Net Zero Teesside – Environmental Statement

Planning Inspectorate Reference: EN010103

Volume III – Appendices

Appendix 14D: Subtidal Benthic Ecology

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended)

Prepared by: AECOM

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14D. Subtidal Benthic Ecology

14.1 Introduction

Project Background

14.1.1 Net Zero Teesside Power Limited (NZT Power) and Net Zero North Sea Storage Limited (NZNS Storage), together the Applicants are seeking Development Consent for the construction, operation, maintenance and decommissioning of the Net Zero Teesside (NZT) Carbon Capture, Usage and Storage (CCUS) Project (the Proposed Development). The Proposed Development comprises the construction, operation and decommissioning of a CCUS facility comprising a gas-fired generating station with an electrical output of up to 860 MWe, together with equipment required for the capture and compression of carbon dioxide (CO_2) emissions from the power generating station. In addition, there is a need for the provision of supporting infrastructure and connections to support the power generating station and to facilitate the development of a wider industrial carbon capture network on Teesside, the construction of which also forms part of the Proposed Development. The Proposed Development also includes high-pressure compression of CO_2 and the onshore section of a pipeline to export the captured CO_2 for off-shore storage.

14.1.2 The Proposed Development forms the onshore part of the wider NZT Project; further details relates to this are provided in Chapter 4: Proposed Development (ES Volume I, Document Ref 6.2).

Aims and Objectives

14.1.3 The purpose of this report is to present the results of the subtidal benthic ecology surveys undertaken for this project, and to highlight key subtidal benthic receptors that may be affected by the development.

14.1.4 This report is intended to form part of the benthic ecological baseline characterisation study that will be undertaken to inform the various environmental assessments (e.g. Environmental Impact Assessment, Habitats Regulations Assessment, Water Framework Compliance Assessment) required to obtain development consent.

14.1.5 This report is not intended to formally characterise material for dredge and disposal purposes; the draft deemed Marine Licences includes a requirement for pre-construction sampling should dredging works be required.

Structure of Report

14.1.6 This report is structured as follows:

- **Section 14.2: Methodology** – summarises the methodology for undertaking the subtidal benthic surveys as well as the approaches taken for sample and data analysis;

- **Section 14.3: Results** – outlines the results of the subtidal benthic surveys;
- **Section 14.4: Discussion** – discusses the results of the project-specific surveys in relation to existing publicly available information; and
- **Section 14.5: Summary of Findings** – provides a summary of the findings of the project-specific surveys and a desk-based study for subtidal benthic ecology.

14.2 Methodology

14.2.1 The subtidal benthic ecology surveys were undertaken by Ocean Ecology Limited (OEL) on the 22 and 23 December 2019.

Study Area

14.2.2 The Study Area was chosen by taking into the account the location of the Project and the predicted Zone of Influence (ZoI) of potential effects arising from the development. In addition, the Study Area was chosen in order to supplement the ground-truthing of existing information collected for Teesside Offshore Wind Farm (OWF). The Study Area encompasses and runs from Long Scar (7 km to the north) to Redcar Sands (7 km to the south) and up to 7.5 km offshore to the northeast.

14.2.3 The survey design was presented to and discussed with the Marine Management Organisation in September 2019; it included 23 sampling stations, from which triplicate sediment grab samples were collected (Figure 14D-1). Eight of these stations are located in the vicinity of the proposed Water Discharge Corridors / the Tees Bay, forming a 500 m x 500 m grid. A further three stations are situated within the main shipping channel within the Tees Estuary, along the south bank of the River Tees and adjacent to Paddy's Hole. In line with predominant tidal movements, two further far field stations (stations 3 and 4) were selected. Additional details of the sampling station locations, and rationale are provided in Table 14D-1.

