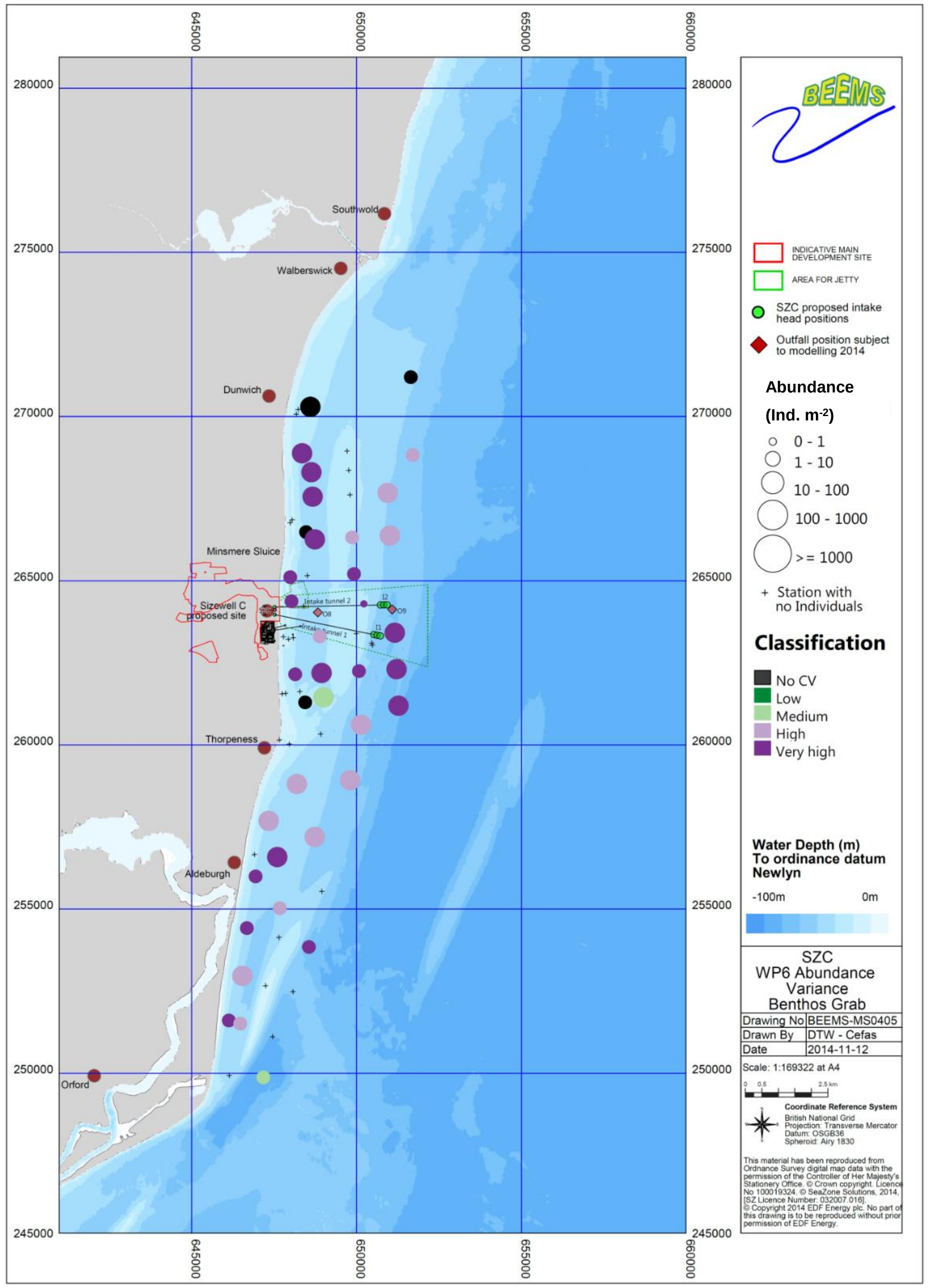

Figure 22: Spatial distribution of the bivalve *Abra alba* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) are obtained from the grab sample.

3.5.3.2 *Buccinum undatum*

***Buccinum undatum*, the common whelk**

Taxon of socio-economical value

Photo © Cefas

The gastropod *Buccinum undatum* is found in a wide range of habitats from muddy sand to rocky seabed (Ager, 2008). The species was observed in 2008, 2011 and 2012 during the first, third and fourth quarter of the year (Figure 23). It was found in very low density at only five stations - two in the north of the area and three in the south (Figure 24). Welk potting had increased between the fisheries review in 2012 and 2016 in the fishing area around Southwold (BEEMS TR123 Ed2).

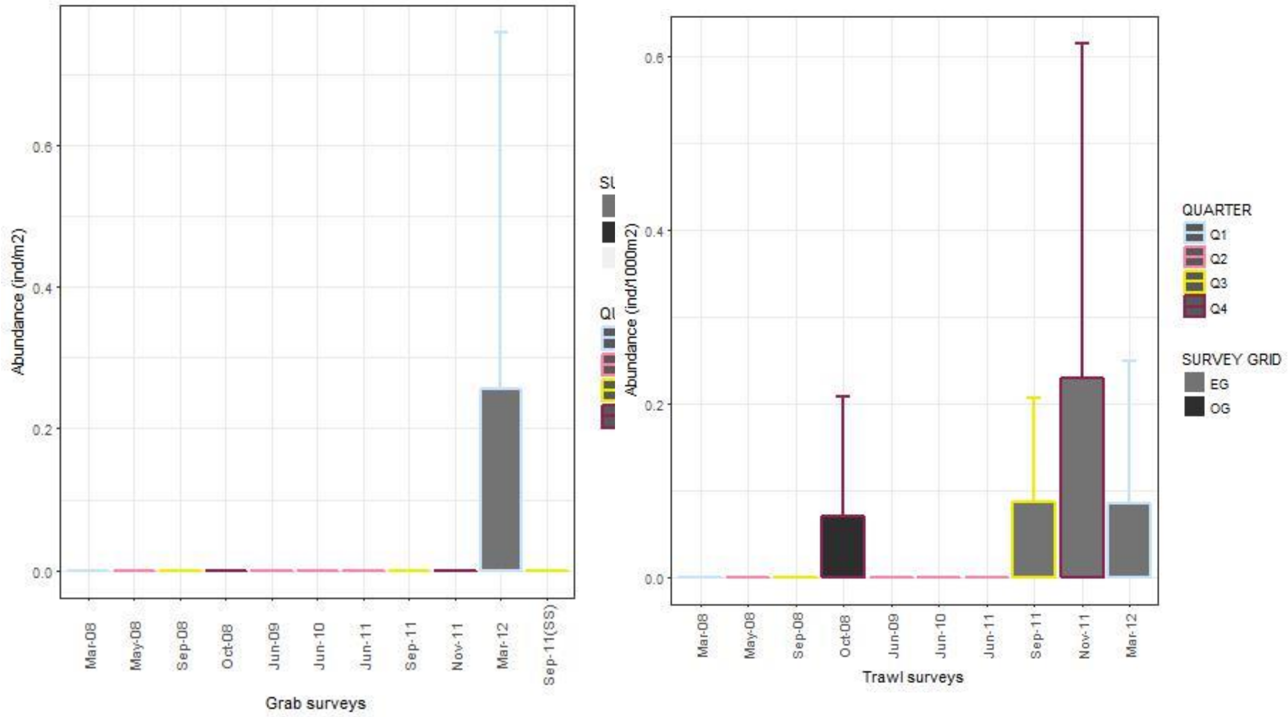

Figure 23: Temporal variation in the abundance (mean ± 95 % C.I.) of *Buccinum undatum*. The abundance data (ind.m^{-2}) were obtained from the grab samples (left) and from the trawl samples (right) (see section 3.5.2 for legend details).

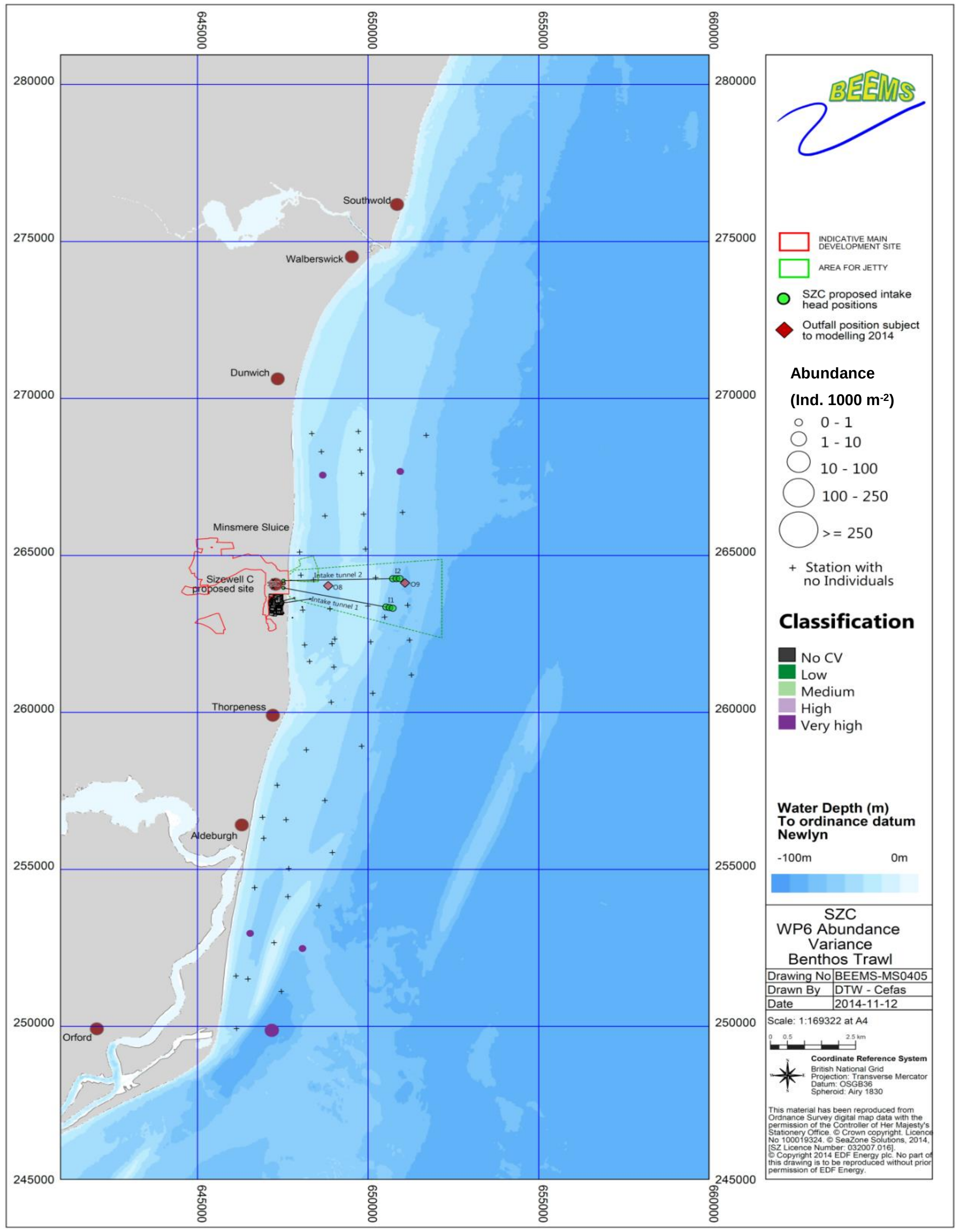

Figure 24: Spatial distribution of the gastropod *Buccinum undatum* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

3.5.3.3 Ensis spp

***Ensis* spp, the razor clam**
Taxon of ecological importance (I)

Photo © Cefas

The bivalve *Ensis* spp. could not be identified to the lowest taxonomic level as all the individuals were juveniles. Probably because of this, abundances were high (several hundreds of individuals per metre square). This taxon was recorded mostly during the second and third quarter of the year, after the recruitment period (Figure 25). *Ensis* spp. was present across most of the area and well-represented in the shallow sublittoral, though apparently absent from the southernmost stations (Figure 26). The highest abundances were observed in areas closer to the coast, in shallower depths and sheltered from the main hydrodynamics by the sandbank, though there was a high degree of variability over time. Four species of razor clam occur in the North Sea infralittoral region, three native species *Ensis ensis, Ensis siliqua* and *Ensis arcuatus* and a non-native *Ensis directus,* spotted in 1989 in Norfolk for the first time (Howlett 1990). Only one adult individual identified to the species level (*Ensis directus)* was found in a grab sample in the study area therefore insufficient evidence is available to infer anything about the possibility that the juveniles found in other stations also belong to this species. *Ensis* spp. is not commercially harvested within the study area.

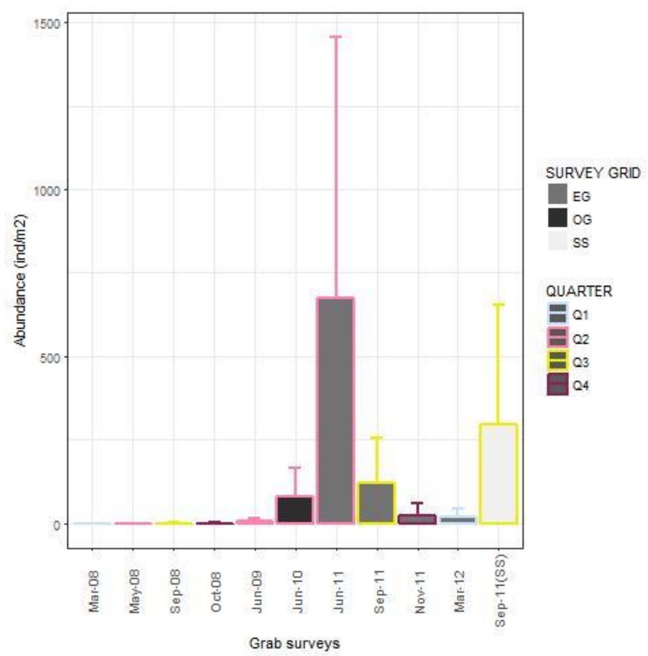

Figure 25: Temporal variation in the abundance (mean ± 95 % C.I.) of *Ensis* spp. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

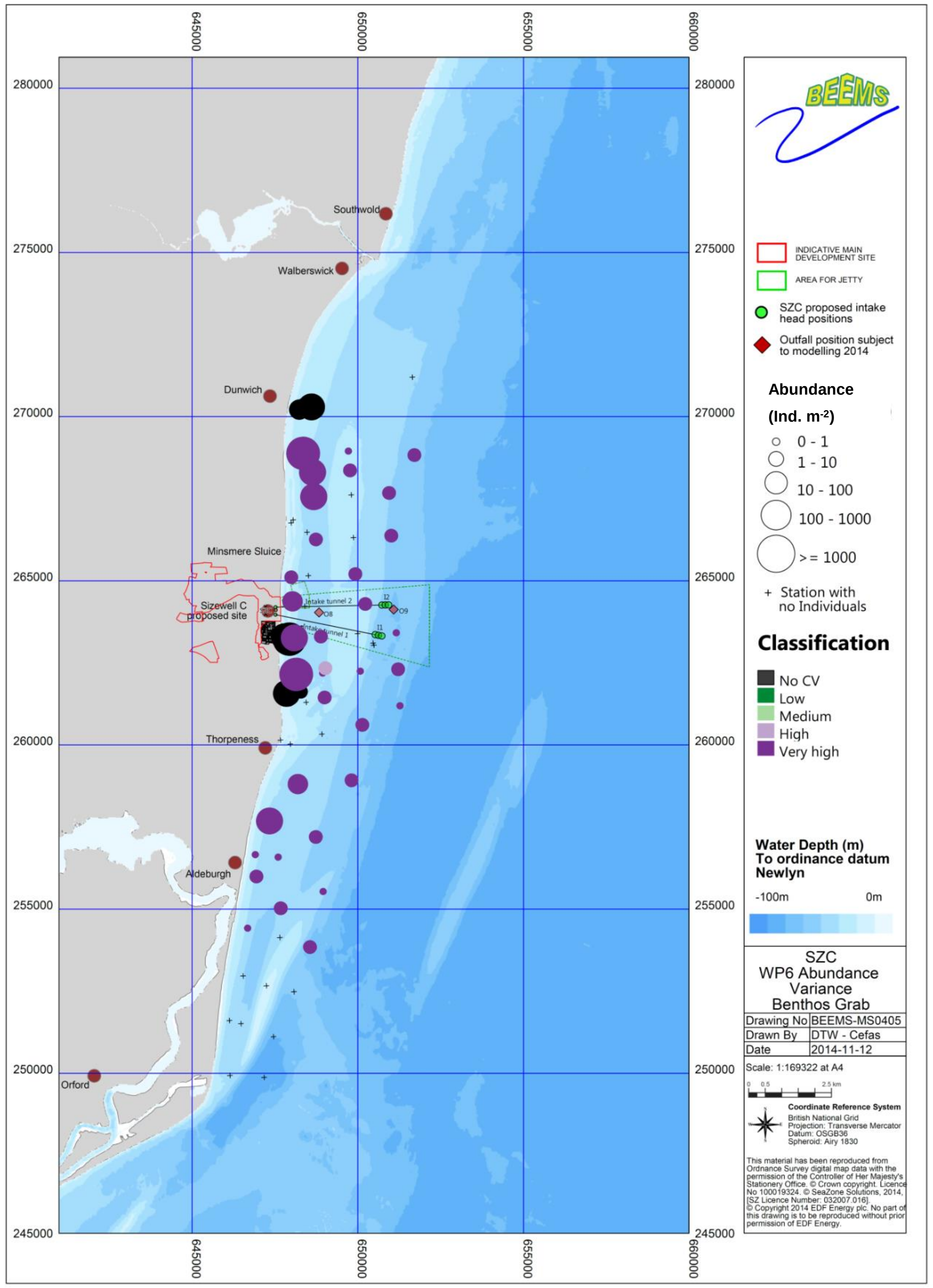

Figure 26: Spatial distribution of the bivalve *Ensis* spp, in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) are obtained from the grab samples.

3.5.3.4 *Limecola balthica*

Limecola balthica, the Baltic tellin

Taxon of ecological importance

Photo © Cefas

The bivalve *Limecola balthica* is found in mud to muddy sand habitats. It is widespread around the British Isles, particularly in estuarine environments (Budd and Rayment, 2001). Its abundance was highly variable over time. It was recorded in significant numbers in 2011 but not at other times (Figure 27). Overall, abundance was relatively low for the species, as it can be found at up to several hundred individuals per square metre in favourable habitats (Budd and Rayment, 2001). It was present throughout the area, except in the southernmost and shallowest locations (Figure 28). It was most abundant, though highly variable over time, in the north of Sizewell Bay where the seabed is sheltered by the sandbank.

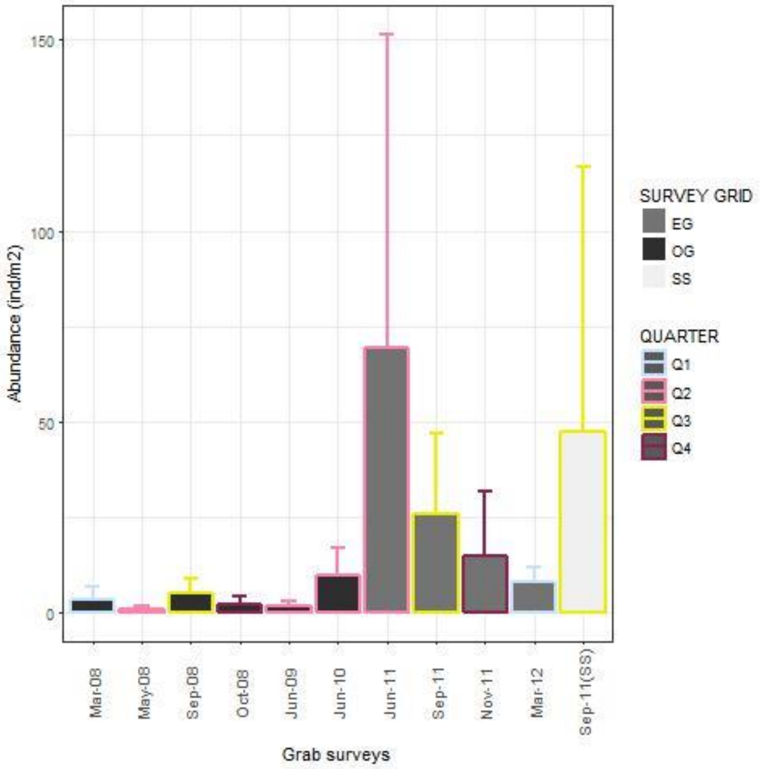

Figure 27: Temporal variation in the abundance (mean ± 95 % C.I.) of *Limecola balthica*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

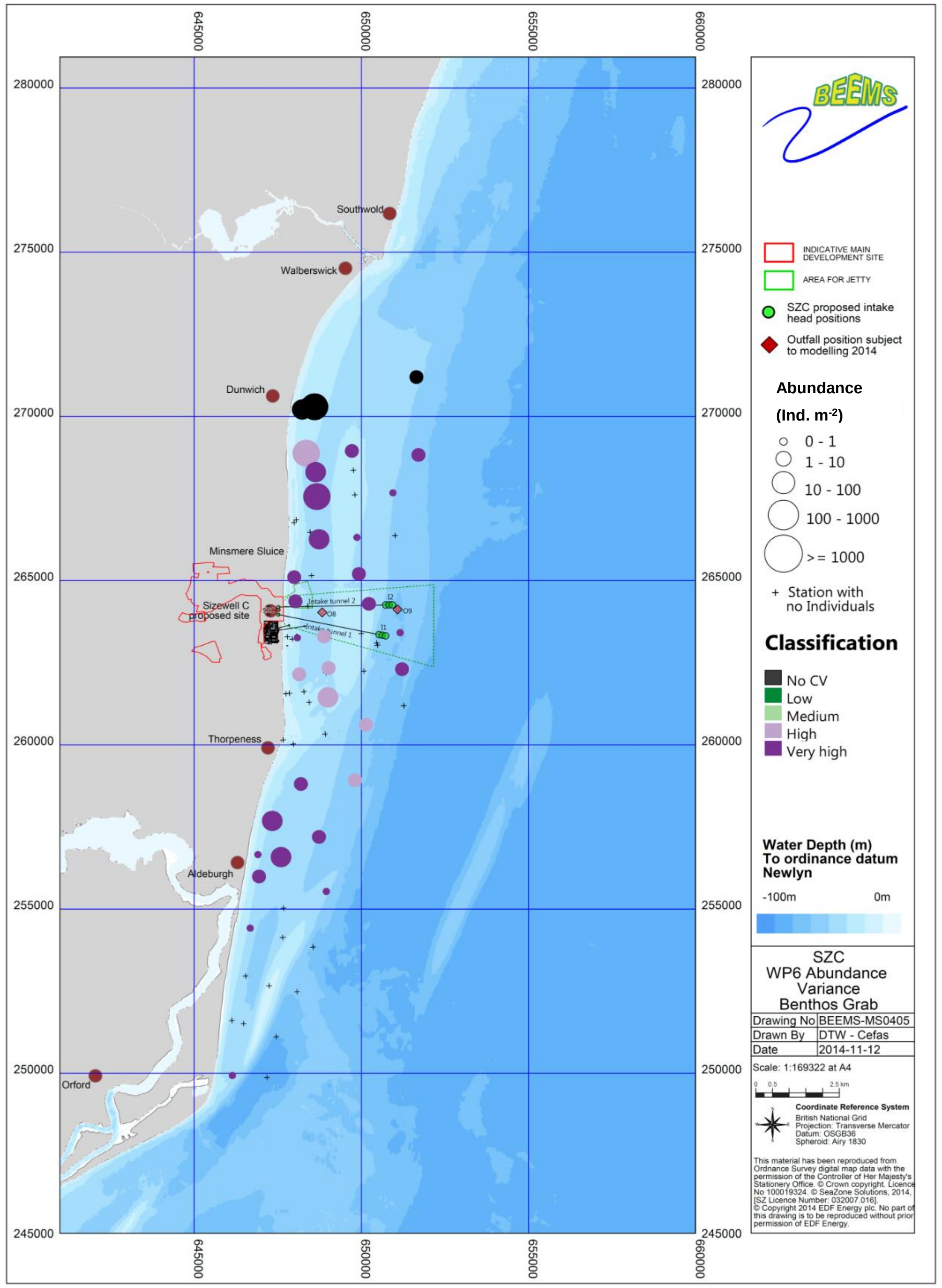

Figure 28: Spatial distribution of the bivalve *Limecola balthica* around Sizewell (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) are obtained from the grab samples.

3.5.3.5 *Mytilus edulis*

Mytilus edulis, the common mussel	
Taxon of ecological importance	Taxon of socio-economical value

Photo © Cefas

The bivalve *Mytilus edulis* occurs in a wide range of habitats from hard substrates to muddy sand. The species is gregarious and can be found in dense beds with several hundreds of individuals per square metre (Tyler-Walters, 2008). Abundance values were low for the species and most of the individuals collected were juveniles. Temporal variability was moderate to very high. Almost no records occurred during two surveys in October 2008 and June 2010 (Figure 29) but two main settlement events were recorded off Sizewell in March 2008 and in June 2009, with 418 ind.m^{-2} and 1190 ind.m^{-2}, respectively (Figure 6). The species was nevertheless recorded throughout the area, including in the shallow sublittoral (Figure 30). A small exploitation of *Mytilus edulis* exists in the River Ore and a few people collect some for their own consumption near Aldeburgh.

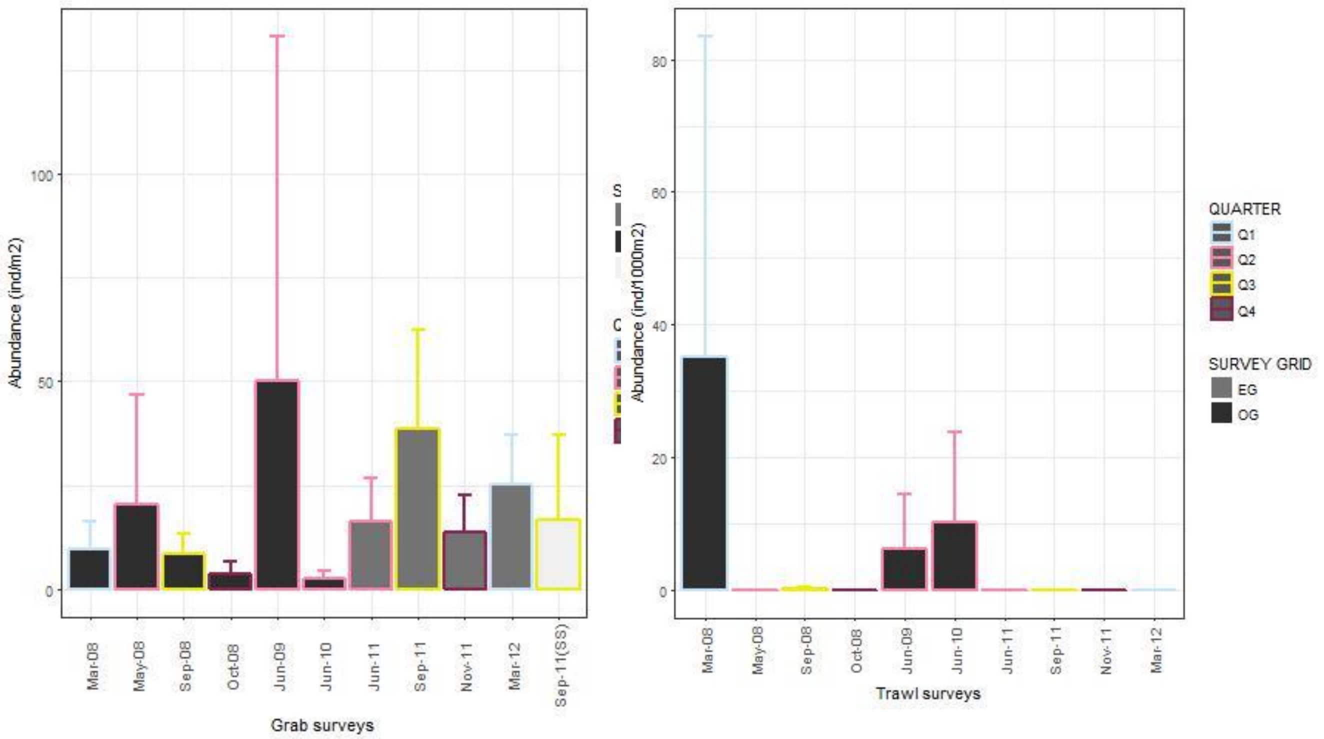

Figure 29: Temporal variation in the abundance (mean ± 95 % C.I.) of *Mytilus edulis*. The abundance data (ind.m^{-2}) were obtained from the grab samples (left) and from the trawl samples (right) (see section 3.5.2 for legend details).

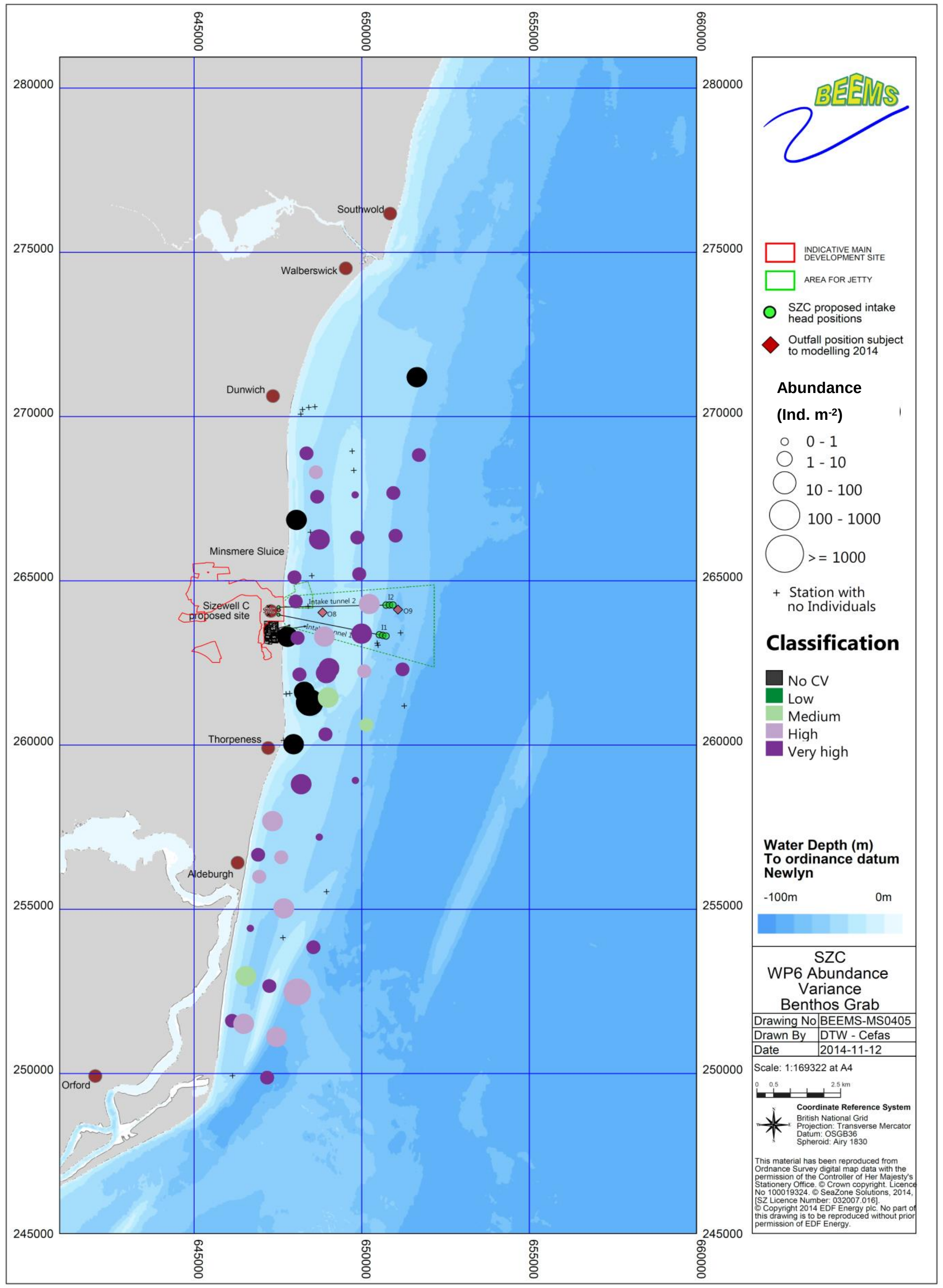

Figure 30: Spatial distribution of the bivalve *Mytilus edulis* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples.

3.5.3.6 *Nucula nitidosa*

Nucula nitidosa, a bivalve mollusc

Taxon of ecological importance (I & E)

Photo © Cefas

The bivalve *Nucula nitidosa* is widespread in the British Isles and generally found in fine sediment such as fine sand or sandy mud (Sabatini and Ballerstedt, 2008). High abundances were recorded in 2008 in the north of the area in the grab samples, and in 2009/2010 in the trawl samples (Figure 31). Lower abundances were recorded in 2011/2012 however the sampling grid had extended to the south of the area (EG) where the species is found in much lower abundance or even absent in the southernmost stations (Figure 31). High to very high inter-annual variation occurred at most of the stations across the surveyed areas (Figure 32).

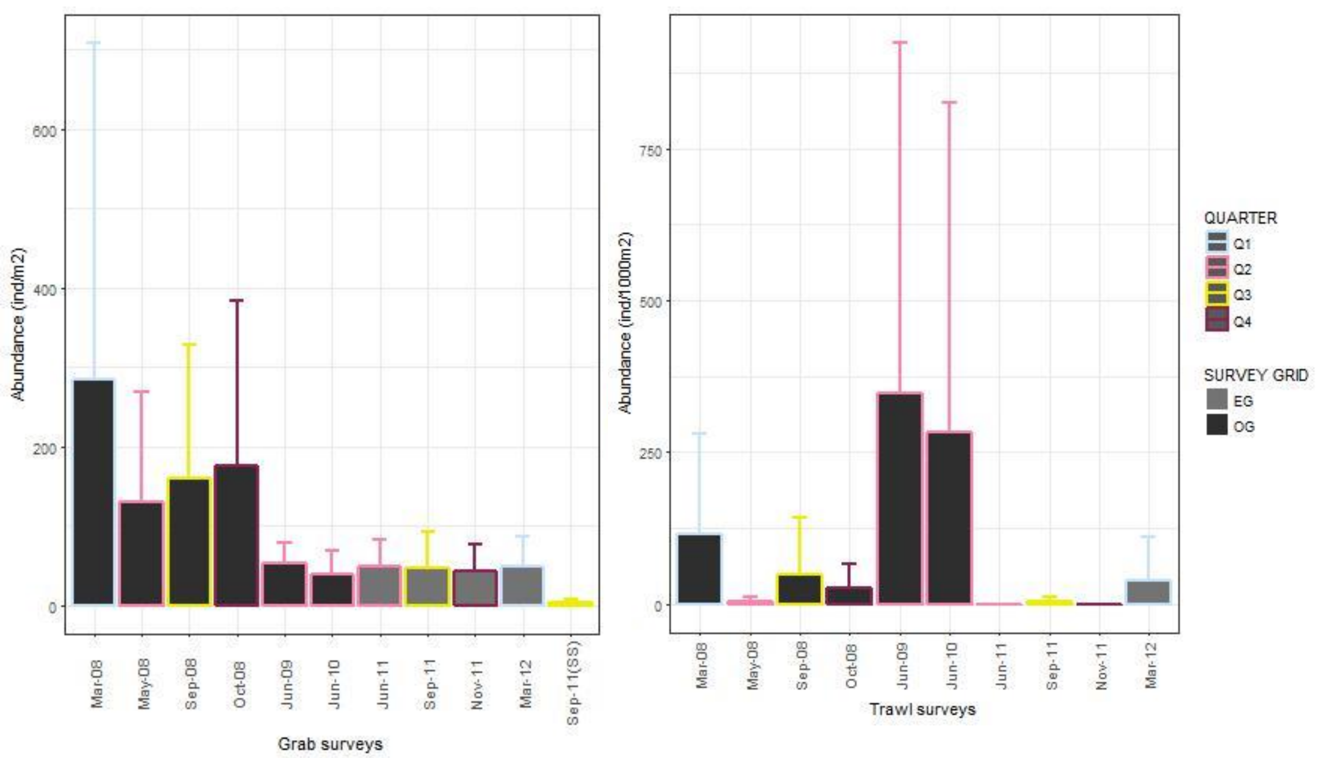

Figure 31: Temporal variation in the abundance (mean ± 95 % C.I.) of *Nucula nitidosa*. The abundance data (ind.m^{-2}) were obtained from the grab samples (left) and from the trawl samples (right) (see section 3.5.2 for legend details).

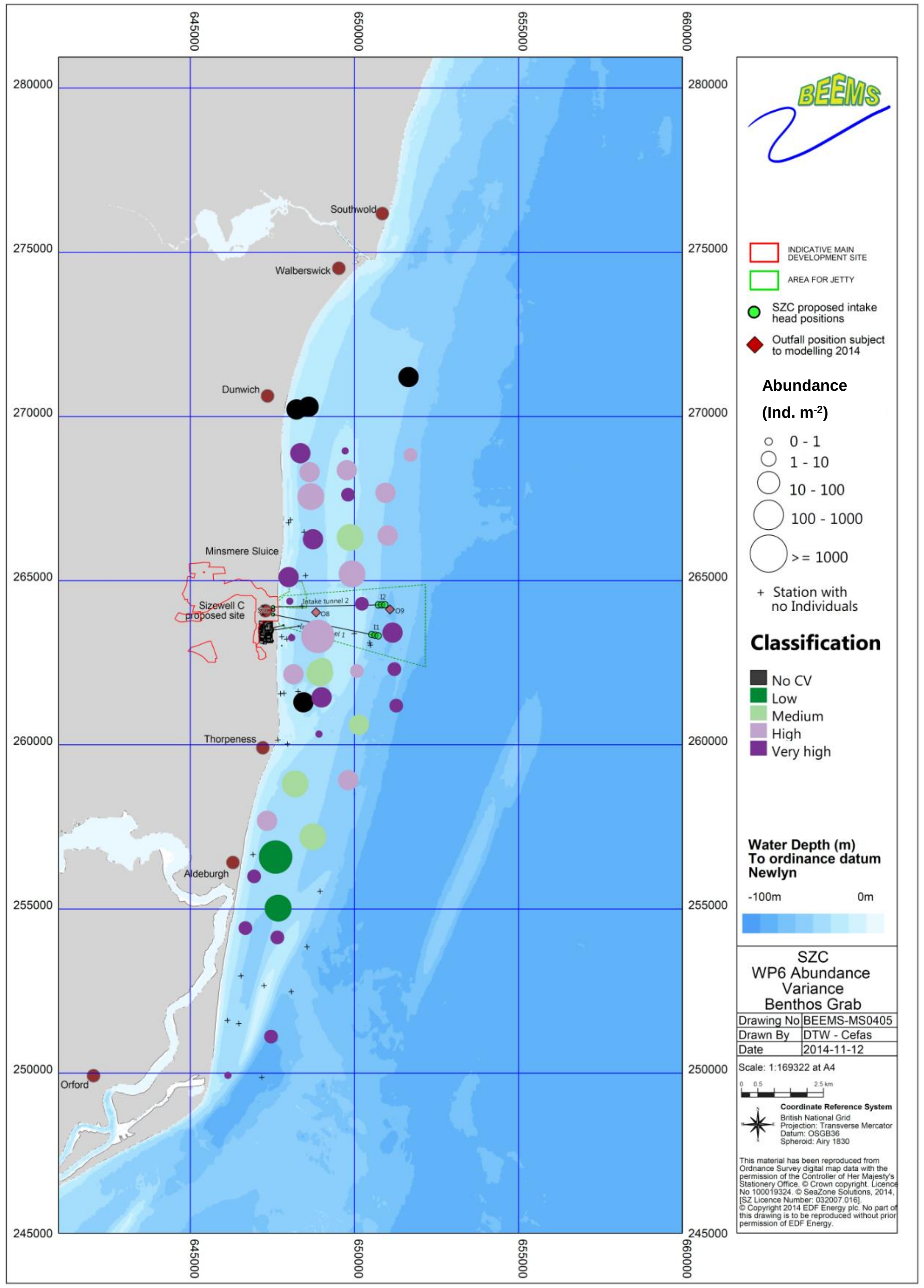

Figure 32: Spatial distribution of the bivalve *Nucula nitidosa* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples.

3.5.3.7 *Nucula nucleus*

***Nucula nucleus*, a bivalve mollusc**
Taxon of ecological importance

Photo © Cefas

The bivalve *Nucula nucleus* is common on all British coasts and is generally found in coarse sand and fine gravel habitats (Hayward and Ryland, 2011). The highest abundances were recorded in 2008 (in grab and trawl samples) and in 2012 (in trawls) (Figure 33). The species was found at almost all stations across the area, with moderate to high variability over time (Figure 34).

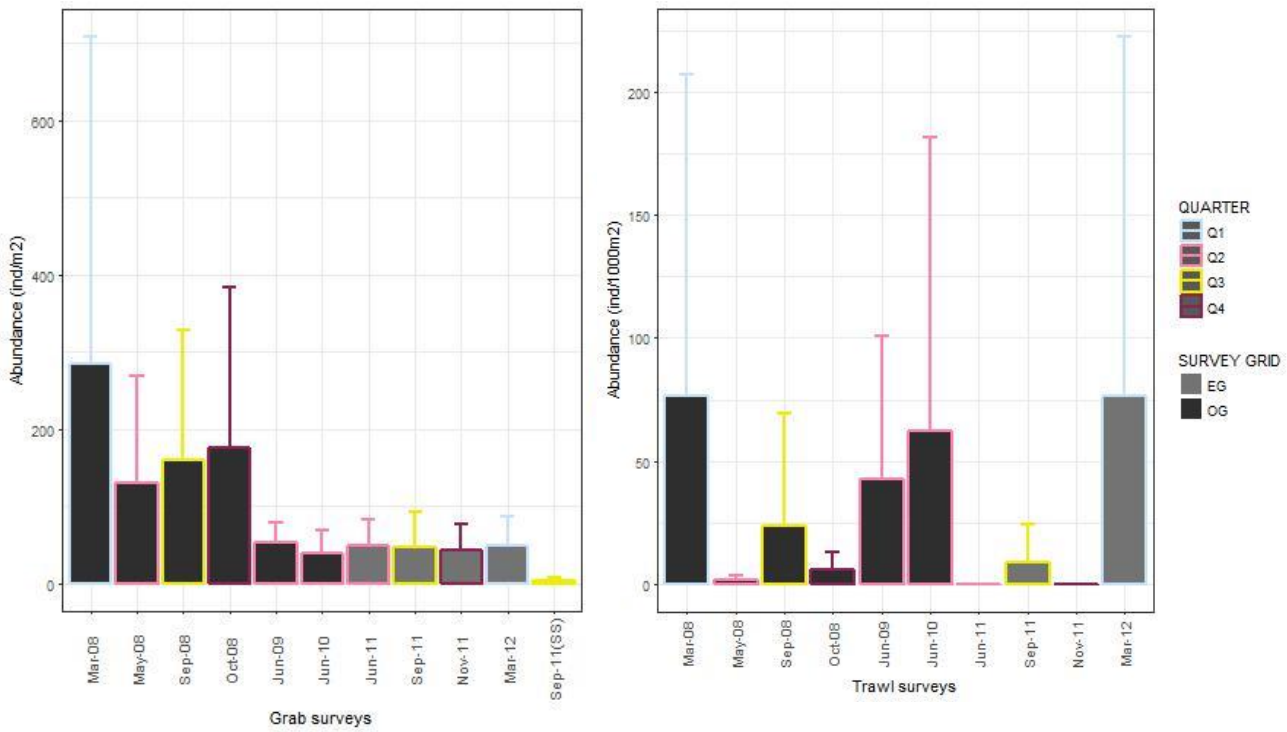

Figure 33: Temporal variation in the abundance (mean ± 95 % C.I.) of *Nucula nucleus*. The abundance data (ind.m^{-2}) were obtained from the grab samples (left) and from the trawl samples (right) (see section 3.5.2 for legend details).

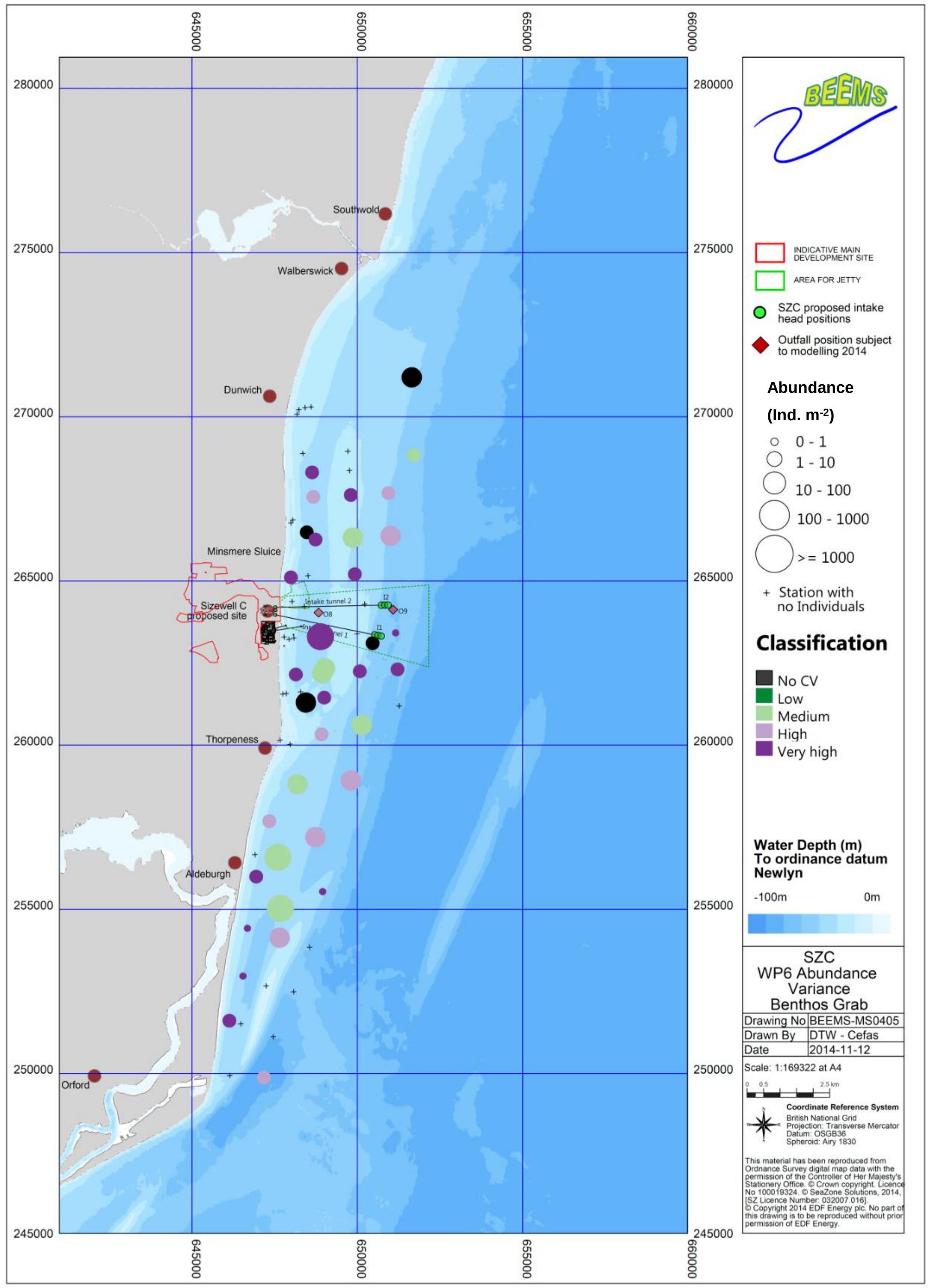

Figure 34: Spatial distribution of the bivalve *Nucula nucleus* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples.

3.5.4 Crabs and lobsters

3.5.4.1 *Cancer pagurus*

***Cancer pagurus*, the brown crab**
Taxon of socio-economical value

Photo © Cefas

The crab *Cancer pagurus* occurs in a wide range of soft and hard substrates around the UK (Neal and Wilson, 2008). The abundance of the species was highly variable between surveys and over years and there was no clear temporal pattern (Figure 35). It was found in 2 m-beam trawl samples between Sizewell and Aldeburgh and appeared to be more localised in the area around Sizewell (Figure 36). Similar observations were made from the samples collected with the otter-trawl (Table 13). This species is commercially targeted within the Greater Sizewell Bay commercial and recreational fishermen setting pots all across the area (BEEMS TR123 Ed2).

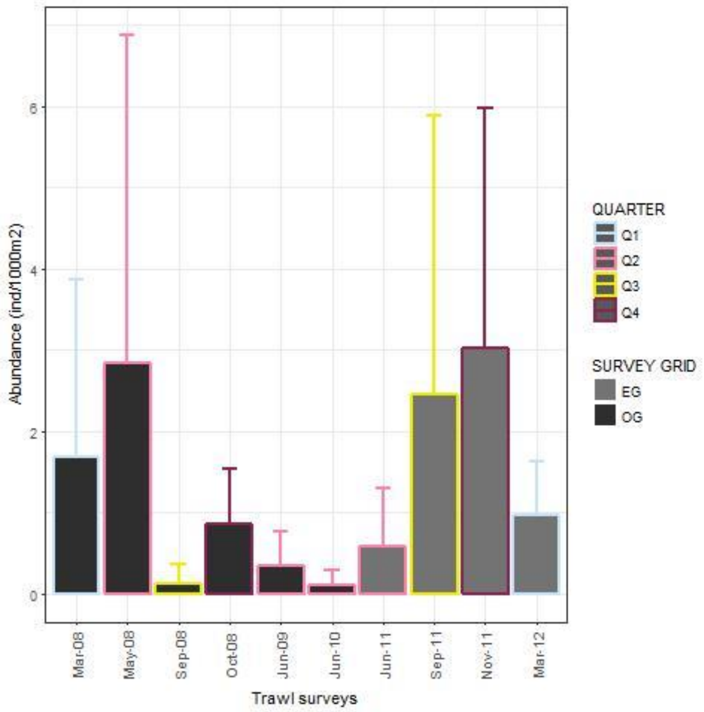

Figure **35:** Temporal variation in the abundance (mean ± 95 % C.I.) of *Cancer pagurus*. The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples (see section 3.5.2 for legend details).

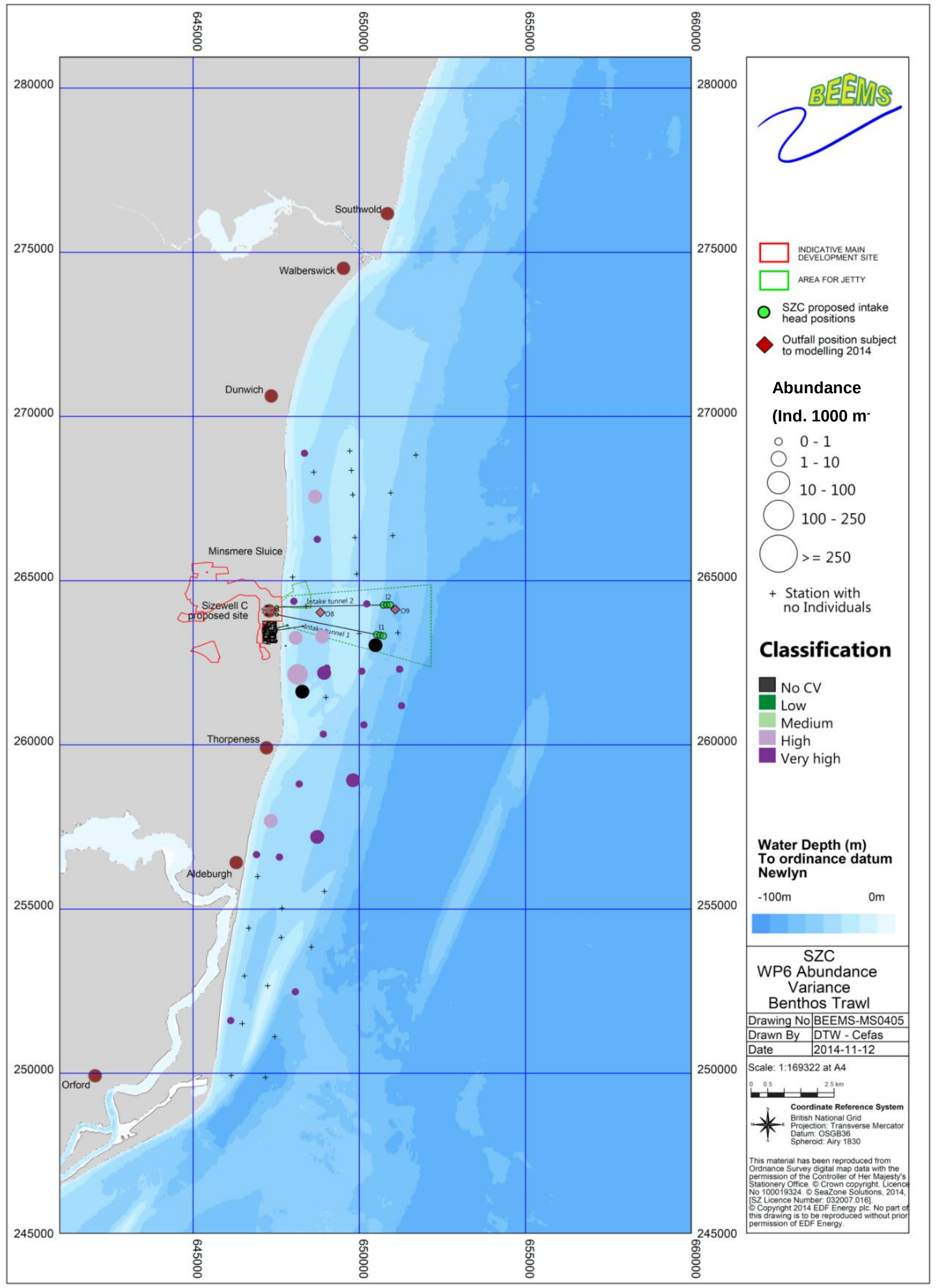

Figure 36: Spatial distribution of the crab *Cancer pagurus* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

3.5.4.2 Homarus gammarus

***Homarus gammarus*, the common lobster**
Taxon of socio-economical value

Photo © Cefas

Homarus gammurus generally occurs on hard substrates (Wilson, 2008). Abundances were highly variable, as the species was caught in only 2008 and 2011 in the 2m-beam trawl (Figure 37). It was found at only a few stations around Sizewell and Thorpeness (Figure 38). The species was caught every year in low abundance with the otter-trawl (Table 13). This species is commercially targeted within the Greater Sizewell Bay commercial and recreational fishermen setting pots across all the area (BEEMS TR123 Ed2).

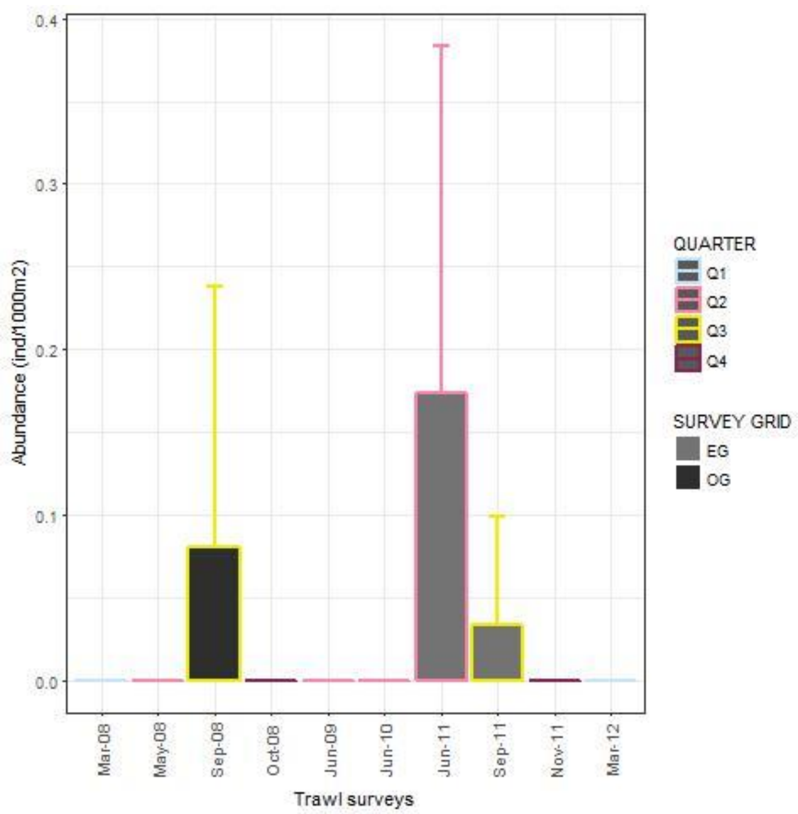

Figure **37:** Temporal variation in the abundance (mean ± 95 % C.I.) of *Homarus gammarus*. The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples (see section 3.5.2 for legend details).

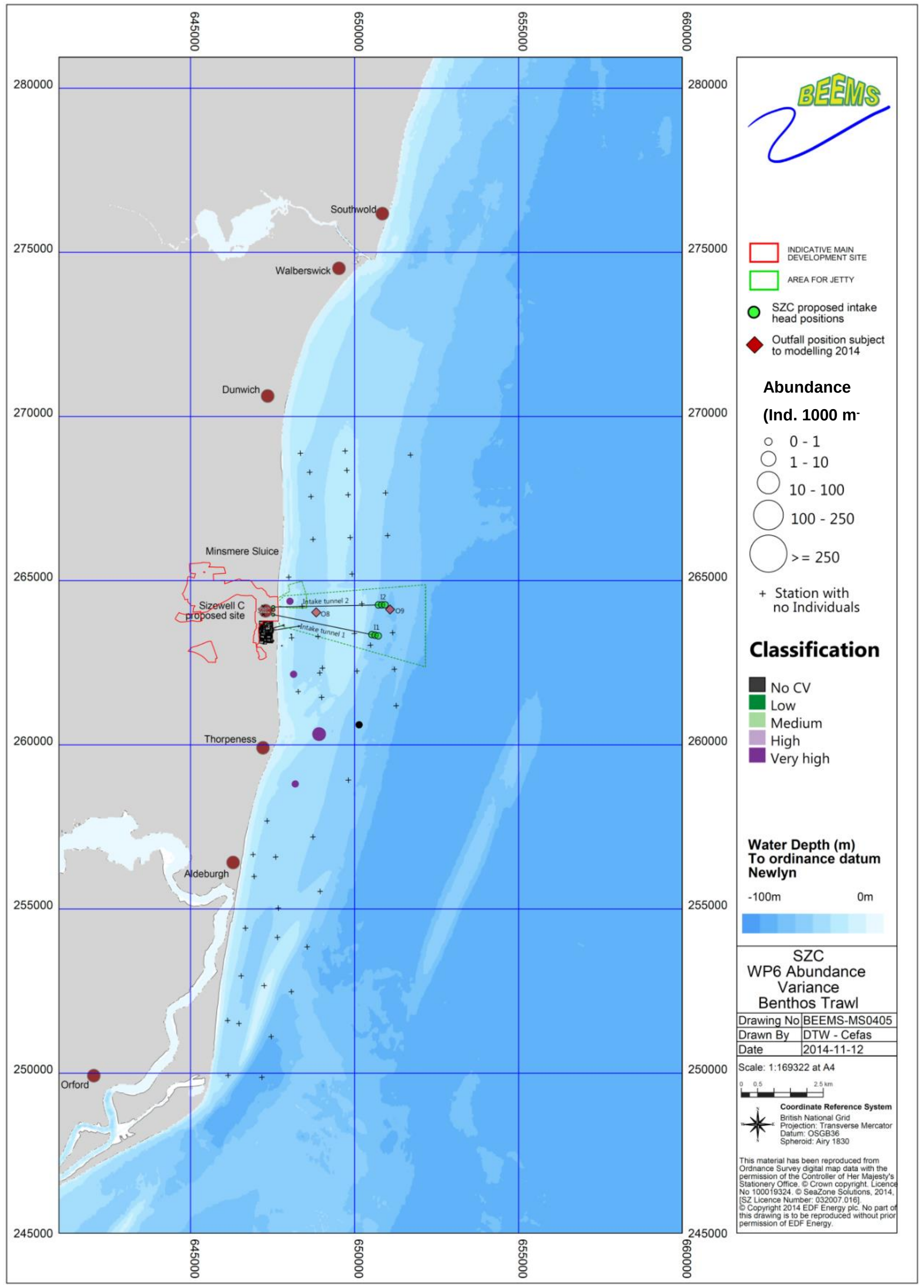

Figure 38: Spatial distribution of the lobster *Homarus gammarus* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

3.5.5 Shrimps and prawns

3.5.5.1 *Bathyporeia elegans*

***Bathyporeia elegans*, the sand digger shrimp**	
Taxon of Ecological importance (I)	
 **Photo © Cefas**	*Bathyporeia elegans* is usually found in fine and muddy sand and is widespread around the British Isles (Richards, 2008). The abundance found in the Greater Sizewell Bay is intermediate for the species as it can be found up to 150 ind.m^{-2} in infralittoral fine sand habitats (JNCC, 2015). It was found throughout the year (Figure 39) and all over the study area, with high to very high temporal variability at most of the stations (Figure 40). The highest abundances were found in the shallow sublittoral stations (Figure 39).