Table 14D-1: Station locations and rationale

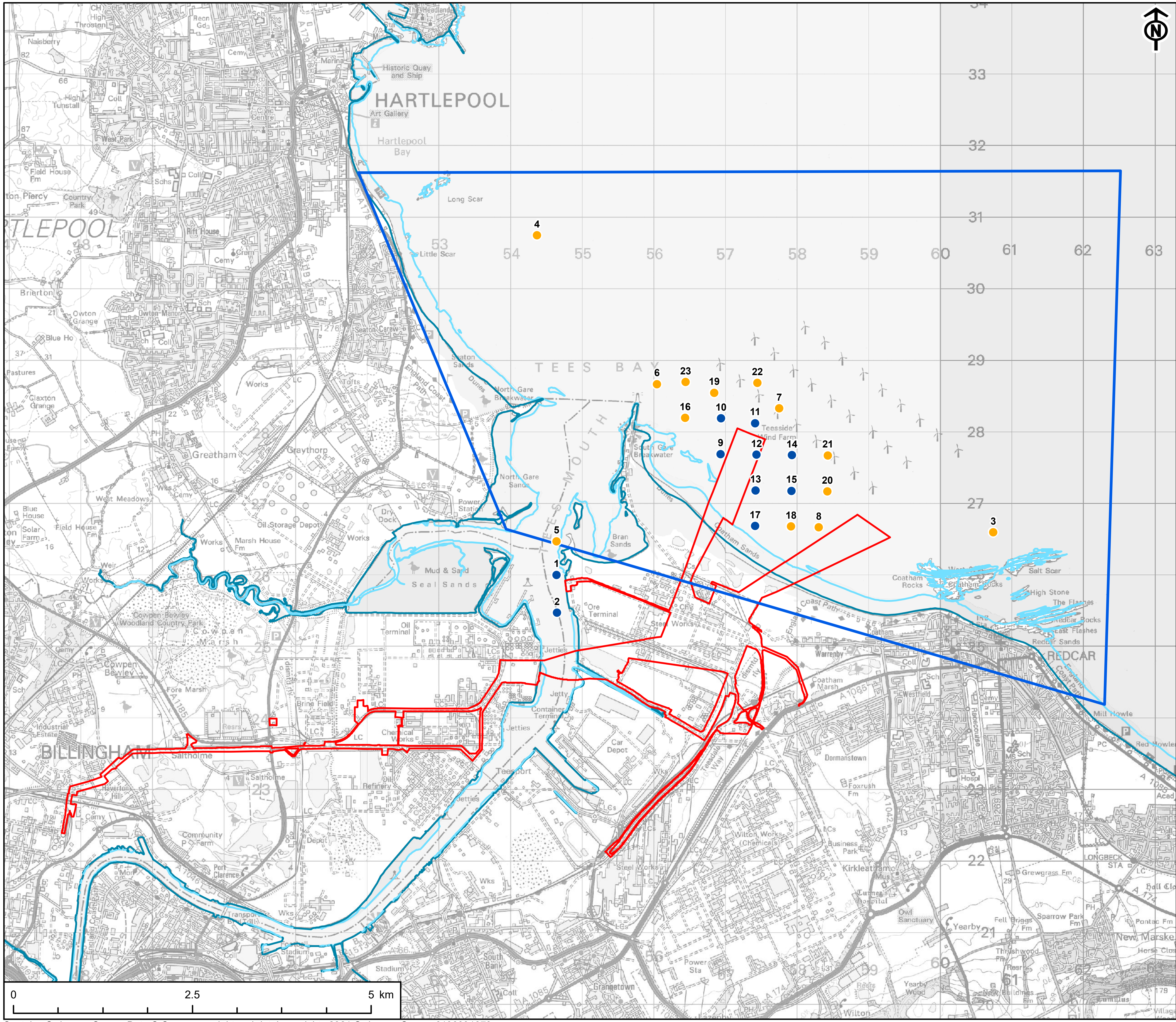
Station	Easting (UTM31)	Northing (UTM31)	Rationale	Sampling Methodology
1	619096	6054757	Proximity to the location of the intake which was potentially required at an earlier phase in the development of the project; it has since been removed.	Macrobenthic / PSA / physico-chemical
2	619115	6054229	Proximity to the location of the intake which was potentially required at an earlier phase in the development of the project; it has since been removed	Macrobenthic / PSA / physico-chemical
3	625189	6055436	Far-field - 3.7 km south east of Existing Water Discharge Corridor	Macrobenthic / PSA