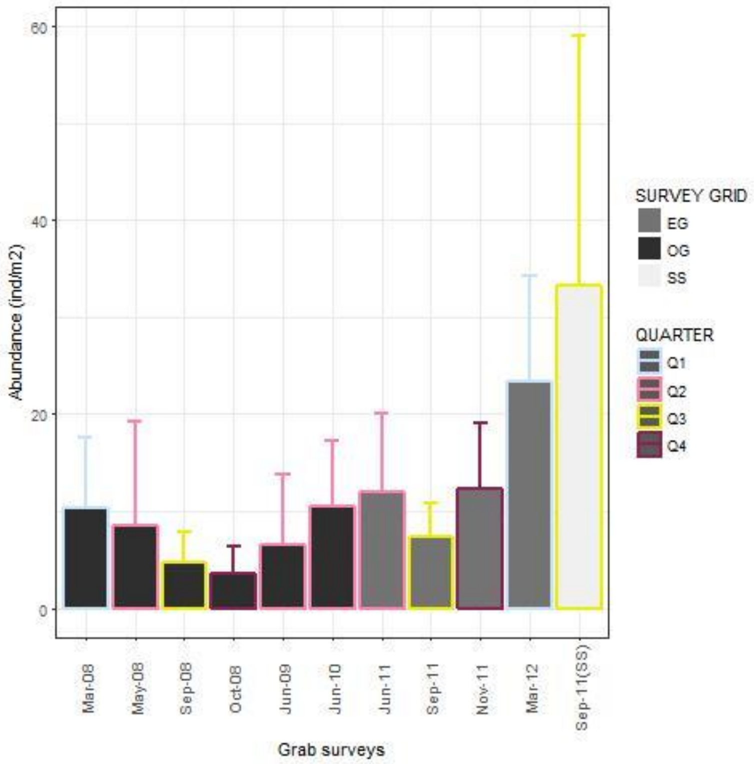

Figure 39: Temporal variation in the abundance (mean ± 95 % C.I.) of *Bathyporeia elegans*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

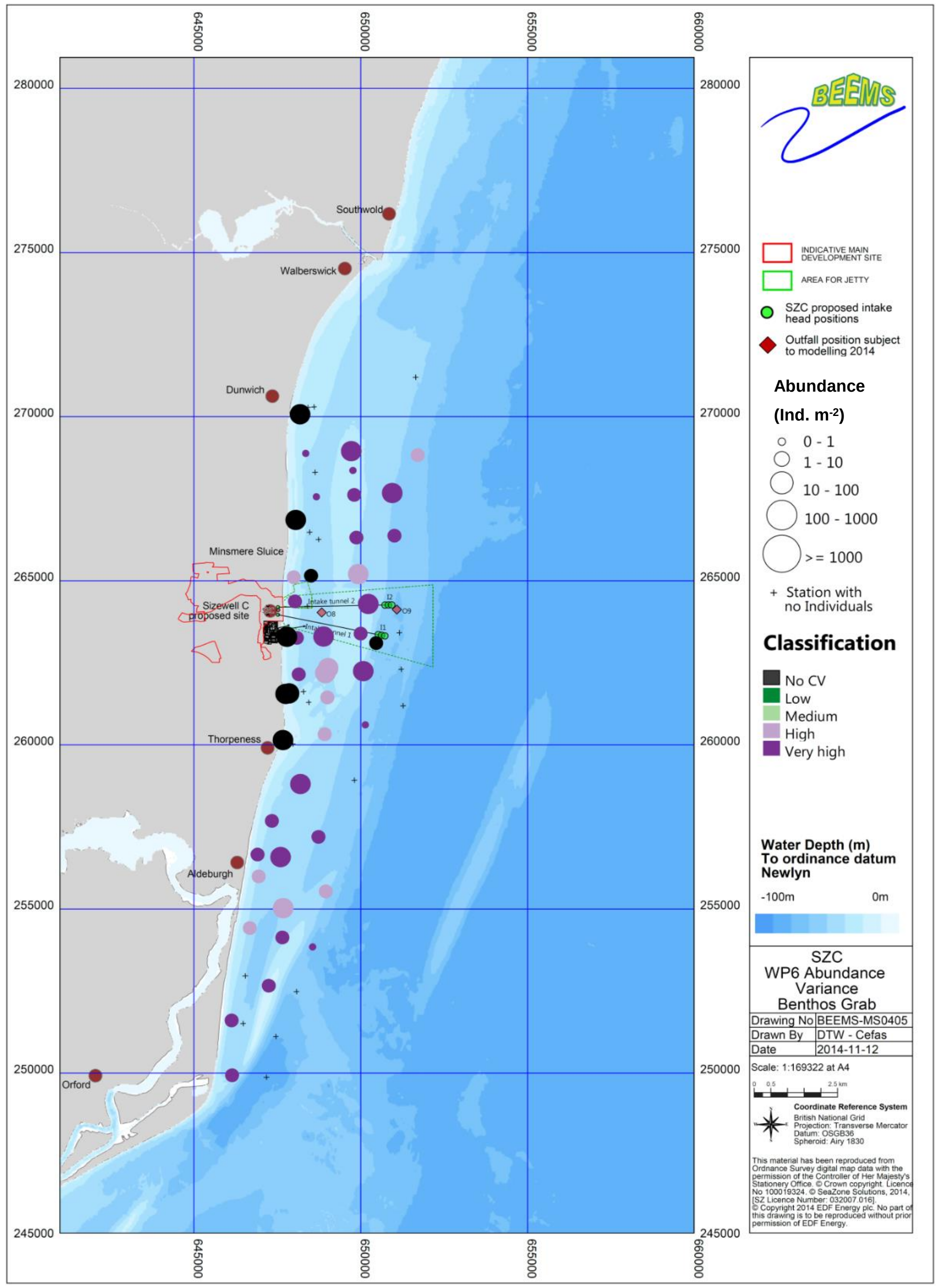

Figure 40: Spatial distribution of the amphipod *Bathyporeia elegans* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples.

3.5.5.2 *Gammarus insensibiis*

Gammarus insensibilis, the lagoon sand shrimp

Taxon of conservation importance

Photo©genustraithandbook.org.uk

Gammarus insensibilis is considered a scarce species and is protected under Schedules 5 and 8 of the Wildlife and Countryside Act 1981. The species is usually found in fine sediment in saline lagoons (Tillin and White, 2017). It was found only in June 2010 in the Greater Sizewell Bay (Figure 41). It was present in low abundance and was highly variable between the stations at which it was found in the north of the survey area and in the shallows in front of the Sizewell station complex (Figure 42).

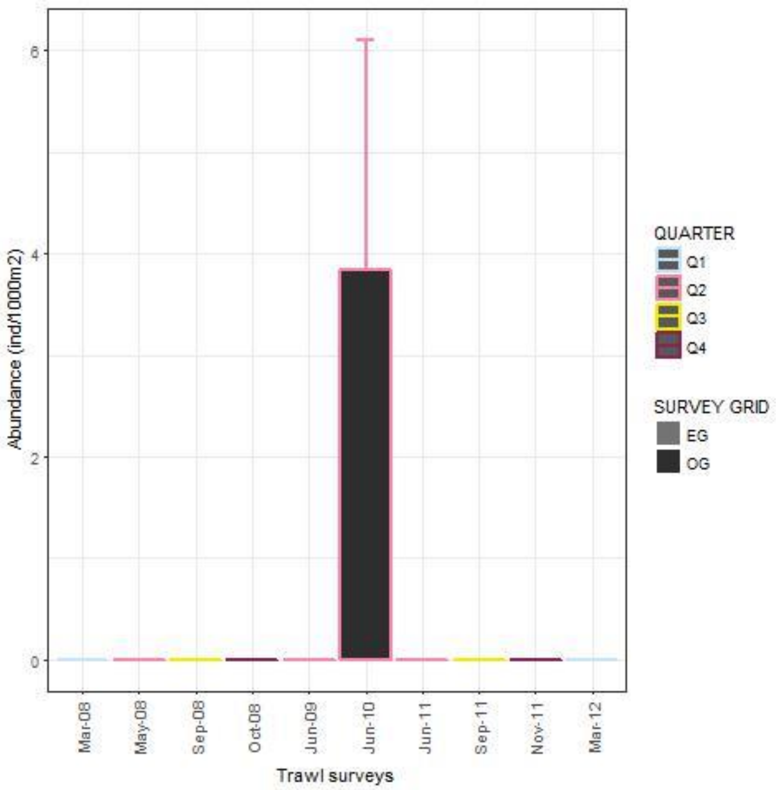

Figure 41: Temporal variation in the abundance (mean ± 95 % C.I.) of *Gammarus insensibilis*. The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples (see section 3.5.2 for legend details).

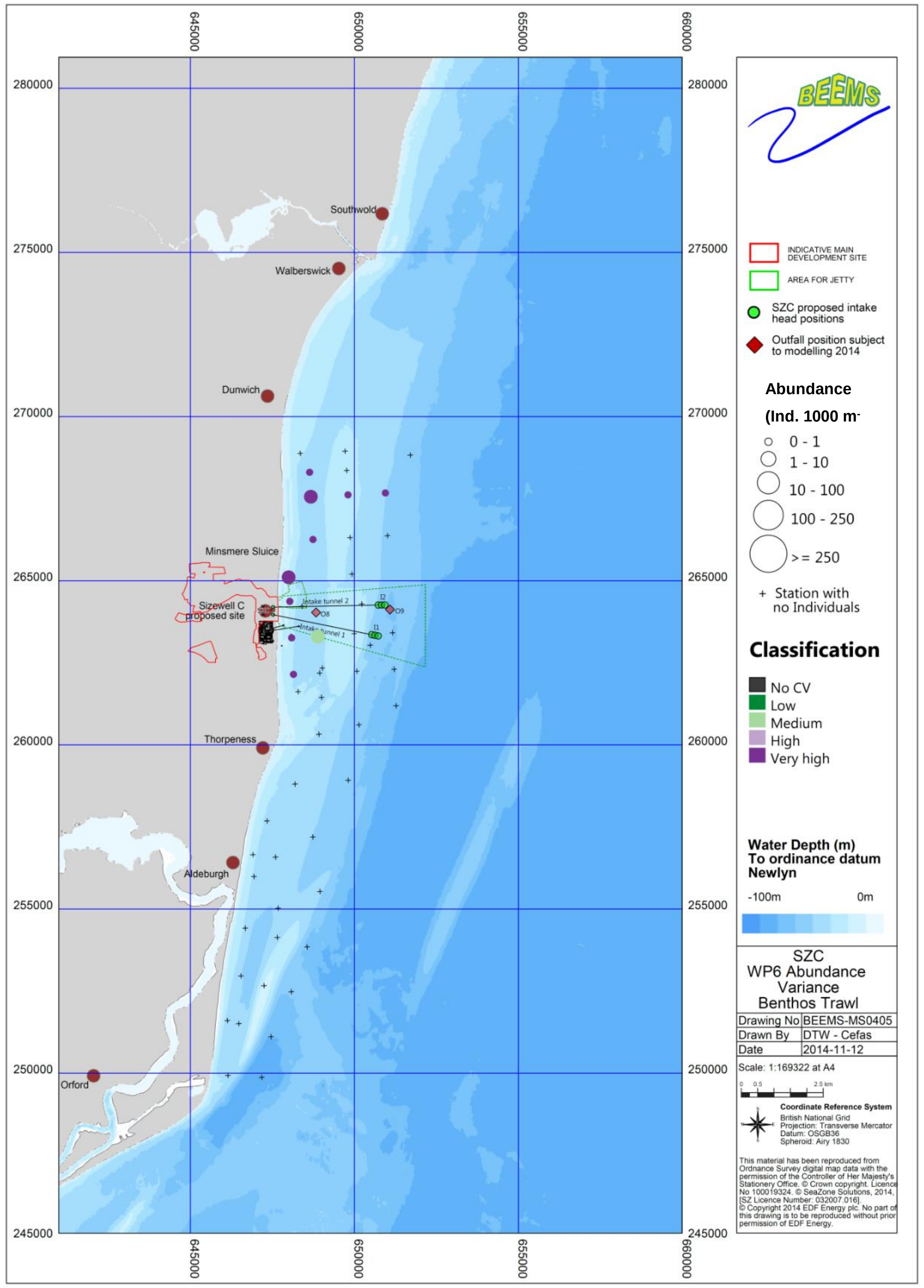

Figure 42: Spatial distribution of the amphipod *Gammarus insensibilis* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples

3.5.5.3 *Corophium volutator*

Corophium volutator, a mud shrimp

Taxon of Ecological importance (I)

Photo © Cefas

Corophium volutator lives in burrows in fine muddy sediments and can be present in high densities in the openings of the burrows. It tolerates a wide range of salinities from nearly fully saline to almost freshwater (Neal and Avant, 2006). The species was found in very high abundance only in September 2008 mostly in offshore waters of the Greater Sizewell Bay (Figure 43 and Figure 6). The species is mostly found in the north part of the survey area, at the exception of two stations in the South (Figure 44).

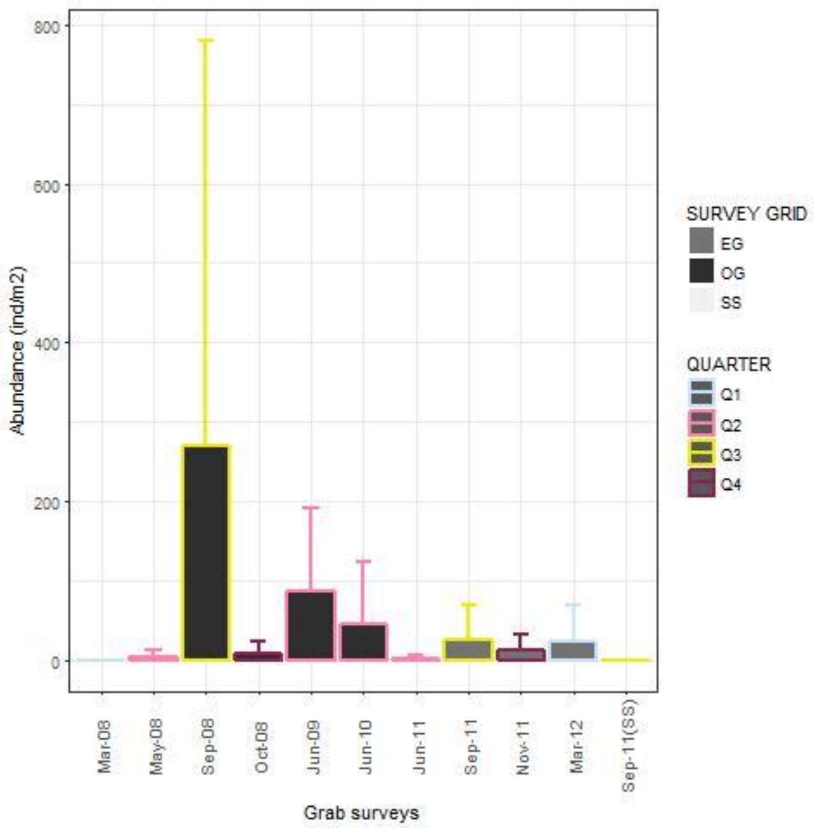

Figure 43: Temporal variation in the abundance (mean ± 95 % C.I.) of *Corophium volutator*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

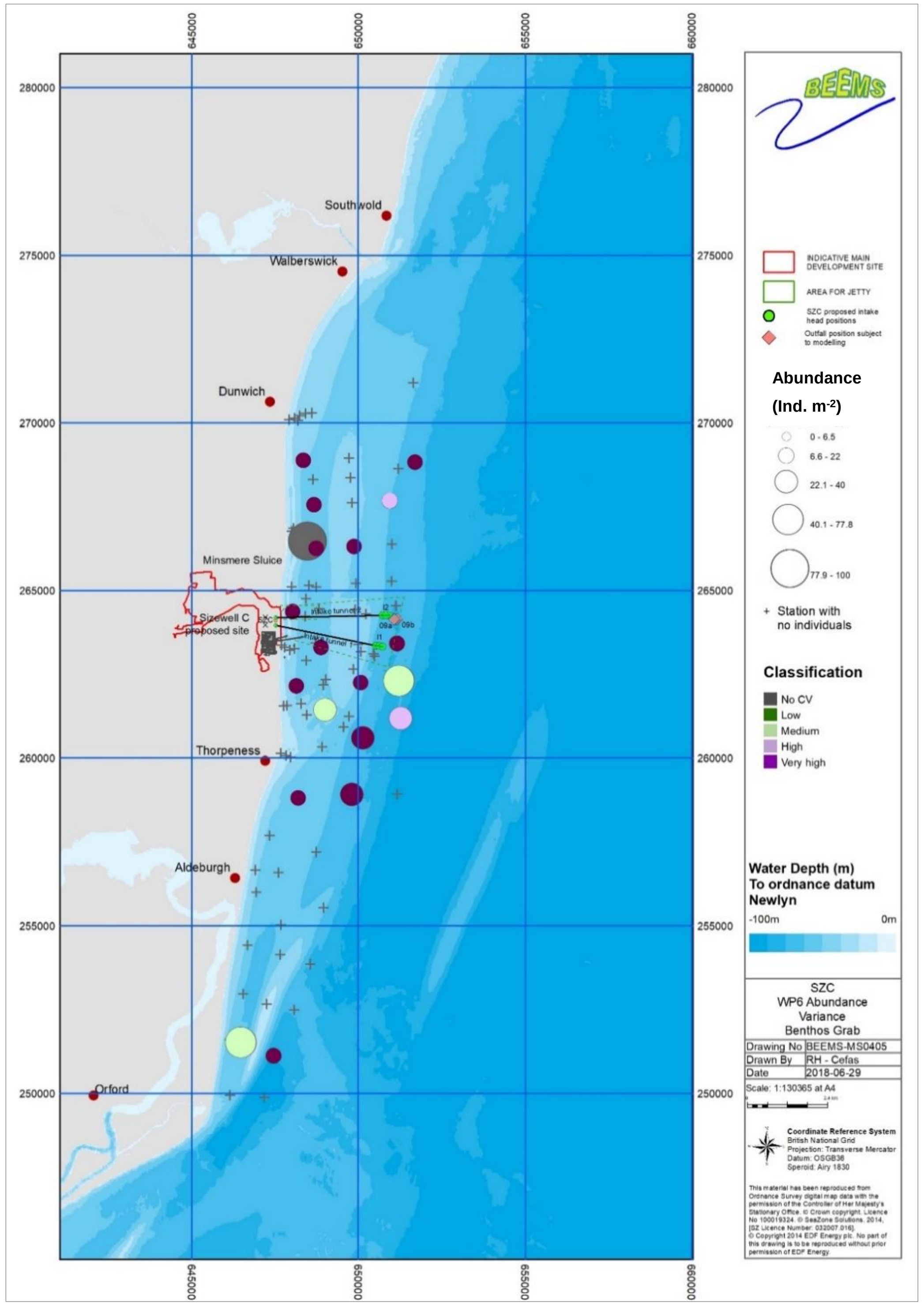

Figure 44: Spatial distribution of the amphipod *Corophium volutator* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples

3.5.5.4 *Crangon crangon*

***Crangon crangon*, the brown shrimp**	
Taxon of Ecological importance (E)	**Taxon of socio-economical value**

Photo © Cefas

Crangon crangon is widespread around the British Isles and generally found in fine sediment habitats (Neal, 2008). The species is known to have a strong seasonal pattern and it can be locally extremely abundant during the summer months (Boddeke, 1976; Reiss *et al.,* 2004). There is evidence of this pattern in the Greater Sizewell Bay, with the highest abundances recorded in June and September (Figure 45). It was observed across the survey grid, with medium to high variability (Figure 46). Brown shrimp are taken along the coast from Sizewell to Orford by several commercial boats using beam trawls in the winter in waters >10 m (BEEMS TR123 Ed2).

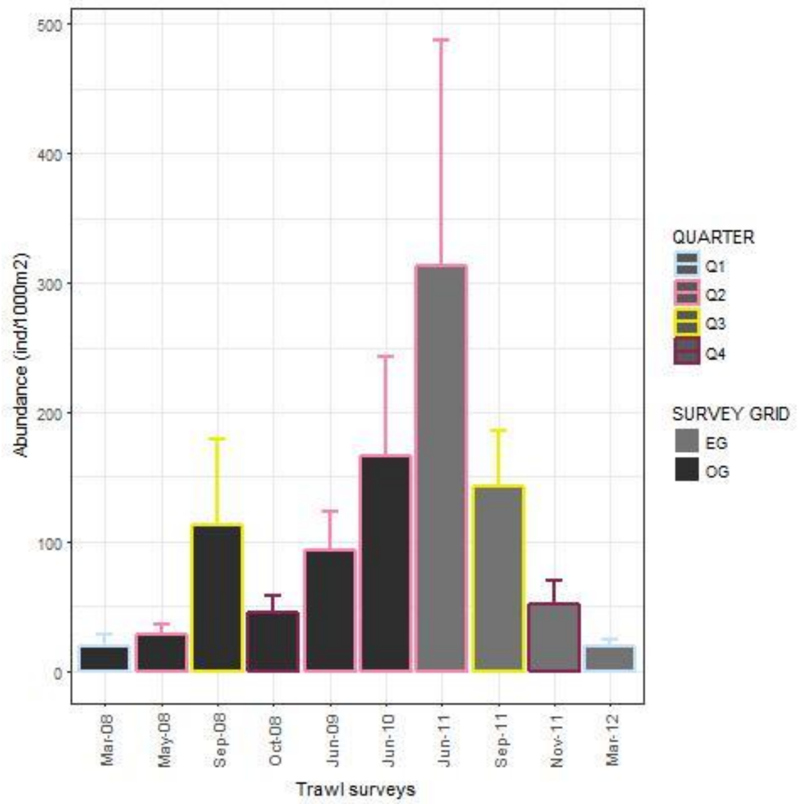

Figure 45: Temporal variation in the abundance (mean ± 95 % C.I.) of *Crangon crangon*. The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples (see section 3.5.2 for legend details).

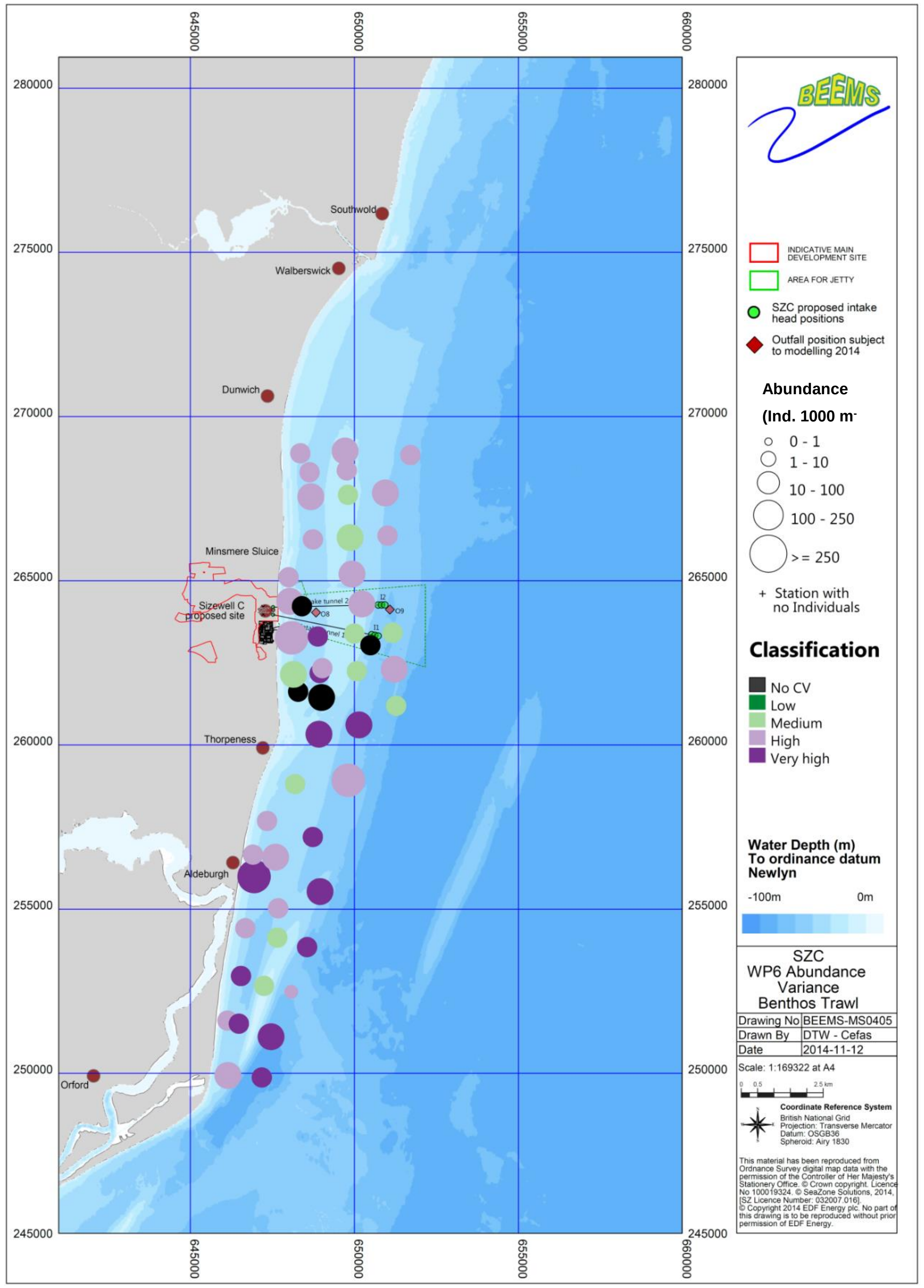

Figure 46: Spatial distribution of the shrimp *Crangon crangon* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

3.5.5.5 *Pandalus montagui*

***Pandalus montagui*, the pink shrimp**	
Taxon of Ecological importance (E)	**Taxon of socio-economical value**

Photo © Cefas

Pandalus montagui is widespread around the British Isles and is found on all kinds of soft and hard substrate (Ruiz, 2008). The abundance value in Sizewell Bay was variable over time, with evidence of a seasonal increase in the summer similar to that of *Crangon crangon* (Figure 47). *P. montagui* was found at almost all of the survey stations and was reasonably abundant (Figure 48). There are limited market opportunities for the pink shrimp in the Greater Sizewell Bay area however the species is still commercially targeted, in a lesser extent than the brown shrimp. The species is usually caught in the winter in deeper water (> 10m) by beam-trawl fishing.

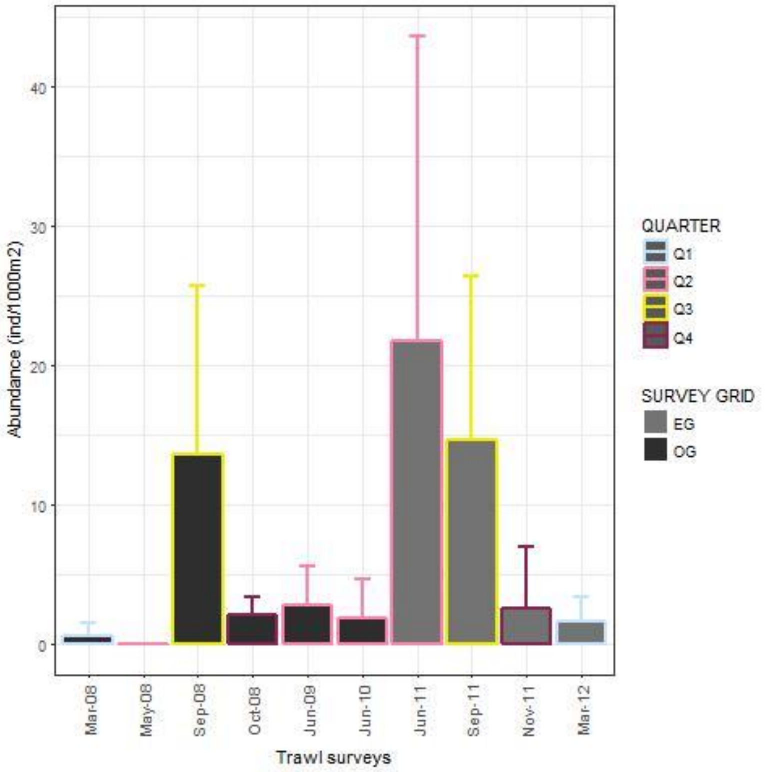

Figure 47: Temporal variation in the abundance (mean ± 95 % C.I.) of *Pandalus montagui*. The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples (see section 3.5.2 for legend details).

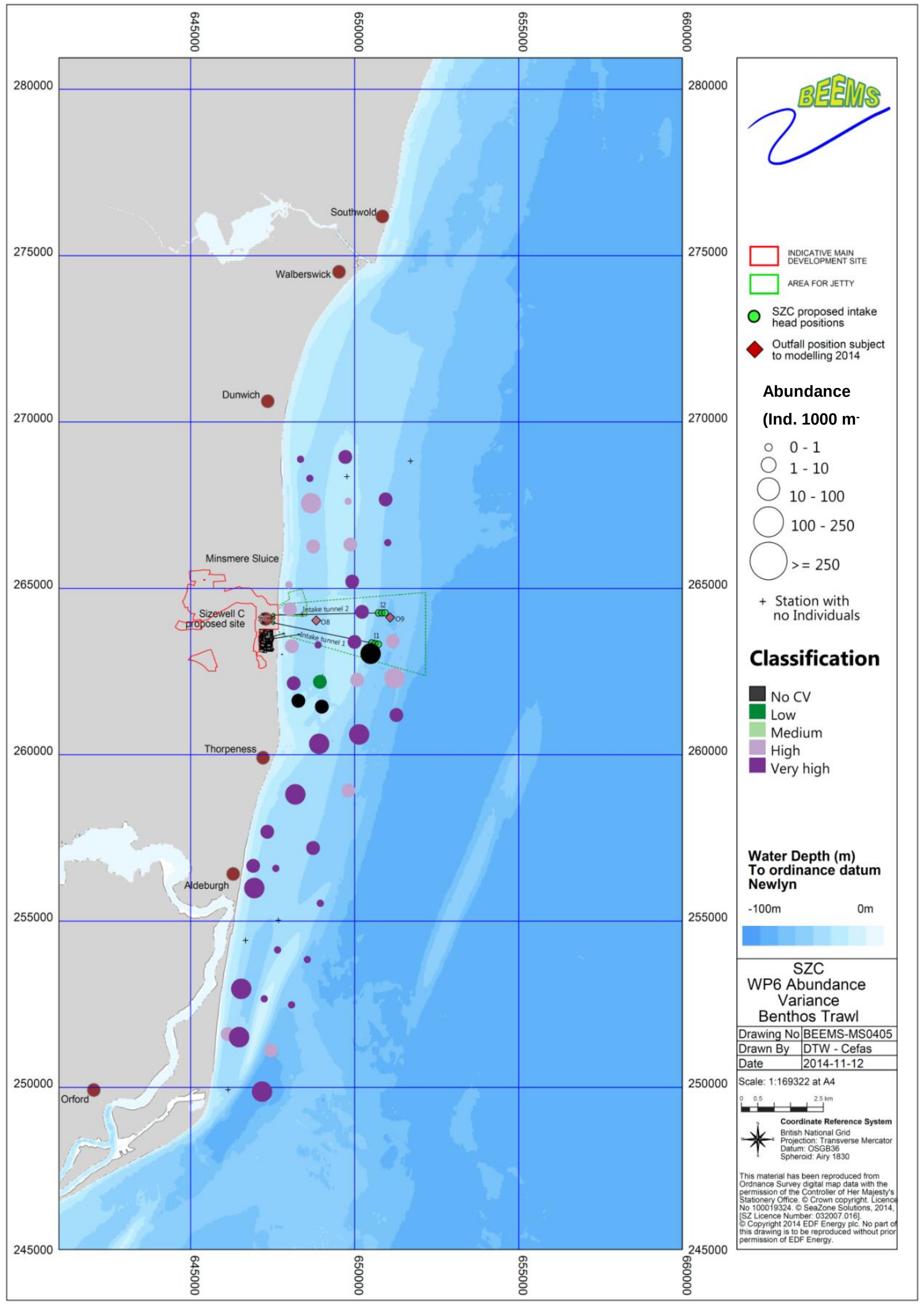

Figure 48: Spatial distribution of the gastropod *Pandalus montagui* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

3.5.6 Polychaetes

3.5.6.1 *Nephtys hombergii*

***Nephtys hombergii*, the catworm**

Taxon of ecological importance

Photo © Cefas

The polychaete *Nephtys hombergii* is generally found in muddy sand habitats. The species is widespread around the British Isles and in favourable environmental conditions can be found in densities of up to 500 ind.m^{-2} (Budd and Hughes, 2005). It was not found in such high density in the Greater Sizewell Bay, though it was consistently present throughout the area (Figure 49) and was one of the least temporally variable of the key species (with a medium to low coefficient of variation at most of the stations, see Figure 50). It was present at almost all the survey stations, though less so and more variably in the very south of the bay (Figure 50).

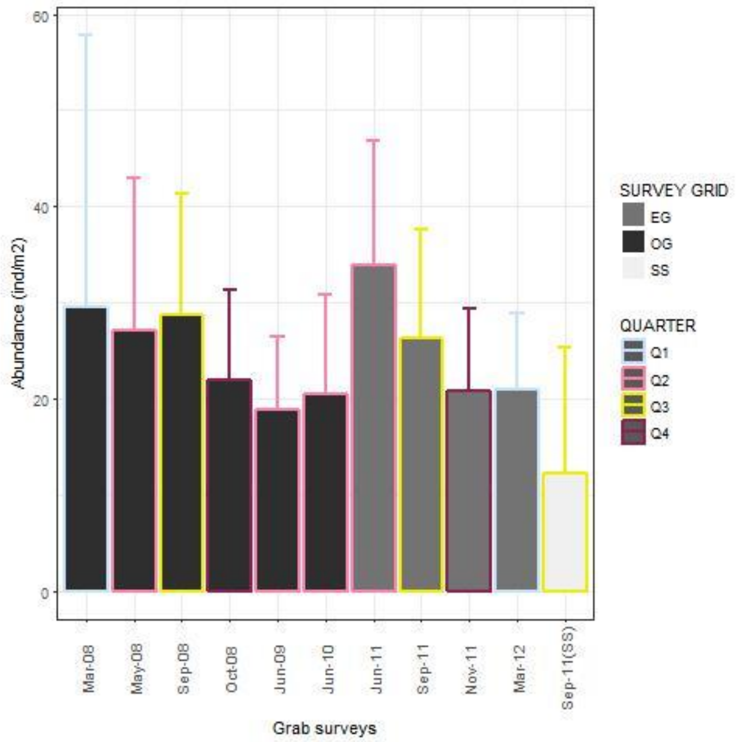

Figure 49: Temporal variation in the abundance (mean ± 95 % C.I.) of *Nephtys hombergii*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

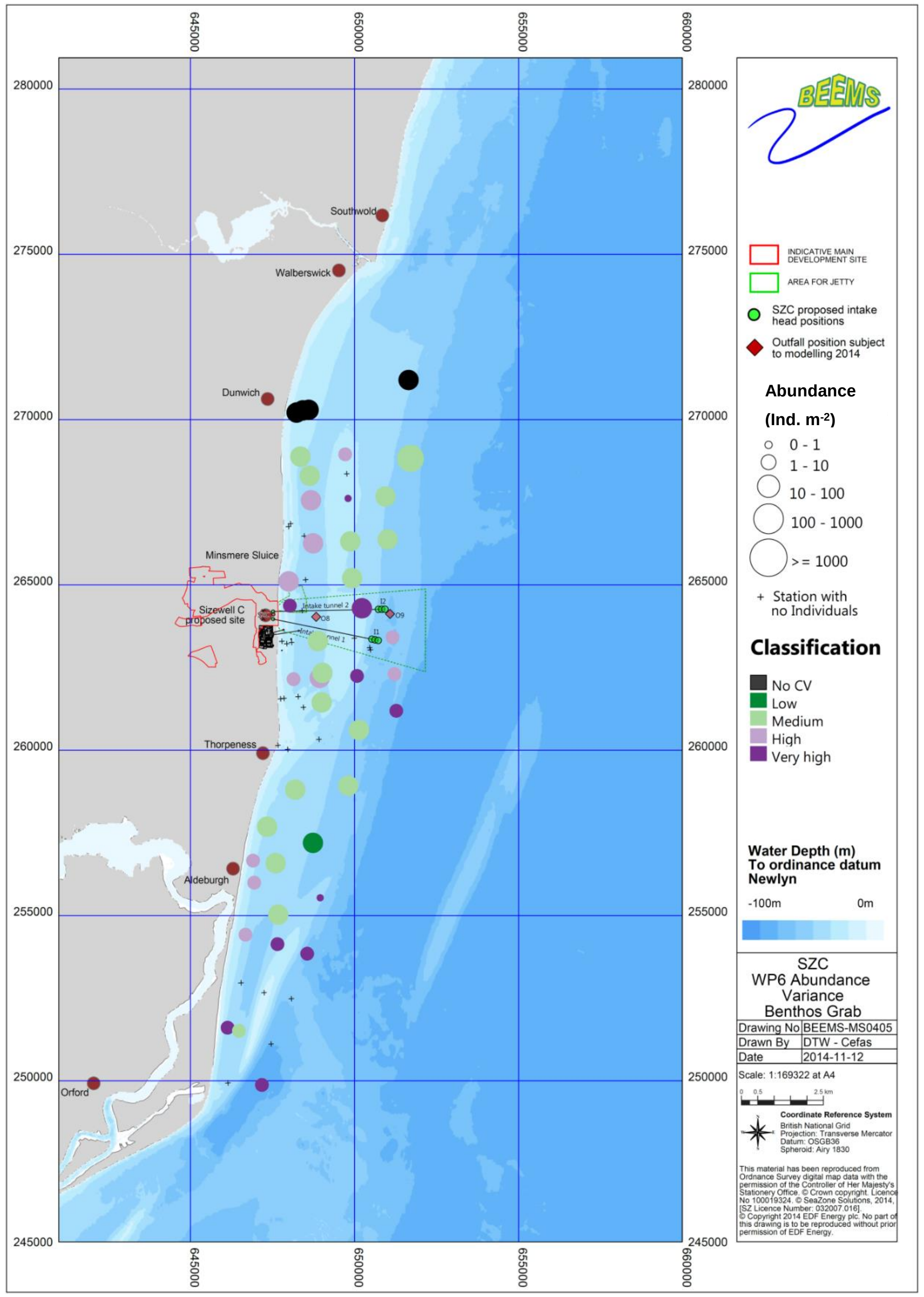

Figure 50: Spatial distribution of the polychaete *Nephtys hombergii* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples

3.5.6.2 Notomastus spp.

Notomastus spp, a bristleworm

Taxon of Ecological importance

Photo © Cefas

Notomastus spp. is found from the lower shore to deep sublittoral habitats, in clean or muddy sand. *Notomastus* had only been identified to the genus level during the monitoring programme at Sizewell because the taxonomy of the different species has not yet been resolved. It is recommended by the NMBAQC scheme[20] to limit the identification to the genus. Its abundance was relatively consistent in 2008 to 2010 (over the original sampling grid) and in 2011 (over the extended sampling grid) (Figure 51). Highest abundance values were recorded during the second quarter of the year (2008, 2009 and 2010) to the east and south of Sizewell-Dunwich Bank (Figure 6). The species is found across the area with highest abundance between Thorpeness and Minsmere (Figure 52).

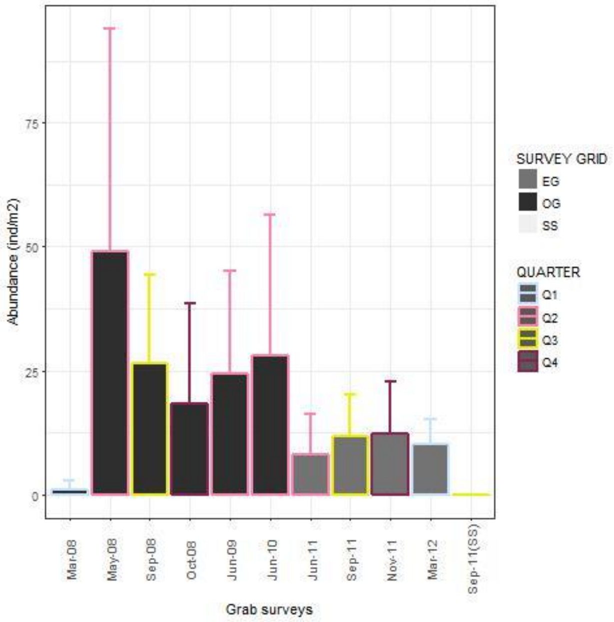

Figure 51: Temporal variation in the abundance (mean ± 95 % C.I.) of *Notomastus spp*. The abundance data (ind.m-2) were obtained from the grab samples (see section 3.5.2 for legend details).

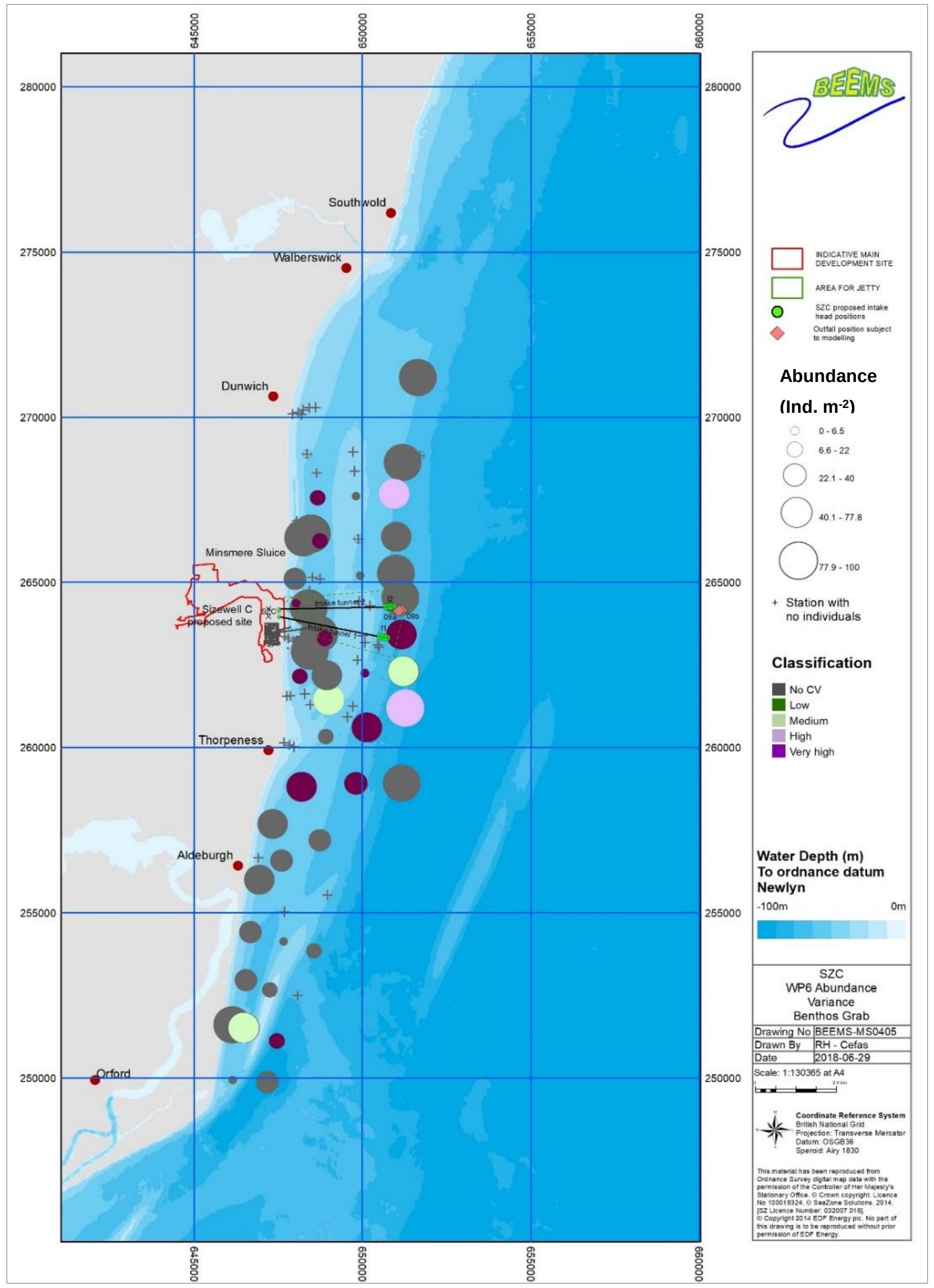

Figure 52: Spatial distribution of the polychaete *Notomastus spp* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

[20] The NMBAQC scheme provides a source of external Quality Assurance (QA) for laboratories engaged in the production of marine biological data (www.nmbaqcs.org/, consulted on the 26/06/2018).

3.5.6.3 *Scalibregma inflatum*

Scalibregma inflatum

Taxon of Ecological importance

Photo © Cefas

The polychaete *Scalibregma inflatum* is widespread around Britain, generally in sand or mud habitats (Snowden, 2008). It was present in very high abundance in the bay, with several thousand individuals per square metre and was most common in June (Figure 53). The species was found throughout the area and was more abundant further offshore around Sizewell and the northern part of the bay, though there was little consistency in its abundance over time at individual stations (Figure 54).

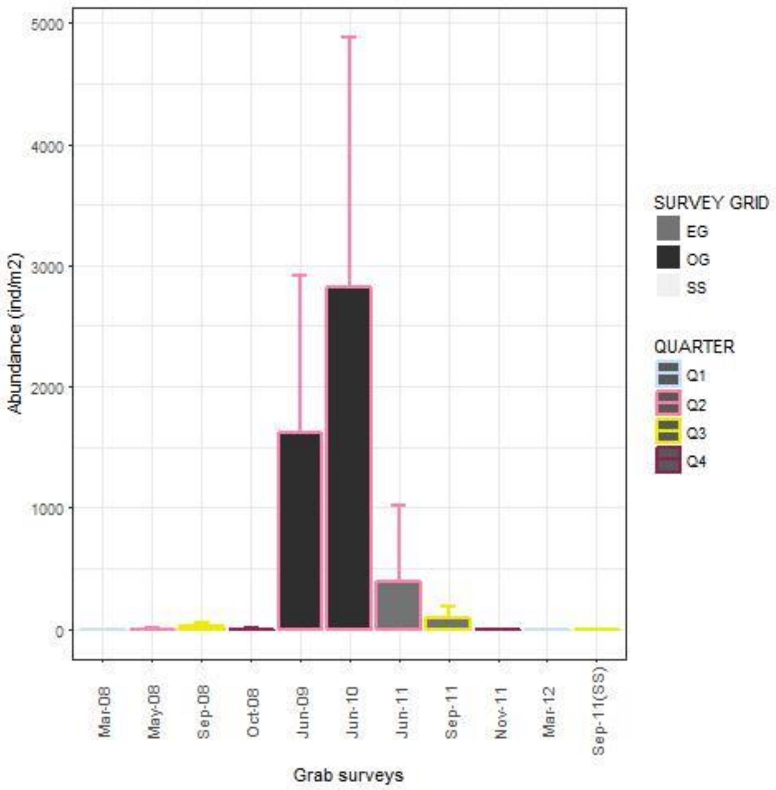

Figure 53: Temporal variation in the abundance (mean ± 95 % C.I.) of *Scalibregma inflatum*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

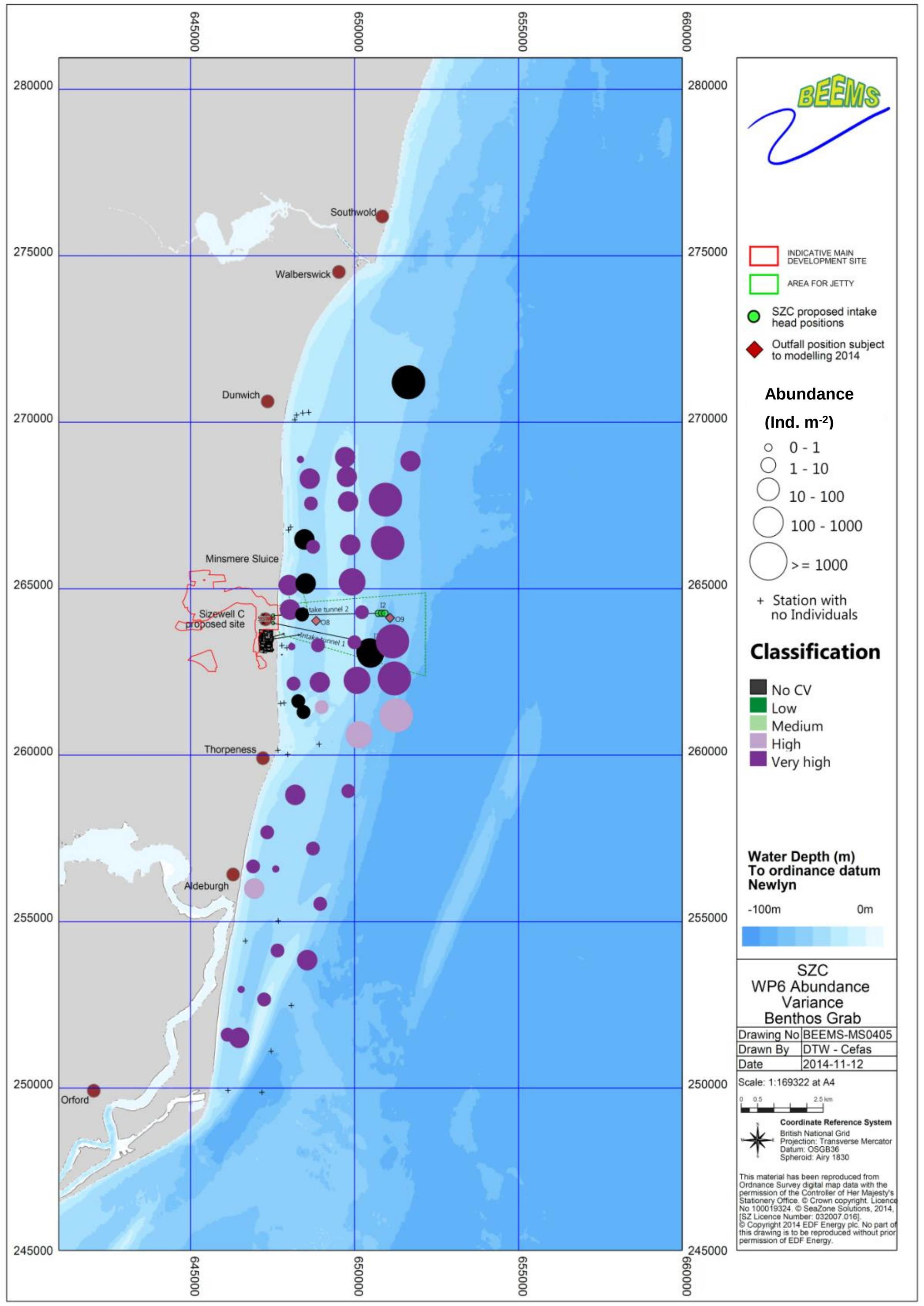

Figure 54: Spatial distribution of the polychaete *Scalibregma inflatum* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples.

3.5.6.4 Spiophanes bombyx

***Spiophanes bombyx*, a bristleworm**
Taxon of Ecological importance

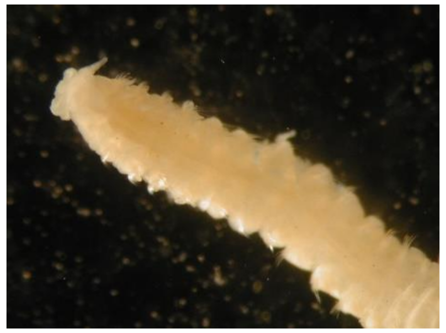

Photo © Cefas

The polychaete *Spiophanes bombyx* is found off most coasts of Britain and occurs in fine clean sand and sandy mud habitats (Ager, 2005). The highest abundances were found in 2011, though there was strong within-year variability with peaks of abundance in in 2011 but not in 2008 (Figure 55). The species was found throughout the area in variable abundances; abundance was moderately to very variable over time at individual stations (Figure 56).

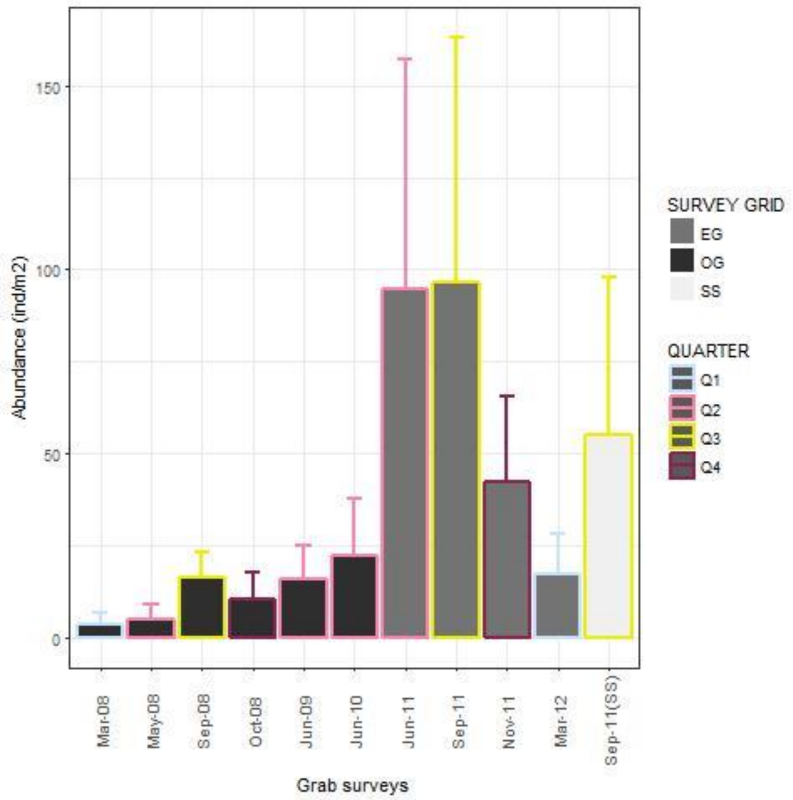

Figure 55: Temporal variation in the abundance (mean ± 95 % C.I.) of *Spiophanes bombyx*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

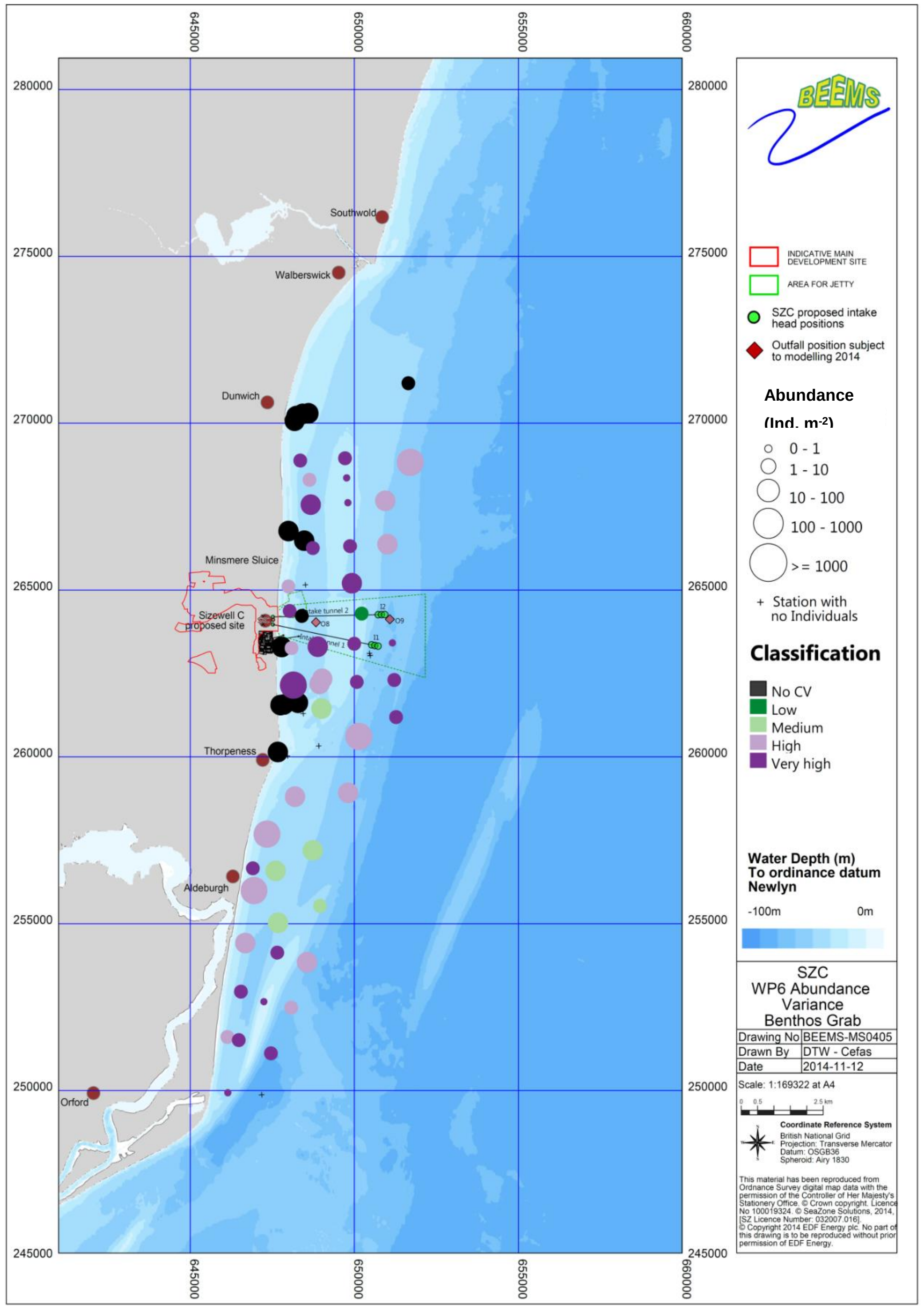

Figure 56: Spatial distribution of the polychaete *Spiophanes bombyx* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples

3.5.6.5 *Sabellaria spinulosa*

Sabellaria spinulosa, the ross worm

Taxon of conservation importance

Photo © Cefas

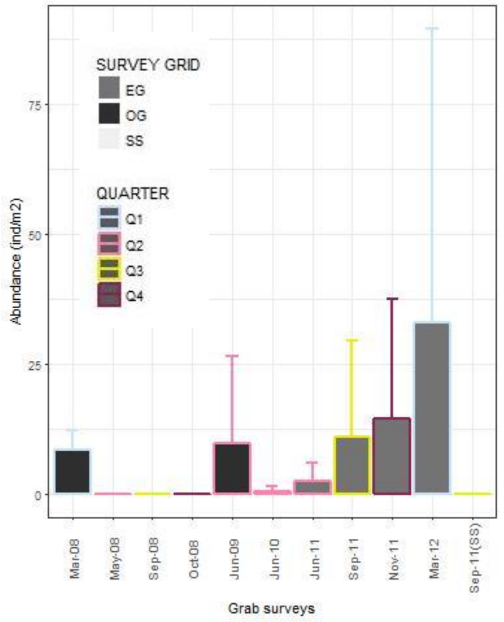

Figure 57: Temporal variation in the abundance (mean ± 95 % C.I.) of *Sabellaria spinulosa*. The abundance data (ind.m^{-2}) were obtained from the grab samples (see section 3.5.2 for legend details).