Station	Easting (UTM31)	Northing (UTM31)	Rationale	Sampling Methodology
4	618759	6059500	Far-field - 4.0 km north west of Existing Water Discharge Corridor	Macrobenthic / PSA
5	619095	6055229	Proximity to the location of the intake which was potentially required at an earlier phase in the development of the project; it has since been removed	Macrobenthic / PSA
6	620463	6057444	Teesside OWF Sampling Station	Macrobenthic / PSA
7	622177	6057130	Teesside OWF Sampling Station	Macrobenthic / PSA
8	622749	6055476	Teesside OWF Sampling Station	Macrobenthic / PSA
9	621365	6056479	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
10	621365	6056979	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
11	621840	6056918	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
12	621865	6056479	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
13	621865	6055979	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
14	622365	6056479	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
15	622365	6055979	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
16	620865	6056979	Proximity to Water Discharge Corridors	Macrobenthic / PSA
17	621865	6055479	Proximity to Water Discharge Corridors	Macrobenthic / PSA / physico-chemical
18	622365	6055479	Proximity to Water Discharge Corridors	Macrobenthic / PSA
19	621264	6057334	Proximity to Water Discharge Corridor - within boundary of Teesside OWF	Macrobenthic / PSA
20	622865	6055979	Proximity to Water Discharge Corridors	Macrobenthic / PSA
21	622866	6056482	Proximity to Water Discharge Corridors - within boundary of Teesside OWF	Macrobenthic / PSA
22	621865	6057479	Proximity to Water Discharge Corridors - within boundary of Teesside OWF	Macrobenthic / PSA

Station	Easting (UTM31)	Northing (UTM31)	Rationale	Sampling Methodology
23	620865	6057479	Proximity to Water Discharge Corridors	Macrobenthic / PSA

PSA = Particle Size Analysis; OWF = Offshore Wind Farm

Figure 14D-1: Subtidal benthic sampling stations



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AECOM

PROJECT
NET ZERO TEESSIDE PROJECT

Net Zero Teesside

APPLICANTS
NZT POWER LTD. AND NZNS STORAGE LTD.

KEY
- Site Boundary
- Subtidal Study Area
- Mean Low Water
- Mean High Water

Subtidal Sampling Location - Sampling Method
- Macrobenthic/PSA
- Macrobenthic/PSA/Physico-Chemical

TITLE
FIGURE 14D-1
SUBTIDAL BENTHIC STATION LOCATIONS AND SAMPLING METHOD

REFERENCE
NZT_210511_SBS_14D-1_v5

SHEET NUMBER
1 of 1

DATE
11/05/21

Survey Design

14.2.4 The DSV Curtis Marshall survey vessel was used to collect and process the seabed sediment samples. A 0.1 m^2 Day grab was used to collect seabed samples, with three replicate samples per station. In total, 69 sediment samples (23 stations x 3 replicates) were taken for subsequent faunal and sediment particle size analysis. Additional replicate samples were also collected at 10 of the 23 stations for subsequent chemical analysis (see Table 14D-1).

14.2.5 Each retrieved grab sample was assessed for validity. Grab samples were deemed unacceptable and repeated if:

- the sample was less than 5 L;
- the jaws of the Day grab failed to close;
- the sample was taken from an unacceptable distance from the target location;
- and there was obvious contamination of the sample from the equipment or debris.

14.2.6 If there were three failed attempts the station was moved 50 m away. This occurred for stations 3 and 9, where hard ground at the target locations resulted in multiple failed attempts.

14.2.7 Samples were processed aboard the survey vessel as follows:

- 10% of sample removed for subsequent sediment particle size analysis (PSA) and transferred to labelled container;
- the sediment sample was gently washed through a 1 mm sieve using a seawater hose; and
- the remaining sample was backwashed into a container and preserved using a diluted formalin solution.

Laboratory and Data Analysis

Particle Size Analysis

14.2.8 Particle size analysis (PSA) was undertaken by OEL, on all 69 macrobenthic samples, undertaken in line with North East Atlantic Marine Biological Quality Control (NMBAQC) protocols (Mason, 2016), using dry sieving for the >1 mm fraction and laser diffraction for the fine fraction residue (<1 mm). Further information on analytical methods can be found in Appendix A.

14.2.9 The dry sieve and laser data were merged for each sample with the results expressed as a percentage of the whole sample. Once the data was merged, PSA statistics and sediment classifications were generated from the percentages of the sediment determined for each sediment fraction using the Gradistat v8 software (Blott, 2010).

14.2.10 Sediment fractions were defined by size classes based on the Wentworth scale of particle size (Wentworth, 1922) (Table 14D-2). Statistics such as mean and median grain size, sorting coefficient, skewness and bulk sediment classes (percentage silt, sand and gravel) were also derived in accordance with the Folk classification system (a method of classifying sediment based on particle sizes defined by Wentworth) (Folk, 1954).