Sabellaria spinulosa, the Ross worm, is an ephemeral species found around British coasts on a range of hard substrata, in exposed areas where sand is available for tube construction (Jackson and Hiscock, 2008). The species can form dense aggregations of up to several thousand individuals per square metre. *Sabellaria* species, when present as reef structures, have high conservation value (Table 15) and so any reef habitat in the Greater Sizewell Bay would need specific consideration in the marine ecology impact assessment. The reefs are protected for their role in harbouring diversity. This is evidenced to a degree in the data from the BEEMS surveys; in the Greater Sizewell Bay, the assemblage clusters with *Sabellaria spinulosa* appeared to have a more diverse and homogeneous species composition that was quite different from the other clusters (see section 3.1.1).

Sabellaria was recovered from the grabs[21] at 22 BEEMS survey stations, but at only five of these were there more than 10 individuals over the whole survey series (one station north of Thorpeness and four stations around Orford Ness) and at only one were individuals present in sufficient abundance to indicate a potential aggregation (SZ126). Abundance was highly variable over time (Figure 57 and Figure 58) and most of the stations that had been characterised by a dominance of *S. spinulosa* at one point in time were characterised differently when revisited in later surveys. When present, the species was more likely to be found on the Coralline Crag exposures around Thorpeness and coarse sediments around Orford Ness than in other areas of the Greater Sizewell Bay (Figure 58 and see Figure 2).

The likelihood of *S. spinulosa* reef occurring within the bay was assessed in BEEMS Scientific Position Paper SPP079, using a combination of BEEMS and historical Sizewell data, information from a regional characterisation and information on the species' colonisation abilities. It is considered unlikely that there are any large temporally stable reef structures in the bay. The information from Thorpeness is sparse due to local logistical constraints but additional information provided by the imaging sonar survey approach is presented in Section 4.1. As part of the ongoing BEEMS programme additional monitoring had been undertaken on the Coralline Crag deposits to establish if reef structures of *S. spinulosa* are present (see section 4.1).

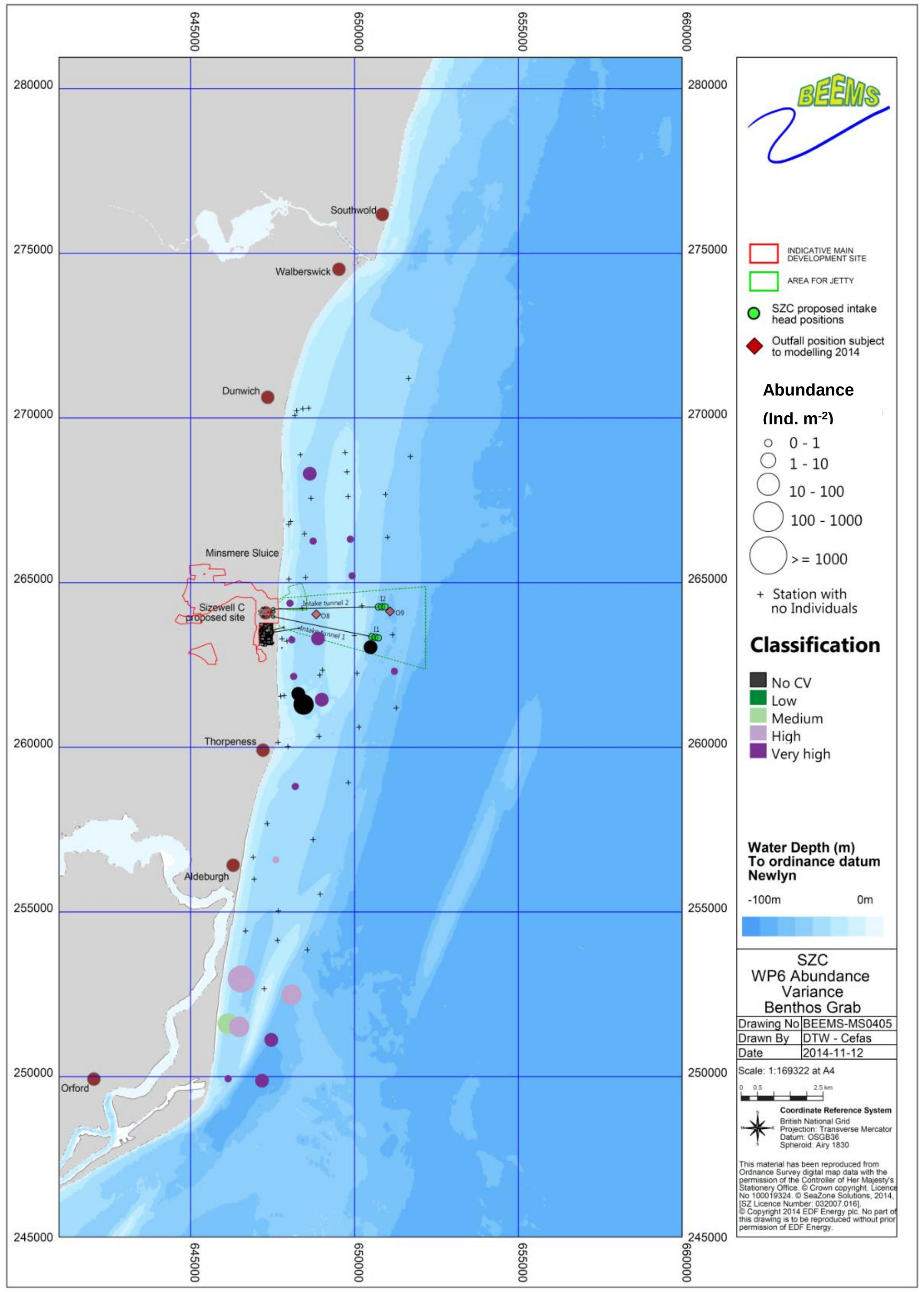

Figure 58: Spatial distribution of the polychaete *Sabellaria spinulosa* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.m^{-2}) were obtained from the grab samples.

[21] Fragments were obtained from the beam trawls in 2008 and 2011.

3.5.7 Echinoderms

3.5.7.1 *Ophiura ophiura*

Ophiura ophiura, a serpent star

Taxon of ecological importance

Photo © Cefas

The brittle star *Ophiura ophiura* is widespread around the British Isles and generally found in sand and muddy sand (Ruiz, 2008). It was abundant in the Greater Sizewell Bay, particularly so in March and September 2008 and in June 2011, though there were no seasonal or inter-annual patterns to its abundance (Figure 59). It was distributed across most of the bay, though largely absent from the southernmost section around Aldeburgh to Orford Ness; it was also inconsistently encountered over time at individual stations (Figure 60).

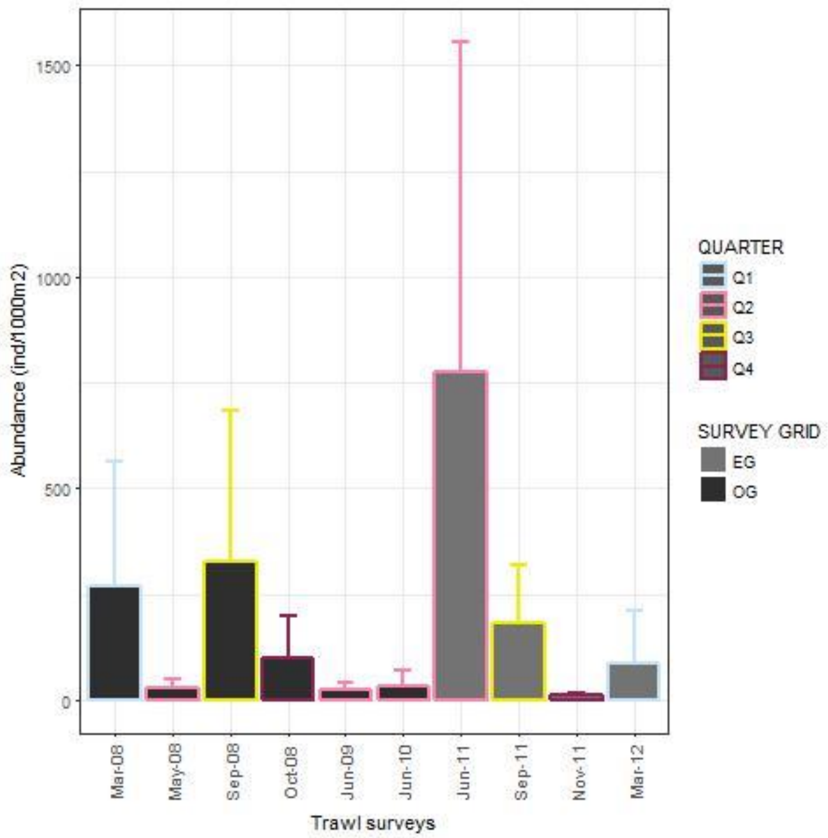

Figure 59: Temporal variation in the abundance (mean ± 95 % C.I.) of *Ophiura ophiura*. The abundance data (ind.m^{-2}) were obtained from the grab samples. The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples (see section 3.5.2 for legend details).

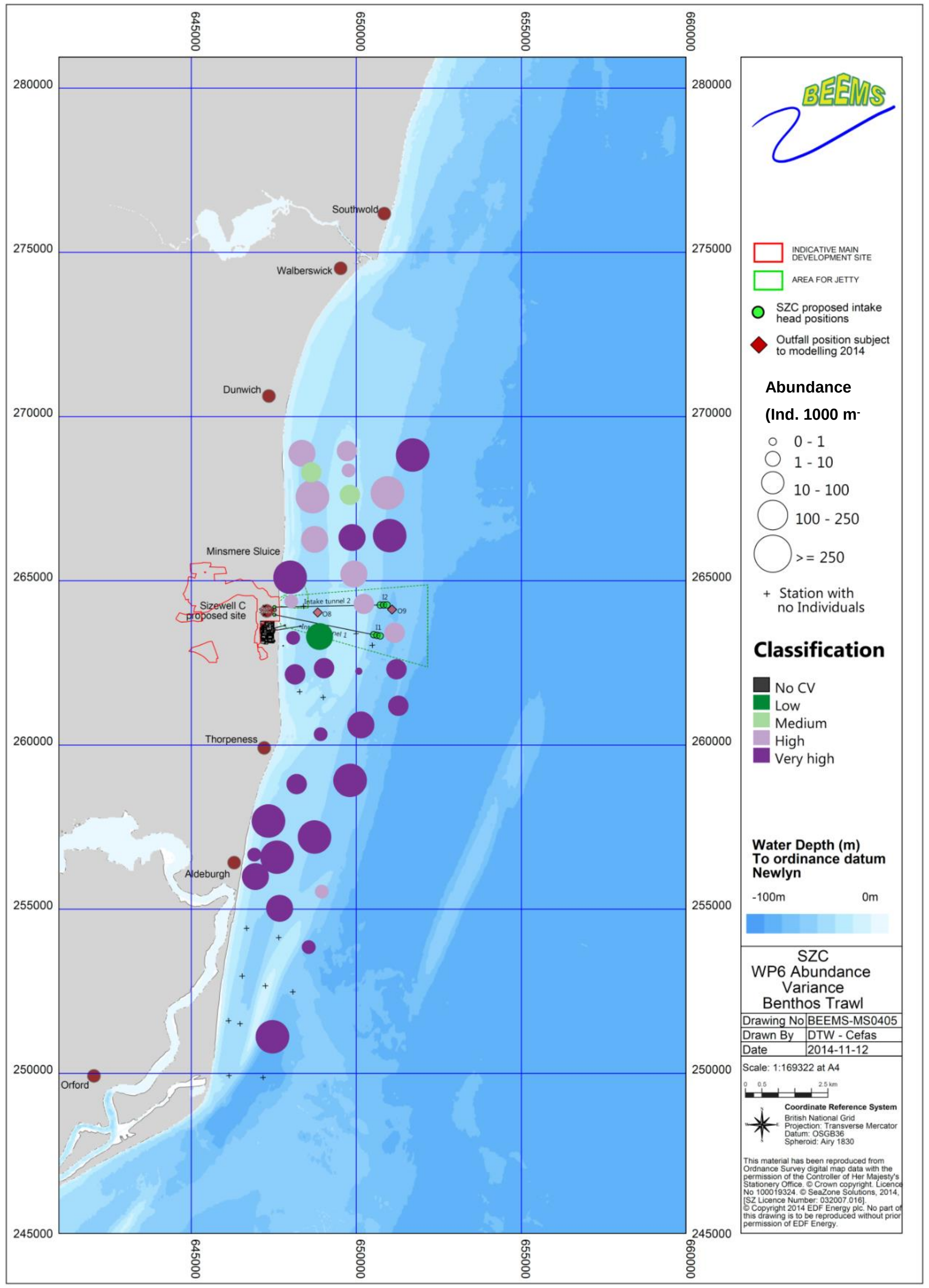

Figure 60: Spatial distribution of the ophiuroid *Ophiura ophiura* in the Greater Sizewell Bay (mean abundance per station). The coefficient of variation (CV) represents the degree of variability of the mean abundance between the sampling periods (2008 and 2012). The abundance data (ind.1000 m^{-2}) were obtained from the trawl samples.

4 Potential Habitats of conservation interest

4.1 The Coralline crag

The Sizewell-Dunwich Bank is a sandbank connected to the headland at Thorpeness by a series of erosion-resistant ridges (or outcrops) of cemented sedimentary material known as Coralline Crag deposits (BEEMS Technical Report TR105). These Pliocene Coralline Crag ridges are formed of bryozoan and mollusc microfossil debris as well as sand and can be several hundreds of metres long, tens of metres wide, and protrude 1-2 m from the surrounding seabed (BEEMS Technical Reports TR087 and TR475; Lees 1983). This hard substrate habitat, sometimes overlain with an ephemeral sand veneer, is locally unusual amongst the sands and gravels of the Greater Sizewell Bay (BEEMS Technical Report TR087 Ed3). The Coralline Crag has been recognised as a hard core that limits the degree to which the Sizewell-Dunwich Bank can move over time (BEEMS Technical Report TR058).

There is little information available on the ecology of the crag deposits. Surveying has proven difficult due to water turbidity and the nature of the substrate. The BEEMS beam trawl and grab surveys have achieved varying degrees of success, mostly providing occasional records on distribution and abundance. Indeed, *Sabellaria spinulosa* has been recorded at two grab sampling locations in the Greater Sizewell Bay, including off Sizewell on the Coralline Crag deposits feature and in the South of the area (Appendix C.6 and Figure 6). *Sabellaria* species, when present as reef structures, are protected under the EU Habitats Directive (92/43/EEC).

Various sources assert that *S. spinulosa* requires hard substratum upon which to settle and become established (Holt *et al.,* 1998; Jones *et al.,* 2000; Jackson and Hiscock 2008), however *S. spinulosa* reefs have been recorded in association with large mobile sandbanks (e.g. George and Warwick 1985). It has been hypothesised that settlement is enhanced at the boundaries of rock aggregations, as the recirculation in such areas increases settlement due to the deposition of cells by eddies in the water (Simmons *et al*., 2005). Based on these factors it was hypothesised that if present, *S. spinulosa* reefs would most likely be found on, or at the fringes, of the hard-Coralline Crag deposits (BEEMS Scientific Position Paper SPP079).

Beam trawl and grab gears are not particularly effective for surveying bedrock so other techniques were trialled such as the use of a freshwater lens drop-down camera during surveys in 2012 which failed to produce usable images due to water turbulence and turbidity. An innovative technique was recently trialled to gain further information on the presence of the species in the Thorpeness area using a high-resolution imaging sonar – the ARIS camera. A series of surveys covered two areas of interest: the inshore Coralline Crag outcrops that are directly off Thorpeness and the offshore Coralline Crag outcrops seaward of the Sizewell-Dunwich Bank (BEEMS Technical report TR473 and BEEMS Technical report TR512). For ease of description the two will be referred as “inshore” and “offshore” Crag respectively (Figure 61).

- Three surveys were carried out on the inshore Coralline Crag between 2016 and 2018 using an ARIS 3000 acoustic imaging camera (BEEMS Technical Report TR473). An additional multibeam echosounder (MBES) survey was completed in September 2018 to achieve comprehensive benthic surface data for the extent of the Coralline Crag habitat. Acoustic imaging survey identified 33 locations where reef-like *S. spinulosa* colonies were present (Figure 61 and Figure 62). These structures were present in all surveys, spanning a period of 32 months, suggesting temporal persistence. Results from semi-automated multibeam data segmentation and classification indicated *S. spinulosa* reef structures are likely to be present upon and around the inshore Coralline Crag outcrops. Evidences were considered insufficient to conclude whether the reef structures met the criteria to be classed as Annex I Reef habitat (Gubbay 2007). However, on the balance of evidence and based on the temporal persistence of the *S. spinulosa* structures, it is likely that biogenic reef habitats exist on the inshore Coralline Crag. The indistinct boundaries between *Sabellaria* patches presents difficulties in determining spatial extent and accurate quantification is not feasible. However, predictive mapping estimated approximately 28ha within the study area as having a high probability of supporting *S. spinulosa* with a further 24.5ha of habitat classified as having moderate probability of supporting *S. spinulosa* (BEEMS Technical Report TR473).

- A survey combining bathymetric (MEBS), sidescan sonar and ground-truthing with the ARIS camera was undertaken in August 2019 at the offshore Coralline Crag (BEEMS Technical report TR512). *S. spinulosa* reef structure were observed across the site and the acoustic imaging survey identified 26 locations where reef-like *S. spinulosa* colonies were present. Results from sidescan sonar interpretation and classification indicated *S. spinulosa* reef structures are likely to be present in hard substrate areas where the Coralline Crag bedrock is exposed, which is also where presence of *S. spinulosa* was confirmed with acoustic camera observation (Figure 61). Again, on the balance of evidence, it is likely that biogenic reef habitat (Annex I reef) exists on the offshore Coralline Crag. Whilst acoustic data acquisition cannot definitively confirm the presence of *S. spinulosa* on the balance of evidence, it is likely that biogenic reef habitat exists on the offshore Coralline Crag. Estimates obtained from sidescan sonar manual mapping showed a total coverage of approximately 18.5ha of reef

A precautionary stance was recommended where evidence gaps meant quantification of the extent of the reef habitat was not possible (BEEMS Technical report TR473 and BEEMS Technical report TR512).

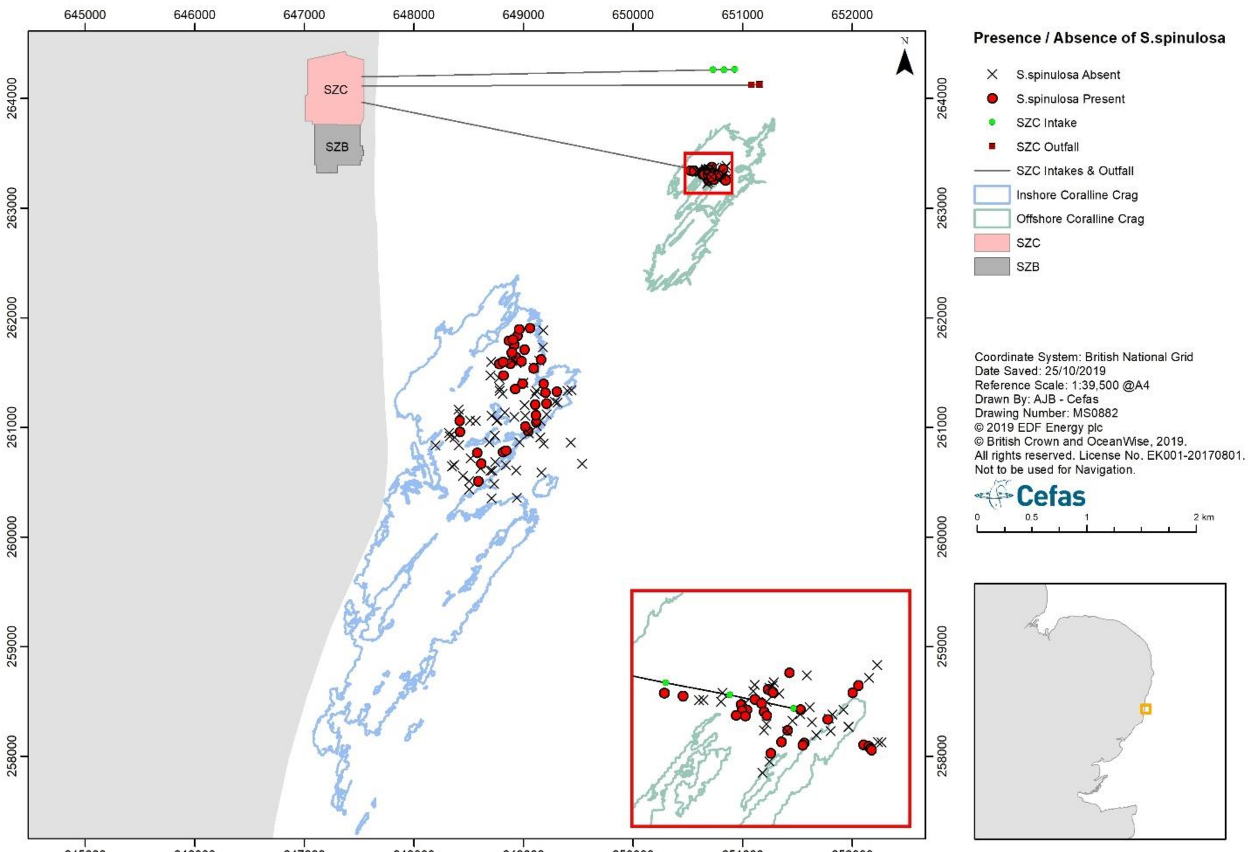

Figure 61:Location of ARIS sampling stations at the inshore and offshore Coralline Crag in the GSB. *Sabellaria spinulosa* was identified from the acoustic image footage at both sites (red points).

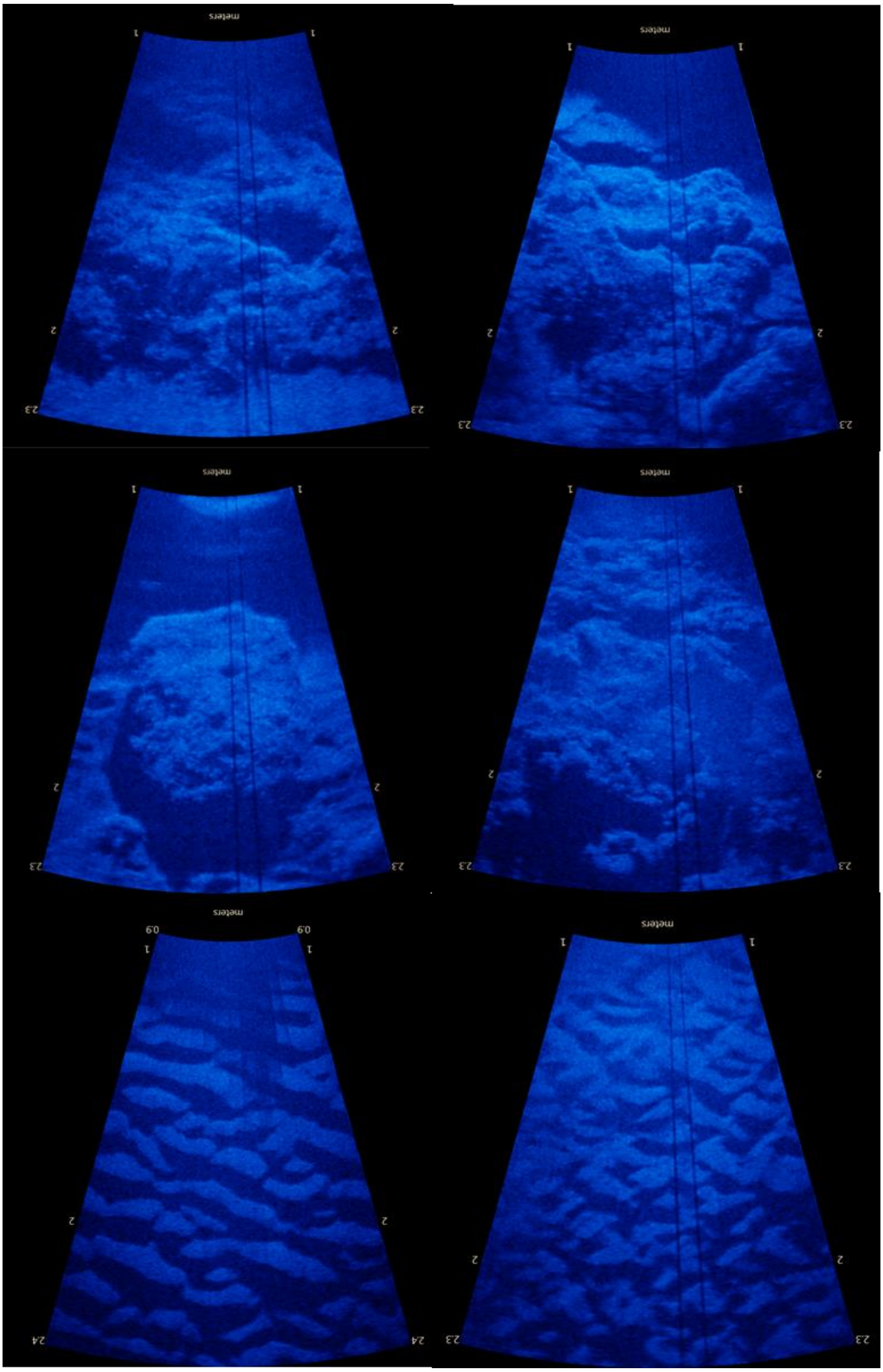

Figure 62: Images extracted from acoustic imaging survey footage recorded during surveys off the coast of Thorpeness, Suffolk during June 2016.
The top four images show possible *Sabellaria spinulosa* aggregations on coralline crag deposits and the two bottom images show sandy areas.

4.2 Sizewell-Dunwich Bank (sandbank)

Sandbanks in offshore water are designated as Annex I Habitat under the Habitats Directive: "*Annex I sandbanks slightly covered by seawater all the time*" occur where areas of sand form distinct elevated topographic features which are predominantly surrounded by deeper water and where the top of the sandbank is in less than 20 metres water depth (EUR28, 2013). Sandbanks slightly covered by water all time are protected for their conservation value as they enhance levels of primary and secondary productivity on or around the sandbank"[22]. Indeed, it has been shown that various fish species use sandbanks as feeding and nursery grounds; making the conservation of sandbanks important to the fishing industry.

Section 3.2 of this report clearly shows that the distribution of the most abundant taxa is affected indirectly by the morphological features of the seabed in the Greater Sizewell Bay. The Sizewell-Dunwich Bank and the Aldeburgh Ridge act as large-scale forms of coastal defense, forcing waves greater than a certain height to break and dissipate most of their energy offshore rather than on the beach face. The bank affects the propagation of the waves to the coast as they not only reduce the total energy arriving at the coast, but they have also been shown to alter the wave spectrum, filtering out longer storm waves that are more likely to break on the bank. Indeed, the wave refraction around banks has been identified as complex, but modelling efforts do show that bank reconfiguration, or removal, significantly alters patterns in alongshore sediment transport and erosion/accretion (BEEMS Technical Report TR058) and therefore affect the distribution of the benthic macrofauna living in the sediment (infauna) and at the surface of the sediment (epibenthic fauna).

The benthic infauna living on the sandbank itself shows low taxa richness and low abundances, as well as a low level of variability (section 3.2.1). However, pulses of abundance, showing an important increase in secondary production over the spring and summer months, have been recorded in the trough and on the flanks of the sandbank. Seasonally high abundance suggests these areas may potentially be important feeding grounds for higher trophic levels. The Sizewell-Dunwich Bank is not an Annex I designated habitat, however, the feature appears to have an important ecological role in the benthic communities of the Greater Sizewell Bay.

[22] JNCC description for the Annex I Sandbanks habitat (http://jncc.defra.gov.uk/page-1452, consulted on the 26/06/2018).

5 Notes on the future baseline

The main driver of change that will affect marine benthic communities and costal habitats in the North Sea, in the absence of planned development over the long term, is climate change. Four major sources of change were identified of Greater Sizewell Bay environment: (i) the potential shifts in distribution of benthic taxa in the southern North-Sea due to global warming; (ii) the possible change in hydrodynamics across the Greater Sizewell Bay due to sea-level rise affecting the sandbank dynamics, (iii) the effect of the ocean acidification on the benthic taxa and (iv) the effect of the coastal-squeeze on onshore features at Sizewell.

All data collected between 2008 and 2017 on benthic features (see section 1.4) are part of baseline dataset against which the effect of the SZC development will be assessed. The SZC construction and operational activities are expected to last in excess of 60 years. Therefore, it is important to consider the possible natural shifts in future baseline conditions due to natural or man-made processes, in the absence of a planned development, in order to predict more accurately the likely significant effects of the construction and operation activities at SZC. The 60-year operational life-cycle of the development suggests that a contemporary baseline is not necessarily appropriate for assessments for the entire operational period. Extrapolation of current baselines to predict future scenarios is challenging, particularly in relation to natural variability, changes in future anthropogenic pressures and climate change. The future baseline is a theoretical situation that would exist in the absence of the development. This section aims to outline the likely evolution of the baseline environment without the proposed development at SZC in terms of natural changes from the current described baseline scenario.

The main driver of change that will affect marine benthic communities and coastal habitats in the North Sea in absence of planned development over the long term is climate change (Hiddink *et al.,* 2015; Weinert *et al.,* 2016). Benthic communities are likely to respond to climate change following a multitude of direct and indirect impacts, but four major sources of change have been identified (Birchenough *et al.,* 2015). These impacts are briefly discussed in the context of Greater Sizewell Bay environment:

- **Global climate warming** is considered to be one of the key drivers likely to cause distributional shifts of species by changing environmental conditions and habitat suitability (Parmesan and Yohe, 2003). Forecasts up to 2099 for the bottom seawater temperature increase in the North Sea projected a range between 0.15°C offshore and 5.4°C in coastal regions (Weinert *et al.,* 2016). Changes in species distribution can be predicted using ecological niche models, a correlative approach exploring the relationship between full spatial coverage of environmental data (e.g. bathymetry, temperature and surface sediments) to explain, and then predict, the patterns in species distribution (Reiss *et al.,* 2011, Hiddink *et al.,* 2015, Weinert *et al.,* 2016). Studies on a selection of North Sea benthic taxa showed that the effect of global climate warming over the next 100 years will not induce biodiversity losses. However, warming is predicted to induce distributional shifts with taxa moving northward as they follow shifts in their thermal niche (Hiddink *et al.,* 2015; Weinert *et al.,* 2016). Weinert *et al.,* 2016 suggest this may results in a compression of the distribution range and therefore a loss in habitat for the southern North Sea benthic macrofauna as many of the southern taxa are limited in their distribution by the 50 m depth contour which would act as an environmental boundary and limit further northward migration in the face of global warming. The authors also indicate that this is likely to induce significant changes in the benthic community composition in the southern and coastal areas of the North Sea due to a decrease of native taxa and a range expansion of the southern species and non-native species.
- **Hydrodynamics** influence the distribution and the functioning of the benthic communities via the transport and dispersal of larvae, via mortality rates due to storm events or by affecting the transport pathway of the primary and secondary production between the seabed and the water column affecting recruitment and food-webs (Birchenough *et al.,* 2015). It was shown in section 3.2 that the presence of the sandbanks in the Greater Sizewell Bay influence the distribution of benthic taxa in the subtidal area. The potential impact of climate change, and more specifically of predicted rising sea levels on sandbank dynamics has been considered in the BEEMS Technical Report TR058. Indeed, the impact of the sea rising on the coast is controlled by the actual sea level rise and future bank elevation. BEEMS Technical Report TR058 states that in a system with sufficient sediment supply, the sea level rise in the coming

100 years (36 cm; IPCC, 2007) is anticipated to have a minor influence on dissipation of wave energy and the inshore wave climate. The shoreline and the onshore and offshore habitats will become affected only if significantly larger changes in sea level occur at the same time as an absence of sediment supply which will see a larger rise in inshore wave heights and potential for shoreline retreat. An increase in storm frequency, associated with storm surges could therefore impact the bank elevation in the medium term (BEEMS Technical Report TR058). However global warming scenarios suggest only a weak increase of storm activity in the future (Birchenough *et al.,* 2015). Therefore, not enough is currently known to accurately forecast how climate change driven changes in hydrodynamics will influence the seabed features of the Greater Sizewell Bay including the sandbanks.

- Rising sea levels have the potential to induce **coastal-squeeze effects** across the UK with beaches becoming increasingly trapped between human development and coastal defences on land (Birchenough *et al.,* 2015). Since the mid-70s, a sea level rise of 4.3 mm. y^{-1} has been recorded by tidal gauges in Suffolk, and since the early 90s the rate was estimated at 3.11 ± 0.6 mm. y^{-1} (satellite altimetry). Predictions suggest an increasing rate reaching 15 mm.y^{-1} for 2085-2115 (Brook and Spencer, 2012). Currently, the impact of sea-level rise on the Suffolk coast induces shoreline retreat and release of sediment from the soft cliff in the area between Lowestoft and Southwold (Brooks and Spencer, 2012) whilst the beaches along the Greater Sizewell Bay alternates trends of erosion (Thorpeness, Sizewell, Dunwich) and accretion (Orfordness, North Thorpeness North, Sizewell North) on the shore line associated to the circulation of the sediment on the various littoral cells (Environment Agency, 2011). Brook and Spencer (2012) suggested that the Sizewell-Dunwich sandbank is likely to protect the coastline in the Greater Sizewell Bay from major changes by attenuating impact of wave energy over the long term. The sandbank is likely to maintain itself, or even possibly gain in height by the provision of sediment from the cliff erosion. This assessment is subject to caution as results are based on model output that can be revised with more recent rates of coastal retreat or more accurate geomorphic settings. The coastal saline lagoons present in Minsmere and Walberswick marshes have similarly been flagged as a vulnerable habitat that could be impacted by sea-level rise (Spencer and Brook, 2012). The retreat of the coastline in the Minsmere-Walsberwick area is expected to reduce and potentially lead to the loss of the saline lagoon habitat in the area within the next 80 to 220 years. Coastal recession is expected to induce a displacement of the lagoon barrier position and hence induce changes in lagoon water quality, with fundamental ecological changes in the habitat characteristics and species composition. The authors propose that the lagoon can only be preserved by the creation of new lagoon areas to compensate for the loss and keep the conservation target of the saline lagoon in a 'favourable status'.
- **Ocean acidification** is a consequence of climate change associated with the unprecedented increasing rate of CO_2 partial pressure in the atmosphere due to anthropogenic activities. Elevated atmospheric CO_2 leads to enhanced uptake by the oceans resulting in a decrease in ocean surface water pH (Caldeira *et al.,* 2003). Some evidence suggests that certain benthic groups are sensitive to a change in pH and associated seawater chemistry. However, there is a large degree of species-specific effects due to ocean acidification which can depend on calcified structure. For example, echinoderm groups show less tolerance to pH change than molluscs or crustacean groups (Birchenough *et al.,* 2015; Zittier *et al.,* 2015; Wittman and Pörtner 2013). Surface seawater monitoring conducted in the North Sea have shown changes in pH in coastal sites in the last 10 years, and the projection over the next 50 years suggests a decrease between 0.1 and 0.5 pH units depending on the level of atmospheric CO_2, 500ppm or 1000ppm respectively for the median or worst IPCC scenario (Blackford and Gilbert, 2007; Birchenough *et al.,* 2017; IPCC, 2001). One study looked at the effect of ocean acidification on a typical North Sea species survival and distribution, *Mytilus edulis*, also identified as a key taxon in the Greater Sizewell Bay (section 3.5.3.5). The study showed that the population is likely to be highly resilient to decreases in pH in the seawater thanks to metabolic compensation mechanisms and that the thermal stress associated with global warming is more relevant to understanding the effects of climate change on the distribution and survival of the species (Zittier *et al.,* 2015). The effect of ocean acidification on the fitness of benthic organisms is, therefore, complex.

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Appendix A BEEMS Feeder Reports

A.1 Technical Reports

BEEMS Technical Report TR025. Impingement sampling for fish and crustaceans at Sizewell B nuclear power station, October 2008. Cefas, Lowestoft.

BEEMS Technical Report TR049. Sizewell: Potential for Identifying Sediment Sources and Sediment Transport Pathways on the central Suffolk Shoreline, Sizewell Bay. Cefas, Lowestoft.

BEEMS Technical Report TR058. Sizewell: Morphology of coastal sandbanks and impacts to adjacent shorelines. Cefas, Lowestoft.

BEEMS Technical Report TR069. Sizewell nearshore communities: Results of the 2 m beam trawl and plankton surveys 2008–2010. Edition 3. Cefas, Lowestoft.

BEEMS Technical Report TR074. Sizewell nearshore communities: Results of the day grab surveys 2008−2009, Edition 2. Cefas, Lowestoft.

BEEMS Technical report TR080. Comprehensive impingement monitoring programme 2009/2010 at Sizewell B: First quarterly report. Cefas, Lowestoft.

BEEMS Technical Report TR087. Sizewell seabed habitat mapping: Interpretation of swath bathymetry, side-scan sonar and ground-truthing results - Edition 3. Cefas, Lowestoft.

BEEMS Technical Report TR096. Comprehensive impingement monitoring programme 2009/2010 at Sizewell B: Third quarterly report. Cefas, Lowestoft.

BEEMS Technical Report TR105. Sizewell Physical Science with respect to Coastal Geo-Hazard, 2012. Cefas, Lowestoft.

BEEMS Technical Report TR107. Sizewell: Seabed Sediment Characteristics, Bedforms and Sediment Transport Pathways in the Sizewell Area Report. Cefas, Lowestoft.

BEEMS Technical Report TR120. SZ Comprehensive impingement monitoring programme 2009/10: Final report. Cefas, Lowestoft.

BEEMS Technical Report TR123. Review of commercial and recreational fisheries activity in the vicinity of Sizewell power station. Cefas, Lowestoft.

BEEMS Technical Report TR133. Sizewell Thermal Plume Modelling: Stage 2 - Modelling Results. Cefas, Lowestoft.

BEEMS Technical Report TR196. SZ Comprehensive impingement monitoring programme II (2010/11): Final report. Cefas, Lowestoft.

BEEMS Technical Report TR201. Sizewell nearshore communities: Results of the 2 m beam trawl and day grab surveys 2011−2012. Edition 2. Cefas, Lowestoft.

BEEMS Technical Report TR207. Comprehensive impingement monitoring programme III at Sizewell B power station: Year 3 interim report, 2011-2012. Cefas, Lowestoft.

BEEMS Technical Report TR215. Comprehensive impingement monitoring programme III at Sizewell B power station: Year 3 final report 2011 – 2012. Cefas, Lowestoft.

BEEMS Technical Report TR237. The intertidal assemblages of Sizewell and its surrounding coasts. Cefas, Lowestoft.

BEEMS Technical Report TR238. Benthic assemblages of the Sizewell shallow subtidal zone. Cefas, Lowestoft.

BEEMS Technical Report TR270. Comprehensive impingement monitoring programme IV at Sizewell B power station: Year 4 final report 2012 – 2013. Cefas, Lowestoft.

BEEMS Technical Report TR314. Sizewell supplementary water quality monitoring data 2014/2015. Cefas, Lowestoft.

BEEMS Technical Reports TR315. Sizewell Zooplankton Synthesis 2008-12. Cefas, Lowestoft.

BEEMS Technical Report TR338. Sizewell Nearshore Communities: Results of the 2 m Beam Trawl and Day Grab Surveys 2014, Edition 3. Cefas, Lowestoft

BEEMS Technical Report TR339. Sizewell Comprehensive Impingement Monitoring Programme 2014 – 2017. Cefas, Lowestoft.

BEEMS Technical Report TR354. Sizewell Brackish ponds salinity monitoring. Cefas, Lowestoft.

BEEMS Technical Report TR473. Coralline Crag Characterisation. Cefas, Lowestoft.

BEEMS Technical Report TR512. Sizewell C offshore acoustic *Sabellaria spinulosa* survey: August 2019. Cefas, Lowestoft.

A.2 Characterisation reports

BEEMS Technical Reports TR315. Sizewell zooplankton synthesis 2008-2012. Cefas. Lowestoft.

BEEMS Technical Reports TR324. Sizewell marine mammal characterisation. Cefas. Lowestoft.

BEEMS Technical Reports TR345 Sizewell Characterisation Report – Fish. Cefas. Lowestoft.

BEEMS Technical Reports TR346 Sizewell Characterisation Report- Phytoplankton. Cefas. Lowestoft.

A.3 Science Position Papers

BEEMS Scientific Position Paper SPP079. Distribution and Temporal Continuity of Sabellaria Spinulosa at Sizewell. Cefas, Lowestoft.

Appendix B Detailed sampling programme

B.1 Map of the subtidal sampling station

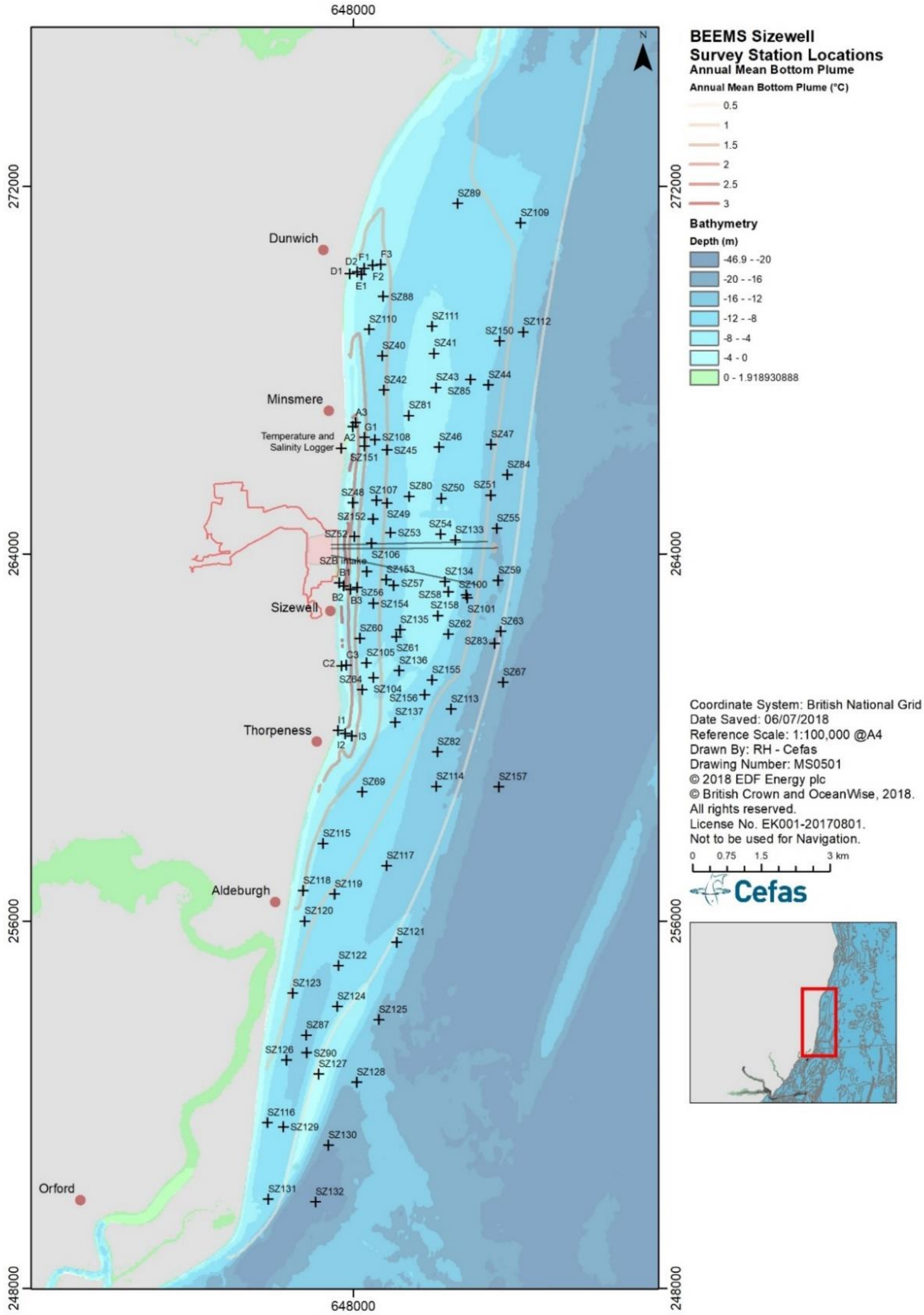

Figure 63: Map of the subtidal sampling stations in the Greater Sizewell Bay.

B.2 Grab surveys (infauna)

Table 16: Number of replicate grab samples for each station and each survey.
Most of the samples were done with a day grab, at the exception of: * sampled with a Hamon grab and ** samples with a Van Veen grab.

Stations	SZ40	SZ41	SZ42	SZ43	SZ44	SZ45	SZ46	SZ47	SZ48	SZ49	SZ50	SZ51	SZ52	SZ53	SZ54	SZ55	SZ56	SZ57	SZ58	SZ59	SZ60	SZ61	SZ62	SZ63	SZ67	SZ69
SIZE108	3		3	3		3	3		3		3		3				3	3			3					
SIZE208	3	3	3	3	3	3	3	3	3		3		3				3	3		2	3		3	3	3	3
SIZE308	3	2	3	3	3	2	3	3	3		3		3				3	3		3	3	3	3	3	3	3
SIZE408	3	1	3	3	3	3	3	3	2		2		3				3	3		2	3	3	3	3	3	3
SIZE209	3	3	3	3	3	3	3	3	3		3		3				3	3		3	3	3	3	3	3	3
SIZE510	3	3	3	3	3	3	3	3	3		3		3				3	3		3	3	3	3	3	3	3
SIZE511			3	3	3	3					3		3				3	3			3		3	3		3
SIZE611			3	3	3	3					3		3				3	3			3		3	3		3
SIZE711			3	3	3	3					3/3*		3				3	3			3		3	3		3
SIZE112			3	3	3	3					3/3*		2				3	3			3		3	3		3
SIZE814				1		1	1	1	1	1	1	1	1	1	1	1			1	1	1		1	1		1

Stations	SZ110	SZ111	SZ112	SZ113	SZ114	SZ115	SZ116	SZ117	SZ118	SZ119	SZ120	SZ121	SZ122	SZ123	SZ124	SZ125	SZ126	SZ127	SZ128	SZ129	SZ130	SZ131	SZ132	SZ133	SZ134	SZ135	SZ136	SZ137
SIZE511	3	3	3	3	3	3		3	3	3	3	2	3	3	3	3	3	3		3		3		3	2	3	3	3
SIZE611	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	2	3	3	3
SIZE711	3	2	3/3*	3/3*	3	3	3*	3	3	3/3*	3	3	3	3	3	3	3*	3	3*	3	3*	2	3*	2	2	3	3	3
SIZE112	3	3	3/3*	3/3*	3	3	3*	3	3	3/3*	3	3	3	3	3	3	3*	3	3*	3	3*	3	3*	3	3	3	3	3
SIZE814	1	1	1	1	1			1			1		1	1												1		1

Stations	SZ53	SZ54	SZ55	SZ100	SZ101	SZ104	SZ105	SZ106	SZ107	SZ108	SZ109	SZ150	SZ151	SZ152	SZ153	SZ154	SZ155	SZ156	SZ157	SZ158
SIZE209				1	1	1	1	1	1	1	1									
SIZE814	1	1	1									1	1	1	1	1	1	1	1	1

Stations	A2	A3	B1	B2	B3	C2	C3	D1	D2	E1	F1	F2	F3	G1	I1	I2	I3
SSUB111	1**	2**	1**	3**	3**	3**	3**	1**	1**	3**	3**	3**	3**	1**	3**	3**	3**

B.3 2 m-beam Trawl survey (epifauna)

Table 17: Number of replicate 2 m-beam trawl samples for each station and each survey.

Stations	SZ40	SZ41	SZ42	SZ43	SZ44	SZ45	SZ46	SZ47	SZ48	SZ50	SZ52	SZ53	SZ54	SZ55	SZ56	SZ57	SZ59	SZ60	SZ61	SZ62	SZ63	SZ64	SZ67	SZ69	SZ83	SZ84	SZ89	SZ90
SIZE108	1		1	1	1	1	1		1	1	1				1	1	1	1		1	1		1	1				
SIZE208	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1		1	1		1					
SIZE308	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1		1	1				
SIZE408	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1		1	1				
SIZE209	1	1	1	1	1	1	1	1	1	1	1				1		1	1		1	1		1	1				
SIZE510	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1		1	1		1	1				
SIZE511			1	1	1	1				1	1				1	1		1		1	1	1		1				
SIZE611			1	1	1	1				1	1				1	1		1		1	1			1				
SIZE711			1	1	1	1				1	1				1	1		1		1	1			1				
SIZE112			1	1	1	1				1	1				1	1		1		1	1			1				
SIZE814						1	1	1				1	1	1				1		1	1			1	1	1	1	1

Stations	SZ110	SZ111	SZ112	SZ113	SZ114	SZ115	SZ116	SZ117	SZ118	SZ119	SZ120	SZ121	SZ122	SZ123	SZ124	SZ125	SZ126	SZ127	SZ128	SZ129	SZ130	SZ131	SZ132	SZ133	SZ134	SZ135	SZ136	SZ137
SIZE511	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1
SIZE611	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SIZE711	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1
SIZE112	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SIZE814	1	1	1		1																					1		

Stations	SZ101	SZ103	SZ105	SZ106	SZ150	SZ151	SZ157
SIZE209	1	1	1	1			
SIZE814					1	1	1

B.4 Commercial Otter Trawl survey

Table 18: Number of replicate otter trawl samples for each station and each survey.

Stations	SZ80	SZ81	SZ82	SZ83	SZ84	SZ85	SZ87	SZ88	SZ89	SZ90	SZ92
SIZE108	1		1	1	1						
SIZE208	1	1	1	1	1						
SIZE308	1	1	1	1	1						
SIZE408	1	1	1	1	1	1					
SIZE209			1	1	1	1					
SIZE510			1	1	1	1					
SIZE511		1	1	1	1		1	1	1		
SIZE611		1	1	1	1	1	1	1	1	1	
SIZE711	1	1	1	1	1	1	1		1	1	
SIZE112			1	1	1	1	1			1	
SIZE814	1					1			1	1	1

B.5 Comprehensive impingement programme (CIMP)

Table 19: Number of surveys per month for each sampling year of the CIMP.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	0	3	4	3	3	3	4	4	1	0	7	4
2010	2	4	2	3	3	0	2	2	3	4	3	3
2011	5	2	2	2	2	2	2	3	0	3	3	2
2012	1	3	1	2	3	2	2	3	2	3	2	2
2013	2	2	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	3	2	2	3	2	1	0	0	0
2015	0	0	0	1	3	2	3	2	2	3	2	2
2016	2	3	2	0	0	2	2	2	3	2	3	2
2017	3	2	2	2	1	3	3	3	1	1	0	0

Appendix C Complete taxa list

C.1 Infauna

Table 20: List of infaunal Taxa present in the grab samples.

TAXA		Abundance		Weight		Occurrence (%)
		Total	Cum. %	Total	%	
NON-COLONIAL						
1	***Scalibregma inflatum***	34439	**42**	518.3	25.7	**56**
2	***Nucula nitidosa***	11336	**56**	487.2	24.2	**56**
3	***Ensis spp.***	9403	**68**	156.7	7.8	**48**
4	***Spiophanes bombyx***	2962	**72**	4.3	0.2	**73**
5	***Corophium volutator***	2824	**75**	10.6	0.5	**23**
6	***Nucula nucleus***	1963	**78**	149.3	7.4	**48**
7	***Nephtys hombergii***	1824	**80**	100.7	5.0	**53**
8	***Limecola balthica***	1597	**82**	25.0	1.2	**45**
9	*Barnea candida*	1307	83	81.8	4.1	10
10	***Notomastus spp.***	1161	**85**	37.9	1.9	**52**
11	***Mytilus edulis***	974	**86**	1.9	0.1	**53**
12	Arenicolidae	837	87	9.3	0.5	16
13	***Abra alba***	831	**88**	21.4	1.1	**52**
14	*Sabellaria spinulosa*	767	89	3.5	0.2	27
15	***Bathyporeia elegans***	753	**90**	0.6	0.0	**58**
16	*Dyopedos monacanthus*	579	91	0.4	0.0	22
17	*Nephtys cirrosa*	478	91	17.0	0.8	48
18	*Phoronis spp.*	409	92	3.2	0.2	25
19	Actiniaria	390	92	32.8	1.6	32
20	*Nephtys spp.*	364	93	0.6	0.0	59
21	*Lagis koreni*	346	93	21.3	1.1	33
22	*Scoloplos armiger*	345	94	2.3	0.1	53
23	*Lanice conchilega*	337	94	1.1	0.1	41
24	*Abra nitida*	318	94	4.7	0.2	24
25	*Nemertea spp.*	257	95	8.9	0.4	51
26	*Kurtiella bidentata*	223	95	0.7	0.0	28
27	*Ophiura ophiura*	208	95	35.6	1.8	36
28	*Hilbigneris gracilis*	175	95	0.9	0.0	31
29	*Diastylis rathkei*	155	96	1.4	0.1	40
30	*Magelona johnstoni*	154	96	0.4	0.0	35
31	*Eunereis longissima*	145	96	19.4	1.0	28
32	*Urothoe brevicornis*	140	96	0.4	0.0	24
33	*Mediomastus fragilis*	130	96	0.2	0.0	32
34	Ophiuridae	126	96	0.8	0.0	34
35	*Pygospio elegans*	124	97	0.1	0.0	20
36	*Anoplodactylus petiolatus*	111	97	0.0	0.0	19
37	*Spio martinensis*	111	97	0.1	0.0	28
38	Pholadidae	101	97	0.2	0.0	6
39	*Nephtys kersivalensis*	96	97	1.5	0.1	22
40	*Ophelia borealis*	96	97	4.5	0.2	25

41	*Amphipholis squamata*	89	97	0.2	0.0	15
42	*Dipolydora caulleryi*	81	97	0.1	0.0	5
43	*Spio armata*	76	98	0.2	0.0	23
44	*Nephtys caeca*	72	98	9.9	0.5	26
45	*Molgula manhattensis*	65	98	0.7	0.0	5
46	*Ampelisca spinipes*	63	98	0.8	0.0	8
47	*Echinocardium cordatum*	59	98	199.6	9.9	22
48	*Goniada maculata*	59	98	0.8	0.0	26
49	*Nototropis guttatus*	56	98	0.1	0.0	15
50	*Polycirrus spp.*	54	98	1.4	0.1	14
51	*Tellimya ferruginosa*	52	98	0.9	0.0	11
52	Asteroidea	51	98	0.2	0.0	8
53	Nematoda	48	98	0.0	0.0	18
54	*Magelona mirabilis*	47	98	0.2	0.0	15
55	*Pariambus typicus*	46	98	0.0	0.0	8
56	*Achelia echinata*	39	98	0.0	0.0	15
57	*Diastylis bradyi*	36	98	0.1	0.0	24
58	*Capitella spp.*	35	99	0.0	0.0	15
59	Polychaeta	35	99	3.4	0.2	19
60	Spatangoida	34	99	5.5	0.3	16
61	*Nototropis falcatus*	33	99	0.1	0.0	18
62	Jassa *spp.*	32	99	0.1	0.0	9
63	*Nymphon brevirostre*	30	99	0.1	0.0	11
64	*Pholoe inornata*	30	99	0.0	0.0	10
65	*Harmothoe impar*	29	99	0.6	0.0	13
66	*Pisidia longicornis*	29	99	0.1	0.0	17
67	*Aphelochaeta marioni*	27	99	0.1	0.0	13
68	*Glycera lapidum*	26	99	0.2	0.0	7
69	*Saxicavella jeffreysi*	26	99	0.1	0.0	1
70	*Eulalia ornata*	25	99	0.1	0.0	9
71	*Mysta picta*	25	99	0.1	0.0	8
72	*Podarkeopsis capensis*	25	99	0.0	0.0	10
73	*Bathyporeia pelagica*	24	99	0.0	0.0	10
74	*Unciola crenatipalma*	24	99	0.0	0.0	6
75	Amphiuridae	20	99	0.0	0.0	13
76	*Pontocrates altamarinus*	18	99	0.0	0.0	16
77	*Lepidonotus squamatus*	16	99	0.3	0.0	8
78	*Abludomelita obtusata*	15	99	0.0	0.0	6
79	*Nototropis swammerdamei*	14	99	0.0	0.0	9
80	*Schistomysis kervillei*	14	99	0.1	0.0	6
81	*Sthenelais boa*	14	99	1.4	0.1	8
82	Ascidiacea	13	99	0.0	0.0	10
83	*Crangon crangon*	13	99	0.8	0.0	9
84	*Glycera alba*	13	99	0.2	0.0	13
85	*Ophiura albida*	13	99	0.5	0.0	9
86	*Pholoe baltica*	13	99	0.0	0.0	8
87	*Phyllodoce rosea*	13	99	0.0	0.0	7
88	*Pontocrates arenarius*	13	99	0.0	0.0	5
89	*Spisula spp.*	13	99	0.0	0.0	11
90	*Caulleriella alata*	12	99	0.0	0.0	3

91	*Clymenura*	12	99	0.1	0.0	2
92	*Eteone longa*	12	99	0.0	0.0	10
93	*Eusyllis blomstrandi*	12	99	0.0	0.0	3
94	*Microphthalmus*	12	99	0.0	0.0	1
95	*Nephtys longosetosa*	12	99	0.8	0.0	5
96	*Cirriformia tentaculata*	11	99	0.0	0.0	5
97	*Glycera tridactyla*	11	99	0.7	0.0	9
98	*Acidostoma spp.*	10	99	0.1	0.0	7
99	*Ampharete lindstroemi*	10	99	0.0	0.0	5
100	Decapoda	10	100	0.1	0.0	8
101	*Eumida sanguinea*	10	100	0.0	0.0	2
102	Sagittidae	10	100	0.0	0.0	9
103	*Aonides paucibranchiata*	9	100	0.0	0.0	5
104	*Aoridae*	9	100	0.0	0.0	6
105	*Perioculodes longimanus*	9	100	0.0	0.0	6
106	*Spisula elliptica*	9	100	2.3	0.1	3
107	*Ammothella longipes*	8	100	0.0	0.0	5
108	*Flabelligera affinis*	8	100	0.1	0.0	2
109	Mysidae	8	100	0.0	0.0	6
110	*Abra spp.*	7	100	0.0	0.0	2
111	*Ampelisca diadema*	7	100	0.0	0.0	5
112	*Ampharete grubei*	7	100	0.1	0.0	5
113	*Asterias rubens*	7	100	1.3	0.1	7
114	*Caprella tuberculata*	7	100	0.0	0.0	2
115	*Tharyx species A*	7	100	0.0	0.0	6
116	*Tubificoides pseudogaster*	7	100	0.0	0.0	6
117	Balanus *spp.*	6	100	0.2	0.0	3
118	*Golfingia Golfingia elongata*	6	100	0.5	0.0	5
119	*Phyllodoce mucosa*	6	100	0.0	0.0	6
120	*Scolelepis Scolelepis squamata*	6	100	0.0	0.0	6
121	*Siriella armata*	6	100	0.2	0.0	3
122	*Spirobranchus*	6	100	0.0	0.0	2
123	*Bodotria scorpioides*	5	100	0.0	0.0	6
124	*Gastrosaccus spinifer*	5	100	0.0	0.0	5
125	*Glycera oxycephala*	5	100	0.0	0.0	6
126	*Lumbrineris cingulata*	5	100	0.0	0.0	3
127	*Photis pollex*	5	100	0.0	0.0	5
128	*Sphaerosyllis bulbosa*	5	100	0.0	0.0	1
129	Spionidae	5	100	0.0	0.0	5
130	*Tharyx killariensis*	5	100	0.0	0.0	6
131	*Aphrodita aculeata*	4	100	0.0	0.0	2
132	*Aricidea Aricidea minuta*	4	100	0.0	0.0	1
133	*Carcinus maenas*	4	100	0.0	0.0	3
134	*Malmgrenia arenicolae*	4	100	0.0	0.0	2
135	*Portumnus latipes*	4	100	0.3	0.0	5
136	*Spio decorata*	4	100	0.0	0.0	3
137	*Stenothoe marina*	4	100	0.0	0.0	3
138	*Cheirocratus intermedius*	3	100	0.0	0.0	2
139	*Eurydice spinigera*	3	100	0.0	0.0	3
140	*Hippolyte varians*	3	100	0.1	0.0	3