Table 14D-2: Wentworth scale of particle size for defining sediment type (Wentworth, 1922)

Wentworth Scale of Particle Size	Phi units (φ)[1]	Sediment Type
≥256 mm	≥8	Boulders
64 - 256 mm	-8 to -6	Cobble
4 - 64 mm	-6 to -2	Pebble
2 - 4 mm	-2 to -1	Granule
1 - 2 mm	-1 to 0	Very coarse sand
0.5 - 1 mm	0 to 1	Coarse sand
250 - 500 µm	1 to 2	Medium sand
125 - 250 µm	2 to 3	Fine sand
63 - 125 µm	3 to 4	Very fine sand
15.63 - 63 µm	4 to 5	Coarse silt
7.81 - 15.63 µm	5 to 6	Medium silt
3.91 - 7.81 µm	6 to 7	Fine silt
1.95 - 3.91 µm	7 to 8	Very fine silt
<1.95 µm	8 to 10	Clay

Sediment Chemistry Analysis

14.2.11 All chemical and metal analysis was undertaken by SOCOTEC UK Limited in accordance with MMO Marine Licensing Requirements (MMO, 2018). Table 14D-3 summarises the analytics.

Table 14D-3: MMO marine sediment analysis carried out by SOCOTEC UK Ltd.

Determinands	Limit of Detection	Method / Instrument
Organic matter (Total Organic Carbon)	0.02%	Carbonate removal and sulphurous Acid / combustion at 800°C / NDIR
Metals suite (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc)	0.015 – 2 mg/kg	Aqua-regia extraction & ICP-MS
Organotins (DBT, TBT)	0.001 mg/kg	Acid digest and solvent extraction GC-MS
Polycyclic Aromatic Hydrocarbons (DTI 2-6 ring aromatics + EPA 16)	1 µg/kg	Solvent extraction & GC-MS

[1] A modification of the Wentworth scale, using a logarithmic ($\varphi = -\log_2 \frac{D}{D_0}$) transformation

Determinands	Limit of Detection	Method / Instrument
Total Hydrocarbon Content	1 mg/kg	Ultra-violet fluorescence spectroscopy
Polychlorinated Biphenyls (25 congeners including ICES 7)	0.00008 mg/kg	Solvent extraction & Triple Quad GC-MS
Organochlorine pesticides	0.0001mg/kg	Solvent extraction & Triple Quad GC-MS

NDIR = Non-dispersive infra-red spectrophotometry; ICP-MS = Inductively coupled plasma mass spectrometry; DBT = Dibutyltin; TBT = Tributyltin; GC-MS = gas chromatography mass spectrometry; DTI = Doppler tissues imaging; EPA = Environmental Protection Agency; ICES = International Council for the Exploration of the Sea

Macrofaunal Analysis

14.2.12 Macrobenthic analysis was undertaken by OEL in line with the NMBAQC Processing Requirement Protocol (PRP) (Worsfold and Hall, 2010).

14.2.13 All biota that had been retained on the 1 mm sieve were identified to species level, where possible, and enumerated by trained benthic taxonomists using the most up to date taxonomic literature and checked against existing reference collections and the World Register of Marine Species (WoRMS) for the latest taxonomic nomenclature. Colonial taxa (e.g. hydroids and bryozoans) were identified to species level where possible and recorded as present (P).

14.2.14 Major group biomass (Annelida, Crustacea, Mollusca, Echinodermata and Other taxa) was measured to the nearest 0.0001 g blotted wet weight. As a standard, conventional conversion factors, defined by Eleftheriou and Basford (1989), were then applied to provide equivalent dry weight biomass (Ash Free Dry Weight). The conversion factors applied were:

- Annelida = 15.5 %;
- Crustacea = 22.5 %;
- Mollusca = 8.5 %;
- Echinodermata = 8.0%; and
- Other = 15.5 %.

14.2.15 A single reference collection, preserved in 70% IDA of all taxa identified, was retained for Quality Assurance (QA) purposes.

14.2.16 The macrofaunal community structure and diversity was analysed using the following parameters:

- abundance (N);
- species richness (S) (total number of species);
- species diversity (H' loge) (Shannon-Wiener index[2]); and
- biomass (g).

[2] Shannon-Weiner index differs from species richness in that it takes into account not just the number of species but also the abundance of each species

Multivariate Analysis

14.2.17 The PRIMER v7 software package (Clarke and Gorley, 2015) was utilised to undertake multivariate statistical analysis on the macrobenthic dataset. In order to fully investigate the community assemblage patterns in the data, a suite of analytical routines was employed – the results for which can be found in Section 14.3.