141	*Idotea linearis*	3	100	0.2	0.0	3
142	*Limnodriloides*	3	100	0.0	0.0	1
143	*Macropodia spp.*	3	100	0.0	0.0	3
144	*Nephtys assimilis*	3	100	0.8	0.0	3
145	*Polydora cornuta*	3	100	0.0	0.0	1
146	*Psammechinus miliaris*	3	100	3.0	0.1	3
147	*Pseudopolydora pulchra*	3	100	0.0	0.0	2
148	*Schistomysis spiritus*	3	100	0.0	0.0	2
149	*Scolelepis Scolelepis foliosa*	3	100	0.0	0.0	2
150	*Spio filicornis*	3	100	0.0	0.0	3
151	*Tubificoides benedii*	3	100	0.0	0.0	1
152	*Alitta succinea*	2	100	0.0	0.0	1
153	*Buccinum undatum*	2	100	0.8	0.0	2
154	*Cancer pagurus*	2	100	0.1	0.0	2
155	*Diastylis rugosa*	2	100	0.0	0.0	2
156	*Eualus cranchii*	2	100	0.0	0.0	2
157	*Eurydice pulchra*	2	100	0.0	0.0	2
158	*Euspira nitida*	2	100	1.1	0.1	2
159	*Fabulina fabula*	2	100	0.1	0.0	2
160	*Harpinia antennaria*	2	100	0.0	0.0	1
161	*Hesionura elongata*	2	100	0.0	0.0	2
162	*Liocarcinus spp.*	2	100	0.0	0.0	2
163	*Lumbrineris latreilli*	2	100	0.1	0.0	2
164	Macrochaeta	2	100	0.0	0.0	2
165	*Marphysa bellii*	2	100	0.1	0.0	2
166	*Mesopodopsis slabberi*	2	100	0.0	0.0	2
167	*Owenia fusiformis*	2	100	0.2	0.0	2
168	*Oxydromus spp.*	2	100	0.0	0.0	2
169	*Philocheras trispinosus*	2	100	0.5	0.0	1
170	*Photis longicaudata*	2	100	0.0	0.0	2
171	*Scolelepis bonnieri*	2	100	0.1	0.0	2
172	*Tanaopsis graciloides*	2	100	0.0	0.0	2
173	*Ampharete baltica*	1	100	0.0	0.0	1
174	*Amphicteis gunneri*	1	100	0.0	0.0	1
175	Amphipoda	1	100	0.0	0.0	1
176	*Anobothrus gracilis*	1	100	0.0	0.0	1
177	*Anoplodactylus pygmaeus*	1	100	0.0	0.0	1
178	*Aonides oxycephala*	1	100	0.0	0.0	1
179	*Aphelochaeta species A*	1	100	0.0	0.0	1
180	*Austrominius modestus*	1	100	0.0	0.0	1
181	Bivalvia	1	100	0.0	0.0	1
182	*Chaetozone zetlandica*	1	100	0.0	0.0	1
183	*Cleantis prismatica*	1	100	0.0	0.0	1
184	*Corystes cassivelaunus*	1	100	0.0	0.0	1
185	*Crassicorophium crassicorne*	1	100	0.0	0.0	1
186	*Diastylis spp.*	1	100	0.0	0.0	1
187	*Diastylis lucifera*	1	100	0.0	0.0	1
188	*Diastylis tumida*	1	100	0.0	0.0	1
189	*Echiurus echiurus*	1	100	3.6	0.2	1
190	*Enteropneusta spp.*	1	100	0.0	0.0	1

191	*Epitonium clathratulum*	1	100	0.0	0.0	1
192	*Ericthonius spp.*	1	100	0.0	0.0	1
193	*Eudorella truncatula*	1	100	0.0	0.0	1
194	*Eulalia bilineata*	1	100	0.0	0.0	1
195	*Eurydice truncata*	1	100	0.0	0.0	1
196	*Eusarsiella zostericola*	1	100	0.0	0.0	1
197	*Exogone verugera*	1	100	0.0	0.0	1
198	*Gammarellus homari*	1	100	0.0	0.0	1
199	Gammaridae	1	100	0.0	0.0	1
200	*Glycera spp.*	1	100	0.0	0.0	1
201	*Glycinde nordmanni*	1	100	0.0	0.0	1
202	*Hypereteone foliosa*	1	100	0.0	0.0	1
203	*Idotea spp.*	1	100	0.0	0.0	1
204	*Lacuna crassior*	1	100	0.0	0.0	1
205	*Leptinogaster spp.*	1	100	0.0	0.0	1
206	*Mactra stultorum*	1	100	0.0	0.0	1
207	Magelonidae	1	100	0.0	0.0	1
208	*Malacoceros spp.*	1	100	0.0	0.0	1
209	*Modiolus spp.*	1	100	0.0	0.0	1
210	*Monopseudocuma gilsoni*	1	100	0.0	0.0	1
211	*Myodocopida spp.*	1	100	0.0	0.0	1
212	*Myrianida brachycephala*	1	100	0.0	0.0	1
213	*Nassarius reticulatus*	1	100	1.8	0.1	1
214	Nereididae	1	100	0.0	0.0	1
215	*Nicolea venustula*	1	100	0.0	0.0	1
216	*Nototropis vedlomensis*	1	100	0.0	0.0	1
217	*Nymphon gracile*	1	100	0.0	0.0	1
218	*Ophelina acuminata*	1	100	0.0	0.0	1
219	*Ophiothrix fragilis*	1	100	0.0	0.0	1
220	Paguridae	1	100	0.0	0.0	1
221	*Pandalus montagui*	1	100	0.0	0.0	1
222	*Paramysis Longidentia nouveli*	1	100	0.0	0.0	1
223	*Peringia ulvae*	1	100	0.0	0.0	1
224	*Petricolaria pholadiformis*	1	100	0.0	0.0	1
225	*Phascolion strombus*	1	100	0.0	0.0	1
226	*Phoxichilidium femoratum*	1	100	0.0	0.0	1
227	*Phyllodoce spp.*	1	100	0.0	0.0	1
228	*Phyllodoce groenlandica*	1	100	0.1	0.0	1
229	*Phyllodoce longipes*	1	100	0.0	0.0	1
230	*Pisione remota*	1	100	0.0	0.0	1
231	*Polydora ciliata*	1	100	0.0	0.0	1
232	*Procerastea spp.*	1	100	0.0	0.0	1
233	*Protodorvillea kefersteini*	1	100	0.0	0.0	1
234	*Protodrilus spp.*	1	100	0.0	0.0	1
235	*Psamathe fusca*	1	100	0.0	0.0	1
236	*Pseudopolydora paucibranchiata*	1	100	0.0	0.0	1
237	*Pseudopotamilla reniformis*	1	100	0.0	0.0	1
238	*Retusa obtusa*	1	100	0.0	0.0	1
239	*Saccocirrus papillocercus*	1	100	0.0	0.0	1
240	*Schistomeringos rudolphi*	1	100	0.0	0.0	1

241	*Schistomysis spp.*	1	100	0.0	0.0	1
242	Serpulidae	1	100	0.0	0.0	1
243	*Spio goniocephala*	1	100	0.0	0.0	1
244	*Spisula solida*	1	100	0.1	0.0	1
245	*Steromphala cineraria*	1	100	0.1	0.0	1
246	*Syllis spp.*	1	100	0.0	0.0	1
247	*Syllis species D*	1	100	0.0	0.0	1
248	*Syllis variegata*	1	100	0.0	0.0	1
249	*Tritonia spp.*	1	100	0.0	0.0	1
250	TURBELLARIA	1	100	0.0	0.0	1
251	*Urothoe spp.*	1	100	0.0	0.0	1
252	*Urothoe pulchella*	1	100	0.0	0.0	1
253	*Venerupis corrugata*	1	100	0.1	0.0	1
254	*Vitreolina philippi*	1	100	0.0	0.0	1
	COLONIAL					
255	*Alcyonidioides mytili*	-	-	-	-	6
256	*Alcyonidium diaphanum*	-	-	-	-	2
257	*Alcyonidium parasiticum*	-	-	-	-	2
258	*Alcyonium digitatum*	-	-	-	-	2
259	*Amathia spp.*	-	-	-	-	6
260	*Amathia lendigera*	-	-	-	-	23
261	*Anguinella palmata*	-	-	-	-	45
262	*Aspidelectra melolontha*	-	-	-	-	9
263	*Barentsia spp.*	-	-	-	-	2
264	*Bicellariella ciliata*	-	-	-	-	20
265	*Bougainvilliidae*	-	-	-	-	1
266	*Calycella syringa*	-	-	-	-	1
267	*Campanulariidae*	-	-	-	-	15
268	*Conopeum reticulum*	-	-	-	-	38
269	*Corymorpha nutans*	-	-	-	-	1
270	*Crisia spp.*	-	-	-	-	8
271	*Crisidia cornuta*	-	-	-	-	2
272	*Crisularia plumosa*	-	-	-	-	8
273	*Diphasia spp.*	-	-	-	-	1
274	*Einhornia crustulenta*	-	-	-	-	9
275	*Electra monostachys*	-	-	-	-	27
276	*Electra pilosa*	-	-	-	-	44
277	*Escharella immersa*	-	-	-	-	1
278	*Eucratea loricata*	-	-	-	-	22
279	*Eudendrium spp.*	-	-	-	-	7
280	*Farrella repens*	-	-	-	-	3
281	*Flustra foliacea*	-	-	-	-	10
282	*Halecium spp.*	-	-	-	-	11
283	*Hydrallmania falcata*	-	-	-	-	24
284	*Lovenella clausa*	-	-	-	-	2
285	*Loxosomella murmanica*	-	-	-	-	1
286	*Loxosomella varians*	-	-	-	-	10
287	*Membranipora membranacea*	-	-	-	-	1
288	*Nolella spp.*	-	-	-	-	3
289	*Obelia bidentata*	-	-	-	-	3

290	*Obelia dichotoma*	-	-	-	-	6
291	*Pedicellina spp.*	-	-	-	-	1
292	*Schizomavella auriculata*	-	-	-	-	3
293	*Schizomavella linearis*	-	-	-	-	2
294	*Scrupocellaria scruposa*	-	-	-	-	7
295	*Sertularella spp.*	-	-	-	-	2
296	*Sertularia spp.*	-	-	-	-	59
297	Smittoidea	-	-	-	-	1
298	Tubulariidae	-	-	-	-	8
299	*Tubulipora spp.*	-	-	-	-	1
300	*Vesicularia spinosa*	-	-	-	-	15
301	*Walkeria uva*	-	-	-	-	1

C.2 Epifauna

Table 21: List of epifaunal taxa present in the 2m-beam trawl samples.

Taxa		Abundance		Occurrence (%)
		Total	Cum. %	
NON-COLONIAL				
1	***Ophiura ophiura***	78713	**57**	**71**
2	***Crangon crangon***	21338	**73**	**98**
3	***Nucula nitidosa***	13895	**83**	**35**
4	***Nucula nucleus***	4897	**87**	**37**
5	*Sabellaria spinulosa*	3200	89	2
6	*Asterias rubens*	2587	91	89
7	*Abra alba*	1900	92	25
8	*Ophiura albida*	1883	93	51
9	*Crangon allmanni*	1353	94	75
10	*Pandalus montagui*	1221	95	83
11	*Psammechinus miliaris*	904	96	14
12	*Liocarcinus holsatus*	886	97	92
13	*Mytilus edulis*	535	97	29
14	*Pagurus bernhardus*	534	97	92
15	*Lagis koreni*	489	98	22
16	*Abra nitida*	404	98	17
17	*Idotea linearis*	396	98	62
18	*Cancer pagurus*	252	99	44
19	*Carcinus maenas*	244	99	40
20	*Nephtys spp.*	234	99	25
21	*Diastylis rathkei*	171	99	30
22	*Palaemon serratus*	164	99	54
23	*Limecola balthica*	115	99	6
24	*Pandalina brevirostris*	114	99	11
25	*Philocheras trispinosus*	108	99	38
26	*Actiniaria spp.*	93	99	21
27	*Crossaster papposus*	66	99	11
28	*Macropodia spp.*	45	100	17

29	*Spisula elliptica*	44	100	6
30	*Gammarus insensibilis*	42	100	16
31	*Nucula spp.*	42	100	2
32	*Diastylis bradyi*	39	100	10
33	*Idotea granulosa*	36	100	16
34	*Aphrodita aculeata*	29	100	19
35	*Necora puber*	27	100	14
36	Ophiuridae	25	100	11
37	*Corystes cassivelaunus*	24	100	16
38	*Liocarcinus depurator*	21	100	11
39	Cnidaria	20	100	10
40	*Macropodia parva*	20	100	14
41	*Echinocardium cordatum*	18	100	14
42	*Scalibregma inflatum*	18	100	5
43	Arenicolidae	17	100	5
44	*Atelecyclus rotundatus*	17	100	2
45	*Pagurus prideaux*	17	100	5
46	*Dexamine spp.*	16	100	11
47	*Buccinum undatum*	14	100	13
48	*Macropodia rostrate*	12	100	8
49	*Gammarus spp.*	10	100	8
50	*Pariambus typicus*	10	100	2
51	*Phoronis spp.*	10	100	2
52	*Pontophilus spinosus*	10	100	11
53	*Portumnus latipes*	10	100	6
54	*Nymphon brevirostre*	9	100	3
55	*Pilumnus hirtellus*	9	100	8
56	*Barnea candida*	8	100	2
57	*Diastylis spp.*	7	100	8
58	*Metridium dianthus*	7	100	5
59	*Homarus Gammarus*	6	100	8
60	*Molgula spp.*	5	100	3
61	Cumacea	4	100	2
62	*Doris pseudoargus*	4	100	2
63	*Hyas araneus*	4	100	5
64	*Mactra glauca*	4	100	5
65	*Dendronotus frondosus*	3	100	5
66	*Tritonia hombergii*	3	100	3
67	*Ampelisca spp.*	2	100	3
68	*Euspira nitida*	2	100	2
69	*Hyas coarctatus*	2	100	3
70	Polynoidae	2	100	3
71	*Alpheus glaber*	1	100	2
72	*Ascidiella aspersa*	1	100	2
73	*Athanas nitescens*	1	100	2
74	*Crepidula fornicate*	1	100	2
75	*Diastylis lucifera*	1	100	2

76	*Eurynome aspera*	1	100	2
77	*Goneplax rhomboids*	1	100	2
78	*Harmothoe impar*	1	100	2
79	*Inachus spp.*	1	100	2
80	*Lepidonotus squamatus*	1	100	2
81	*Liocarcinus marmoreus*	1	100	2
82	Nemertea	1	100	2
83	*Nototropis falcatus*	1	100	2
84	Nudibranchia	1	100	2
85	Pasiphaea	1	100	2
86	*Processa canaliculata*	1	100	2
87	*Sthenelais boa*	1	100	2
88	*Urticina felina*	1	100	2
89	*Xantho pilipes*	1	100	2
COLONIAL				
90	*Abietinaria spp.*	-	-	3
91	*Alcyonidium diaphanum*	-	-	33
92	*Alcyonium digitatum*	-	-	5
93	*Amathia lendigera*	-	-	33
94	*Anguinella palmata*	-	-	16
95	*Aurelia aurita*	-	-	2
96	*Bicellariella ciliata*	-	-	6
97	*Campanulariidae*	-	-	8
98	Cnidaria	-	-	2
99	*Coryne spp.*	-	-	2
100	Crisiidae	-	-	5
101	*Diphasia spp.*	-	-	16
102	*Electra Pilosa*	-	-	29
103	*Eucratea loricate*	-	-	2
104	*Eudendrium spp.*	-	-	2
105	*Flustra foliacea*	-	-	48
106	*Halecium spp.*	-	-	2
107	*Hydrallmania falcata*	-	-	76
108	Hydrozoa	-	-	2
109	*Metridium dianthus*	-	-	2
110	Nemertea	-	-	2
111	Porifera	-	-	3
112	*Sabellaria spp.*	-	-	8
113	*Scrupocellaria scruposa*	-	-	5
114	*Sertularella spp.*	-	-	13
115	*Sertularia spp.*	-	-	73
116	Sertulariidae	-	-	11
117	*Tubularia spp.*	-	-	24
118	*Tubularia indivisa*	-	-	13
119	*Vesicularia spinosa*	-	-	27

C.3 CIMP

Table 22: List of epifaunal taxa collected on the drum screens during the CIMP.

Taxa		Abundance		Weight	
		Total	Cum. %	Total	Cum. %
NON-COLONIAL					
1	***Crangon crangon***	3206089	**63**	4050	40
2	***Palaemon serratus***	591685	**75**	1796	58
3	***Pandalus montagui***	553117	**86**	677	64
4	*Liocarcinus holsatus*	328401	92	1296	77
5	*Crangon allmanni*	207095	96	166	79
6	*Metridium dianthus*	53317	97	146	80
7	*Cancer pagurus*	53979	98	567	86
8	*Urticina spp.*	19173	99	104	87
9	Idoteidae	13664	99	12	87
10	*Necora puber*	13149	99	160	89
11	*Carcinus maenas*	8695	99	25	89
12	*Asterias rubens*	6344	100	111	90
13	*Mytilus edulis*	3808	100	23	90
14	*Macropodia rostrata*	3492	100	2	90
15	*Macropodia spp.*	3488	100	2	90
16	*Nereis spp.*	2157	100	4	90
17	*Pilumnus hirtellus*	1620	100	4	90
18	Polynoidae	1176	100	1	90
19	Crangonidae	1113	100	2	90
20	Anemonia	1109	100	3	90
21	*Pasiphaea sivado*	1098	100	1	90
22	*Liocarcinus depurator*	553	100	2	90
23	*Xantho pilipes*	384	100	1	90
24	Nudibranchia	383	100	1	90
25	*Arenicola marina*	347	100	1	90
26	Echinoidea	283	100	1	90
27	Ophiuroidea	267	100	2	90
28	*Pilumnus spinifer*	248	100	1	90
29	*Hyas coarctatus*	246	100	2	90
30	*Processa canaliculata*	246	100	0	90
31	*Bolocera tuediae*	225	100	0	90
32	*Pisidia longicornis*	224	100	0	90
33	*Macropodia tenuirostris*	183	100	0	90
34	*Actinia equina*	183	100	0	90
35	*Psammechinus miliaris*	117	100	2	90
36	*Inachus dorsettensis*	112	100	0	90
37	Majidae	112	100	0	90
38	*Hyas araneus*	95	100	1	90
39	*Abra alba*	95	100	0	90

40	*Liocarcinus pusillus*	80	100	0	90
41	*Liocarcinus marmoreus*	57	100	0	90
42	*Pagurus bernhardus*	38	100	1	91
43	Processidae	15	100	0	91
44	Xanthidae	10	100	0	91
45	*Homarus Gammarus*	9	100	8	91
46	Polychaeta	7	100	0	91
47	*Ophiura ophiura*	4	100	0	91
48	*Spatangus purpureus*	4	100	0	91
49	*Upogebia deltaura*	4	100	0	91
50	Gammaridae	2	100	0	91
51	Holothuroidea	1	100	0	91
52	*Axius stirhynchus*	1	100	0	91
53	*Liocarcinus spp.*	1	100	0	91
54	*Calliostoma zizyphinum*	0	100	0	91
55	*Hediste diversicolor*	0	100	0	91
56	Galatheidae	0	100	0	91
57	Mytilidae	0	100	45	91
58	*Polybius henslowii*	0	100	0	91
	COLONIAL				
59	*Flustra foliacea*	-	-	80	92
60	*Alcyonidium diaphanum*	-	-	44	92
61	*Euspira spp.*	-	-	0	92
62	*Hydrallmania falcata*	-	-	1	92
63	Hydroida	-	-	729	99
64	Porifera	-	-	0	99
65	*Suberites spp.*	-	-	0	99
66	*Tubularia spp.*	-	-	55	100

C.4 Environmental parameter

Table 23: Environmental data for each sampling station including: the depth range, the mean excess temperature range (MET in °C) and the extreme temperature (98th Percentile Excess Temperature) both extracted from the GETM model, and the average value of the grain size fraction (percentage) of the sediment samples used for biological analysis for each station in the Greater Sizewell Bay. Gravel (grain size >2 mm); Coarse sand (0.5 mm to 2 mm); Medium Sand (0.25 mm to 500 mm); Fine sand (0.063 mm to 0.25 mm) and finally Silt/Clay fraction (>0.063 mm). See Figure 63 for the location of sampling stations. The Level 4 EUNIS habitats maps includes the following six classes: A4.13 - *Mixed faunal turf communities on circalittoral rock*, A5.13- *Infralittoral coarse sediment*, A5.23 - *Infralittoral fine sand*, A5.26 - *Circalittoral muddy sand*; A5.33 – *Infralittoral sandy mud* and A3.43 - *Infralittoral mixed sediments*. The colour range reflects the proportion of each sediment fraction (light yellow for 0% and red for 100%).

EUNIS (Level4)	Station	Depth Range	MET	98th PET	Number of Replicate	Grain size (%)				
						Gravel	Coarse sand	Medium sand	Fine sand	Silt/clay
A4.13	I3	0-4 m	1	3.9	1	5	25.4	37.6	32	0
	SZ100	12-16 m	0	0.8	1	1.8	68.5	18.7	7	4
	SZ101	12-16 m	0	0.8	1	3.2	77.6	16.4	1.1	1.7
	SZ104	4-8 m	1	2.8	1	0.3	59.3	37.2	3.2	0
	SZ105	4-8 m	1	2.9	1	0	26.7	43.1	28.5	1.6
	SZ115	8-12 m	1	2.4	4	0.2 ± 0.1	0.6 ± 0.7	12.2 ± 7.1	34.2 ± 17.4	52.8 ± 24.1
	SZ136	8-12 m	1	1.9	4	0.5 ± 0.8	1 ± 0.8	17.5 ± 8.9	51.6 ± 11	29.4 ± 19.2
A5.13	A2	4-8 m	2	6	1	0.6	0.9	50.3	48.3	0
	G1	4-8 m	1	3.2	1	7.6	14	58.5	20	0
	SZ107	8-12 m	1	2.7	1	5	47.7	41.8	3.7	1.8
	SZ108	8-12 m	1	2.8	1	4.1	8.8	11.6	6.8	68.7
	SZ116	8-12 m	0	1.1	3	65.1 ± 9	2.3 ± 1.1	12.5 ± 3	16.8 ± 5.6	3.2 ± 0.9
	SZ126	8-12 m	0	0.9	4	48.9 ± 6.5	10.4 ± 5.5	11.8 ± 4.9	18 ± 3.1	10.9 ± 8.4
	SZ128	12-16 m	0	0.3	3	58 ± 7.6	25.6 ± 7.4	10.3 ± 1.3	4.4 ± 3.9	1.7 ± 2.4
	SZ130	16-20 m	0	0.4	3	28.7 ± 20.8	30.2 ± 9.9	21.6 ± 20.5	10.6 ± 4.6	8.8 ± 6.1
	SZ132	16-20 m	0	0.3	3	58 ± 14.5	5.7 ± 5.1	7.3 ± 5.1	11 ± 6.8	18.1 ± 7.6
	SZ151	4-8 m	1	3.2	1	4.5	33.1	44.8	17.6	0
	SZ152	4-8 m	1	2.8	1	5.4	43.1	45.9	4.7	1
	SZ153	8-12 m	1	2.1	1	16.7	29.7	43.7	7.9	2
A5.23	A3	0-4 m	2	5.8	1	5	23.1	45.1	26.9	0
	B1	0-4 m	4	10.7	1	0.8	2.6	65.8	30.7	0
	B2	0-4 m	3	6.5	1	0.5	0.8	46.1	52.6	0
	B3	0-4 m	2	3.7	1	0.1	1	50.2	48.8	0
	D1	0-4 m	1	3.4	1	0.1	4.7	72.3	22.9	0
	D2	4-8 m	1	3.8	1	0.3	1.2	54	44.5	0
	SZ106	8-12 m	1	2.7	1	1.8	52.8	38.7	4.8	1.9
	SZ113	12-16 m	0	0.7	7	2 ± 1.8	3.7 ± 4.2	10.1 ± 7	45.9 ± 5.7	38.3 ± 15.7
	SZ114	12-16 m	0	0.5	5	1.6 ± 3	2.8 ± 5.6	8.5 ± 9	47.9 ± 4.2	39.3 ± 20.6
	SZ117	12-16 m	0	0.6	5	0.9 ± 1	4 ± 3.5	20 ± 16.4	43.9 ± 10.7	31.2 ± 28.9
	SZ118	4-8 m	1	2.4	4	4.9 ± 2.5	23.8 ± 7.2	41.8 ± 3.7	29.5 ± 7	0 ± 0
	SZ120	8-12 m	1	2	5	7 ± 3.2	15.6 ± 9.1	30.3 ± 9.6	34.5 ± 4.8	12.5 ± 10.1
	SZ121	8-12 m	0	0.4	4	0 ± 0	0 ± 0	28.9 ± 2.6	71.1 ± 2.6	0 ± 0
	SZ123	8-12 m	0	1.5	5	20.3 ± 20.4	13.9 ± 12	34.9 ± 10.2	29.6 ± 9.3	1.2 ± 2
	SZ124	8-12 m	0	0.5	4	0.2 ± 0.1	1.4 ± 0.5	38.1 ± 2.1	58 ± 3.9	2.3 ± 2.7
	SZ125	16-20 m	0	0.3	4	21.9 ± 7.6	41.1 ± 10.8	14.9 ± 1.7	15.6 ± 9.1	6.6 ± 6.7
	SZ127	0-4 m	0	0.5	4	0 ± 0	0.6 ± 0.5	44.1 ± 5.1	55 ± 6.2	0.4 ± 0.7
	SZ129	8-12 m	0	0.7	4	6.6 ± 10.9	1.1 ± 0.7	18.6 ± 8.9	39.8 ± 15.7	33.9 ± 25.8
	SZ131	8-12 m	0	0.7	4	1.3 ± 1.2	1.9 ± 2.1	56 ± 2.3	40.8 ± 1.7	0 ± 0
	SZ133	4-8 m	0	1	4	0 ± 0	0 ± 0	6.9 ± 0.8	90 ± 3.5	3 ± 3.4
	SZ134	4-8 m	0	1	4	0 ± 0	0 ± 0	30.5 ± 4.2	69.3 ± 3.9	0.1 ± 0.3
	SZ154	8-12 m	1	2.6	1	4.3	8.4	25.2	21.5	40.6

	SZ158	4-8 m	0	1.1	1	0	0	21.7	76.2	2.2
	SZ41	4-8 m	0	1.6	5	0 ± 0	0.1 ± 0	34.8 ± 2	65.2 ± 2.1	0 ± 0
	SZ43	4-8 m	0	1.5	11	0 ± 0	0 ± 0	26.8 ± 5.2	72.4 ± 4.7	0.8 ± 1.8
	SZ46	4-8 m	0	1.3	7	0 ± 0.1	0 ± 0	11.5 ± 3.4	82.9 ± 3.3	5.6 ± 3.5
	SZ48	4-8 m	2	3.9	7	1.5 ± 1.4	7.4 ± 4.9	34.5 ± 9.8	43.6 ± 8.2	12.9 ± 10.9
	SZ50	8-12 m	0	1.2	13	0.1 ± 0.2	0.1 ± 0.2	8.4 ± 3.2	73.3 ± 17.3	18.2 ± 20.1
	SZ51	12-16 m	0	0.7	1	0.4	7.3	5.5	44.6	42.2
	SZ52	4-8 m	2	3.3	11	6.4 ± 5.6	31.2 ± 11.3	38.3 ± 6.6	20.6 ± 8.2	3.4 ± 5.8
	SZ54	4-8 m	0	1.2	1	0	2	16.1	77.5	4.4
	SZ55	16-20 m	0	0.6	1	0.1	4.2	10.6	29.7	55.4
	SZ56	4-8 m	1	3.1	10	1.3 ± 1.8	7.2 ± 11.4	39.6 ± 3.8	51.2 ± 14.3	0.7 ± 1.7
	SZ58	4-8 m	0	1	1	0	0	7.7	89.2	3.1
	SZ59	16-20 m	0	0.5	6	1.3 ± 1	21.8 ± 16.1	38.9 ± 13.2	26.3 ± 20.6	11.6 ± 15.3
	SZ60	8-12 m	1	3	11	0.1 ± 0.1	2.1 ± 4.5	33 ± 7.6	57 ± 9.9	7.8 ± 11.5
	SZ62	8-12 m	0	0.9	10	0.3 ± 0.3	16.4 ± 11.6	38.7 ± 7.1	42.3 ± 15.8	2.3 ± 2.9
	SZ63	16-20 m	0	0.4	10	1.2 ± 2.2	7.2 ± 10.9	23.5 ± 11.7	36.2 ± 11.7	31.9 ± 16.5
A5.23/A5.26	C2	0-4 m	3	7.1	1	0	0.8	48.3	50.9	0
	C3	0-4 m	2	4.7	1	0.2	0.5	36	63.3	0
	E1	4-8 m	1	3.7	1	0.3	1.3	40.5	57.9	0
	I1	0-4 m	2	5.4	1	0.2	0.8	53.7	45.3	0
	I2	4-8 m	2	5.6	1	2.3	37.6	48.5	11.6	0
A5.26	SZ112	12-16 m	0	0.6	7	0 ± 0	0.3 ± 0.4	4.1 ± 5.7	35.4 ± 18.8	60.2 ± 23.8
A5.33	SZ45	8-12 m	1	2.3	11	0.2 ± 0.7	2.3 ± 3.7	4.6 ± 8.2	22 ± 6.2	70.9 ± 15.1
A5.33/A5.26	F1	4-8 m	1	3.5	1	0	0.1	15.4	54.2	30.3
	F2	4-8 m	1	2.9	1	0	0.9	1.5	14.4	83.2
	F3	4-8 m	1	2.8	1	0.1	0.2	0.6	11.4	87.7
	SZ109	8-12 m	0	0.7	1	0	0.4	12.9	28.2	58.5
	SZ110	4-8 m	1	3	5	0.1 ± 0.1	1.1 ± 2	3.4 ± 5.7	13.8 ± 3.2	81.6 ± 9.2
	SZ111	4-8 m	0	1.6	5	0 ± 0	0.5 ± 0.3	36.8 ± 7.7	58.1 ± 2.3	4.7 ± 9.2
	SZ119	8-12 m	0	1.5	6	0.1 ± 0.1	0.2 ± 0.1	14.4 ± 7	53.7 ± 9.3	31.7 ± 12.2
	SZ122	8-12 m	0	0.6	5	0.6 ± 0.4	1.2 ± 1	27.2 ± 2.6	67.3 ± 2.4	3.7 ± 2.9
	SZ135	8-12 m	1	1.7	5	0 ± 0	0.4 ± 0.9	21.5 ± 9.6	75.3 ± 13.6	2.7 ± 3.5
	SZ150	8-12 m	0	0.8	1	0.1	3.4	14.1	41.6	40.8
	SZ157	20-50 m	0	0.2	1	0	0	0.6	28.1	71.3
	SZ40	8-12 m	1	2.7	6	0 ± 0	0.9 ± 0.8	1.3 ± 0.4	23.8 ± 4.7	73.9 ± 4.8
	SZ42	8-12 m	1	2.5	10	0 ± 0	0.9 ± 1.5	1.8 ± 1.3	25.1 ± 13.8	72.2 ± 14.8
	SZ44	8-12 m	0	0.8	9	0.1 ± 0.1	6.4 ± 7.8	20.9 ± 7.5	48.4 ± 9.6	24.1 ± 18.3
	SZ47	12-16 m	0	0.7	6	0.8 ± 0.6	13 ± 13.3	15.4 ± 8.6	36.2 ± 9	34.5 ± 20.6
	SZ49	8-12 m	1	2.2	1	0.1	0.1	1.8	27.9	70.3
	SZ53	8-12 m	1	2	1	0.1	0	1.6	31.6	66.7
	SZ57	8-12 m	1	1.9	10	0.1 ± 0.1	0.6 ± 0.7	8.9 ± 9.2	54.4 ± 22.3	36 ± 28.6
	SZ61	8-12 m	1	1.8	4	0 ± 0	0.3 ± 0.3	18.9 ± 4.4	51.2 ± 17.2	29.6 ± 21.2
	SZ67	16-20 m	0	0.3	5	0 ± 0	0.2 ± 0.1	8.2 ± 5.3	25.3 ± 7.2	66.3 ± 12.5
	SZ69	8-12 m	1	2.3	10	0.1 ± 0.1	0.1 ± 0.1	9.7 ± 8.2	44.2 ± 16.8	45.9 ± 24.4
A5.43	SZ137	8-12 m	1	1.9	5	3.7 ± 4.3	20.8 ± 14.5	48.2 ± 11.6	24 ± 11.2	3.4 ± 7.5
	SZ155	8-12 m	0	1	1	1.6	19.2	42.8	34	2.4
	SZ156	8-12 m	0	1.2	1	2.5	43.3	39.7	13	1.5

C.5 Seabed morphology

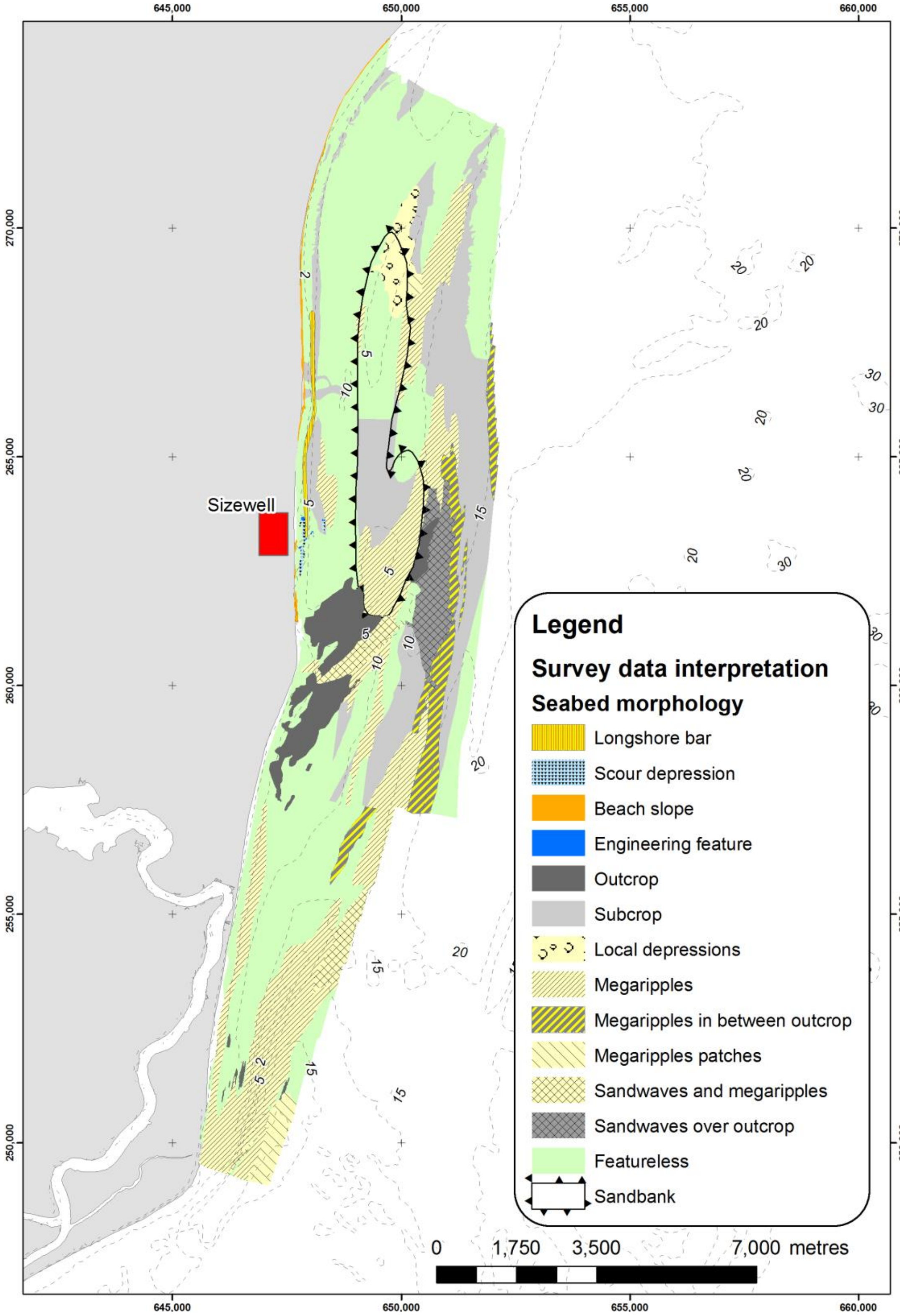

Figure 64: Seabed morphology across the Greater Sizewell Bay survey area derived from backscatter and swath bathymetry observations (See BEEMS TR087 Ed.3).

C.6 *Sabellaria spinulosa* in the Greater Sizewell Bay

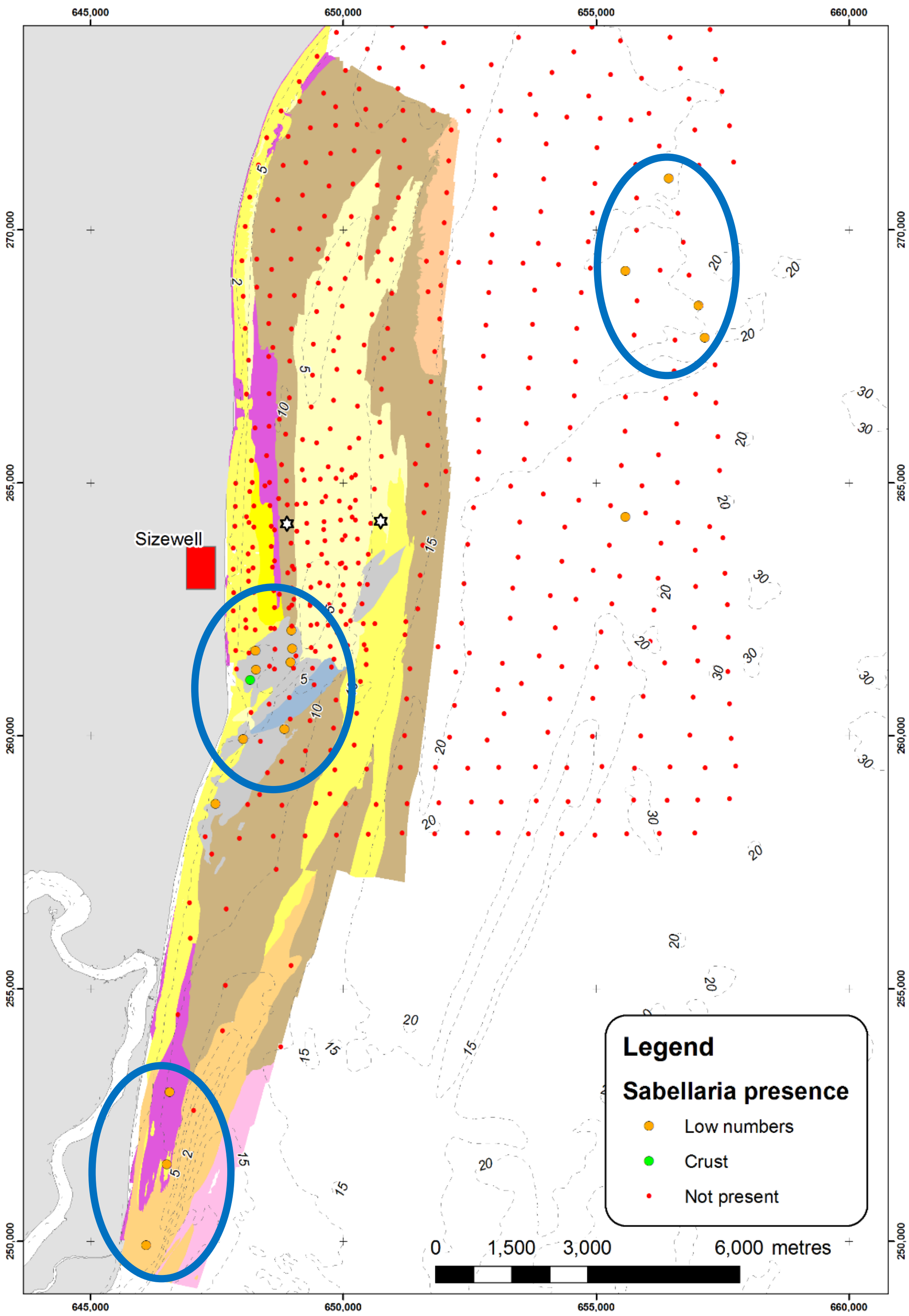

Figure 65: Distribution of sediment samples collected under the BEEMS Programme from 2008 to 2011, with an indication of whether *Sabellaria spinulosa* species are present overlaid on the EUNIS Habitat map (from BEEMS Technical Report TR087 and BEEMS Scientific Position Paper SPP079).
The Coralline Crag deposits are located within the blue circle, near Sizewell.

Figure 66: Examples of *Sabellaria spinulosa* fragment found in day grab samples in the south part of the Greater Sizewell Bay.
See appendix B.1 for the location of each sample.

C.7 Infaunal Quality Index - reference condition

- IQI_{WFD}

Reference conditions in this report are based on a reference for UK marine muddy sands/sandy muds, 0.1 m^2 grab with 1 mm sieve mesh, recommended by the WFD (Phillips et al., 2014). Preliminary reference condition values for the IQI for coastal water, fine depositional sediments (sublittoral sand and mud) were established in 2004 and revised later in 2006 and in 2008 based on a combination of existing data and expert judgement to establish reference conditions (Table 24).

- IQI_{SZ}

Phillips *et al.*, 2014 recommend developing a model between the site specific IQI metrics and the associated environmental data to obtain reliable site-specific reference conditions for the Greater Sizewell Bay. The data driving the biological assemblages have not been clearly identified (see section 3.2) so the site-specific reference condition have not been established. The site-specific calculations were therefore based on the calculation based on the IQI metrics for the sample with the highest AMBI value (Table 24).

Table 24: IQI metric reference condition values from the Environmental agency and from the Greater Sizewell Bay data.
EA value (2004-2006) were established by United Kingdom and Republic of Ireland competent authorities combining expert judgement and existing data (Environmental agency) whilst the GSB values were calculated from the sampling station with the highest AMBI value.

IQI parameters	Environment Agency Phillips *et al.*, 2014			GSB monitoring data
	Sand/Mud (2004)	Sand/Mud (2006)	Sand/Mud (2008)	Max AMBI
Taxa number	82	68	78.6	58
1-(AMBI/7)	1	0.96	0.96	1
Simpson's evenness (1-λ')	1	0.97	1.02	0.939167

C.8 Biological trait definitions

Table 25: Definition and functional significance of the biological traits selected for the characterisation of the Greater Sizewell Bay benthic fauna.
The trait catalogue was compiled by Cefas (Eggleton et al., 2011, Eggleton et al., 2012, Bolam et al., 2014, Bolam et al., 2017).

Trait	Trait Definition and functional significance
Size range (mm)	Maximum recorded size of adult (as individuals or colonies). Implications for the movement of organic matter within the benthic system as large organisms hold organic matter (low turnover) within the system relative to small-bodied species (high turnover).
Morphology	External characteristics of the taxon. For the infauna, mSoft are represented mainly by annelid worms, mTunic by tunicates, mExo represents chitinous (lower crustaceans) and calcareous-shelled (e.g. bivalve and gastropod molluscs, echinoderms, higher crustaceans). Crustose, cushion and stalked traits are shown by various sponges, hydroids and bryozoans.
Longevity (years)	Maximum reported life span of the adult stage. Indicates the relative investment of energy in somatic rather than reproductive growth and the relative age of sexual maturity, i.e. a proxy for relative r- and k- strategy. Short-lived taxa (l1) include small amphipods, while the molluscs *Buccinum* and *Arctica* represent some of the long-lived taxa.
Larval development strategy	Indicates the potential for dispersal of the larval stage prior to settlement from direct (no larval stage, e.g. cumaceans, tanaids), lecithotrophic (larvae with yolk sac, pelagic for short periods, e.g. terebellid worms) to planktotrophic (larvae feed and grow in water column, generally pelagic for several weeks, e.g. sponges, cnidarians). Affects ability to recover from disturbance with planktonic recruitment affording potentially faster recolonization than lecithotrophic and direct development.
Egg development location	Indicates dispersal via the egg stage and the potential susceptibility of eggs to damage from physical disturbance. Benthic eggs (e.g., some eunicid worms) are generally more concentrated over smaller areas than eggs released into the pelagia (e.g., hesionid worms). Asexual reproduction allows the potential to increase numbers rapidly, particularly following disturbance. Brooding is widespread within the lower crustaceans (e.g., amphipods).
Living habit	Indicates potential for the adult stage to evade, or to be exposed to, physical disturbance.). Various lhTube (e.g., serpulid worms), lhBurrow (some bivalve molluscs), lhCrevice (such as piddocks), lhFree (e.g. eumalacostracan crustaceans), lhEpi (e.g., bryozoans) and lhAtt (e.g., ascidians, bryozoans) taxa will vary in their acute responses to physical habitat disturbance depending on this trait (in combination with those of other traits such as mobility and sediment position).
Sediment position	Typical living position in sediment profile. Organisms occupying surficial (e.g. mytilid molluscs, sponges) or shallow positions in the sediment (some bivalves) are more likely to be affected by physical disturbance of their habitats than those living deeper (e.g. some worms). Sediment position also has implications for the effect of the organism to affect sediment-water nutrient and/or oxygen exchange.
Feeding mode	Feeding mode has important implications for the potential for transfer of carbon between the sediment and water and within the sediment matrix. Feeding mode also has important repercussions for many biogeochemical processes.
Mobility	Adults of faster moving species are more likely to evade local disturbance than slow-moving or sessile individuals. Mobility also affects the ability for adult recolonisation of disturbed areas.
Bioturbation	Describes the ability of the organism to rework the sediments. Can either be upward (e.g. maldanid worms), downward (e.g. oweniid worms), onto the sediment (many suspension-feeders) or mixing of the sedimentary matrix (e.g. glyceriid worms). Bioturbation mode has important implications for sediment-water exchange and sediment biogeochemical properties.

C.9 Functional traits of the key benthic taxa

Table 26: Functional traits of the key taxa for the living habitat, the sediment position and the mobility. See appendix C.8 and Table 14 for details on biological traits modalities.

Key Taxa	Living habit						Sediment position				Mobility			
	Tube-dwelling	Burrow-dwelling	Free-living	Crevice/hole/under stone	Epi/endo zoic/phytic	Attached to substratum	Surface	Infauna: 0-5cm	Infauna: 6-10cm	Infauna: >10cm	Sessile	Swim	Crawl/creep/climb	Burrower
Molluscs														
Abra alba		✓						✓			✓			
Buccinum undatum			✓				✓						✓	
Ensis spp.		✓						✓	✓	✓	✓			
Limecola balthica		✓							✓	✓	✓			
Mytilus edulis						✓	✓				✓			
Nucula nitidosa			✓					✓			✓		✓	
Nucula nucleus			✓					✓			✓		✓	
Crabs and lobsters														
Cancer pagurus			✓				✓	✓					✓	
Homarus gammarus			✓				✓					✓	✓	
Shrimps and Prawns														
Bathyporeia elegans			✓				✓	✓					✓	✓
Gammarus insensibilis			✓				✓	✓					✓	
Corophium volutator		✓						✓					✓	
Crangon crangon			✓				✓					✓		
Pandalus montagui			✓				✓					✓		
Polychaetes														
Nephtys hombergii			✓					✓						✓
Notomastus spp.		✓						✓			✓			
Scalibregma inflatum		✓							✓	✓	✓			
Spiophanes bombyx	✓	✓						✓			✓			
Sabellaria spinulosa	✓						✓				✓			
Echinoderms														
Ophiura ophiura			✓				✓						✓	

Table 27: Functional traits of the key taxa for the morphology, the bioturbation and the feeding mode. See appendix C.8 and Table 14 for details on biological traits modalities.

Key Taxa	Morphology						Bioturbators					Feeding mode					
	Soft	Tunic	Exoskeleton	Crustose	Cushion	Stalked	Diffusive mixing	Surface deposition	Upward Conveyor	Downwards conveyer	None	Suspension	Surface Deposit	Subsurface deposit	Scavenger/Opportunist	Predator	Parasite
Molluscs																	
Abra alba			✓					✓					✓	✓			
Buccinum undatum			✓					✓								✓	
Ensis spp.			✓					✓				✓					
Limecola balthica			✓				✓	✓				✓	✓				
Mytilus edulis			✓					✓				✓					
Nucula nitidosa			✓				✓	✓					✓	✓			
Nucula nucleus			✓				✓	✓					✓	✓			
Crabs and lobsters																	
Cancer pagurus			✓				✓	✓								✓	
Homarus gammarus			✓				✓	✓				✓			✓	✓	
Shrimps and Prawns																	
Bathyporeia elegans			✓				✓						✓	✓			
Gammarus insensibilis			✓					✓					✓				
Corophium volutator			✓				✓	✓					✓				
Crangon crangon			✓					✓								✓	
Pandalus montagui			✓					✓								✓	
Polychaetes																	
Nephtys hombergii	✓						✓								✓	✓	
Notomastus spp.	✓						✓							✓			
Scalibregma inflatum	✓						✓						✓	✓			
Spiophanes bombyx	✓							✓				✓	✓	✓			
Sabellaria spinulosa	✓							✓				✓					
Echinoderms																	
Ophiura ophiura			✓					✓								✓	

Table 28: Functional traits of the key taxa for the longevity, the size range, the larval development strategy and the larval development location.
See appendix C.8 and Table 14 for details on biological traits modalities.

Key Taxa	Longevity				Size range						Larv. Dev. Strategy			Larv. Dev. Location			
	<1 year	1-2 years	3-10 years	>10 year	<10 mm	11-20 mm	21-100 mm	101-200 mm	201-500 mm	>500 mm	Planktotrophic	Lecithotrophic	Direct	Asexual/Budding	Sex. shed eggs- P	Sex. shed eggs- B	Sexual brood eggs
Molluscs																	
Abra alba		✓	✓			✓					✓				✓		
Buccinum undatum				✓			✓	✓					✓			✓	
Ensis spp.				✓				✓			✓				✓		
Limecola balthica			✓			✓	✓				✓				✓		
Mytilus edulis				✓			✓				✓				✓		
Nucula nitidosa			✓			✓					✓				✓		
Nucula nucleus			✓			✓					✓				✓		
Crabs and lobsters																	
Cancer pagurus				✓			✓	✓			✓						✓
Homarus gammarus				✓				✓	✓		✓						✓
Shrimps and Prawns																	
Bathyporeia elegans	✓				✓								✓				✓
Gammarus insensibilis	✓					✓							✓				✓
Corophium volutator	✓				✓								✓				✓
Crangon crangon			✓				✓				✓						✓
Pandalus montagui		✓					✓				✓						✓
Polychaetes																	
Nephtys hombergii			✓				✓				✓				✓		
Notomastus spp.		✓							✓		✓				✓		
Scalibregma inflatum		✓					✓					✓			✓	✓	
Spiophanes bombyx		✓					✓				✓				✓		
Sabellaria spinulosa			✓				✓				✓				✓		
Echinoderms																	
Ophiura ophiura			✓				✓	✓			✓				✓		

C.10 *Sabellaria spinulosa* reef

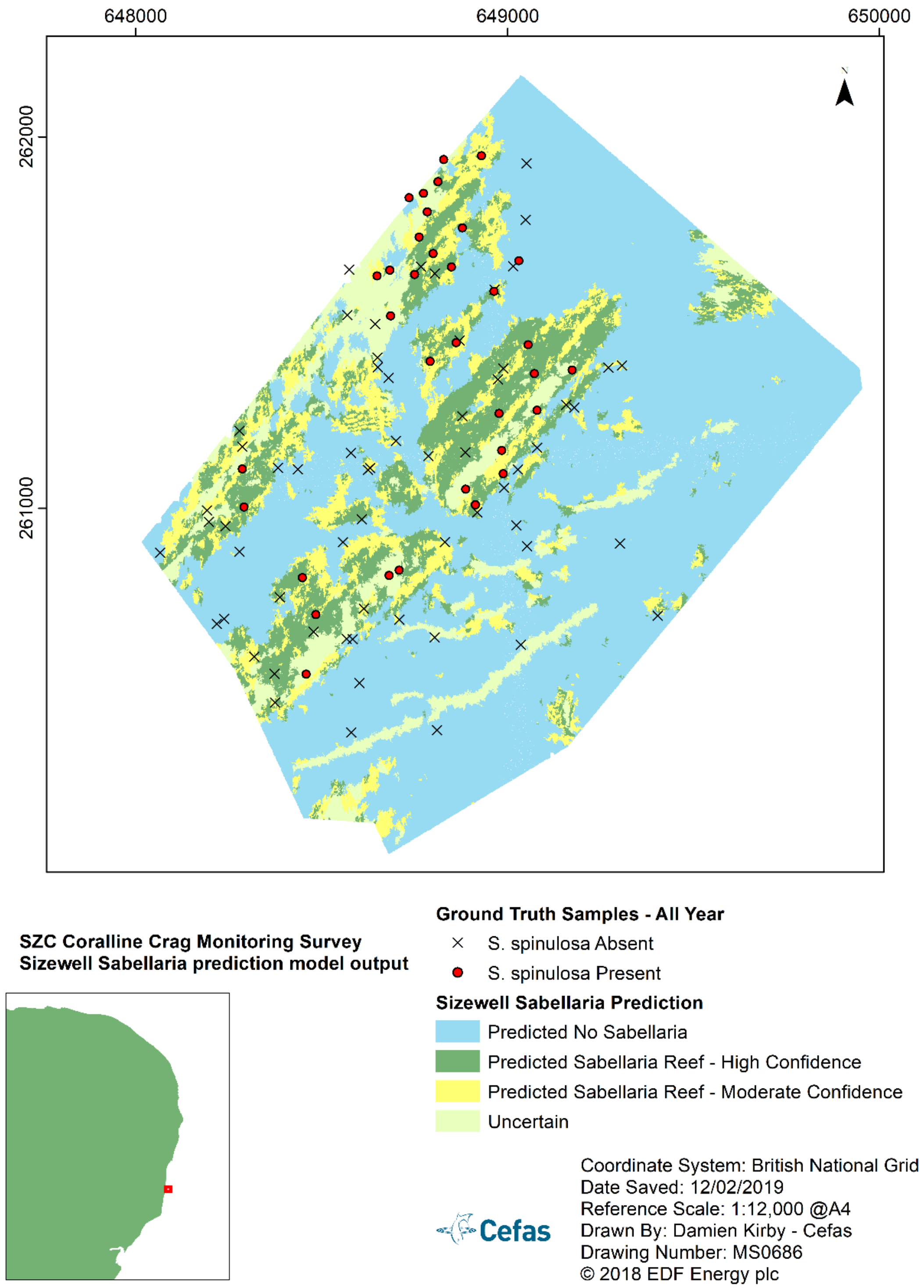

Figure 67: Spatial extent of the *Sabellaria spinulosa* reefs on the inshore Coralline Crag (see BEEMS Technical Report TR473).

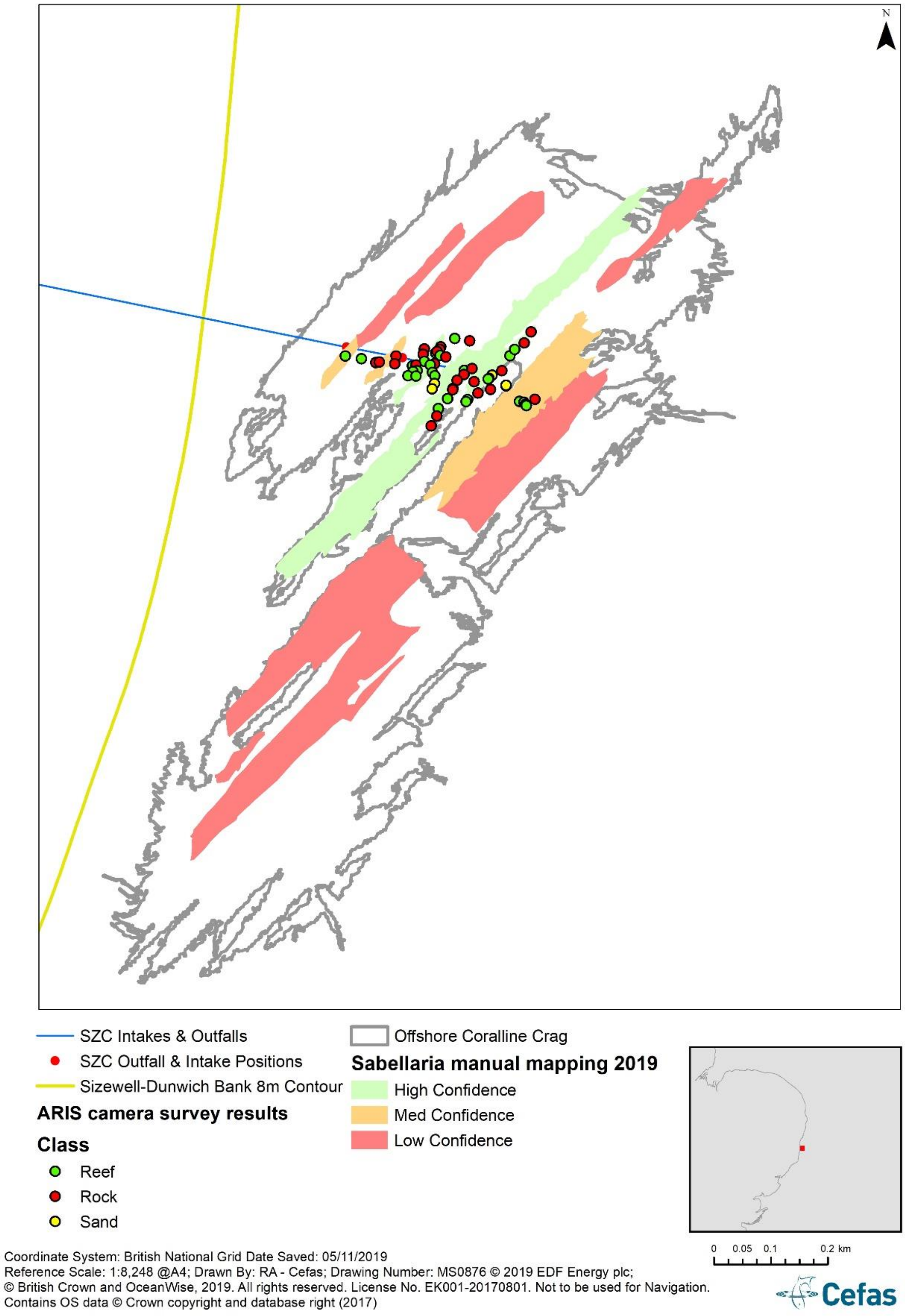

Figure 68: Spatial extent of the *Sabellaria spinulosa* reefs on the offshore Coralline Crag (see BEEMS Technical Report TR512).