14.2.18 To remove the weighting of common or rare species within a sample, the data was first transformed (in this instance square-root transformed[3]). A similarity matrix, which groups samples based on their community assemblage, was then constructed, for which the Bray-Curtis coefficient (S') was produced. Following this, cluster analysis was performed which provides 'natural groupings' of samples which is displayed in a dendrogram. An additional 'similarity profile' (SIMPROF) permutation test was then used to find statistically similar cluster groupings. In addition, multi-dimensional scaling (MDS) plots were created, which give a 2-dimensional representation of the similarity between samples. A Similarity Percentage analysis (SIMPER) test was then run to identify the individual species contributing the highest percentage to similarity within the cluster groupings.

14.2.19 To relate abiotic (environmental) factors to the biotic data, the BEST analysis was undertaken. This test identifies if any of the environmental variables measured are correlated with community patterns and provides a test statistic to determine which variables 'best explain'[4] the community patterns. The BIOENV routine completes this analysis in combination with determining a test of significance to give a variable/combination of variables which correlates highest to the biotic community data. Prior to the analysis, the sediment chemical data was log(x) transformed, and all abiotic data was normalised.

14.2.20 PRIMER v7 was also used to calculate a series of diversity metrics including species richness (S) and the Shannon-Weiner index (H' loge) at each station.

Ecological Quality

14.2.21 An assessment of the ecological quality of the infaunal communities was undertaken (Phillips *et al.,* 2014). The status of the sediment dwelling communities was determined using the Infaunal Quality Index (IQI) which was developed as part of the Water Framework Directive classification of transitional and coastal water bodies (Water Framework Directive TAG, 2008). The IQI is a multi-metric tool which utilises the AZTI Marine Biotic Index (AMBI), Simpson's evenness (a diversity index) and the number of taxa to produce an Ecological Quality Ratio (EQR) value which is a measure of the ecologically quality of infaunal communities. From this, an IQI status can be assigned to a benthic community which can range from bad (<0.24) to high (0.75). Where possible, the most up to date AMBI ecological group scores were used, provided via the AMBI software (http://ambi.azti.es). Granulometric data for each sample was also used to inform the IQI analysis,

[3] Data was transformed in order to prevent skewness and the presence of outliers. This was indicated by using a Draftsman Plot (a version of a scatter plot).
[4] The variable or combination of variables with the highest correlation value. It must be noted that correlation does not necessarily imply causation.

as was the salinity regime (‘coastal’, ‘mesohaline’, ‘oligohaline’, ‘polyhaline’, and ‘transitional’).

14.2.22 The AMBI ecological groupings are as follows:

- AMBI EG-I: ‘“Species very sensitive to organic enrichment and present under polluted conditions (Initial state)”;
- AMBI EG-II: “Species indifferent to organic enrichment, always present in low densities with non-significant variations over time (from initial state to slight unbalanced)”;
- AMBI EG-III: “Species tolerant to excess organic matter enrichment. These species may occur under normal conditions, but their populations are stimulated by organic enrichment (slight unbalanced situations)”;
- AMBI EG-IV: “Second order opportunistic species (slight to pronounced unbalanced situations), mainly small sized polychaetes”; and
- AMBI EG-V: “First-order opportunistic species (pronounced unbalanced situation)”

Habitat Classification

14.2.23 Environmental, sediment PSA and macrofaunal data obtained during the surveys was used to classify the habitats present in accordance with the European Union Nature Information System (EUNIS) classification system (EEA, 2012). An example is shown in Table 14D-4. This classification system uses standard descriptions called ‘biotopes’, which categorise habitats based on the marine zone, the physical nature of the habitat and the biological communities observed. For example, marine habitats can be divided into littoral (also known as intertidal) and subtidal zones, and then classified according to the physical nature of the substratum, either rock or sediment, and the biological community found. Habitats observed were recorded to the lowest level possible.

Table 14D-4: Example of the five-level EUNIS classification system (EEA, 2012)

Level	Habitat Detail
1. Environment	Marine (A)
2. General Habitats	Sublittoral sediment (A5)
3. Broad Scale Habitat	Sublittoral sand (A5.2)
4. Biotope Complexes	Infralittoral fine sand (A5.23)
5. Biotopes	[*Fucus vesiculosus*] on variable salinity mid eulittoral boulders and stable mixed substrata (A1.323)

14.3 Results

Particle Size Distribution

14.3.1 The major sediment fractions at each sampling station are presented in Figure 14D-2. The PSA data has been summarised and classified as per the Folk (1954) classification system (as described in Table 14D-5). There was little variation between the stations located on the coast (excluding stations 1,2, and 5), most of them being dominated be sandy sediments, with a generally low mud (sediment <63 µm) and gravel content (sediment ≥2 mm). For the stations located in the mouth of the Tees estuary (stations 1, 2, and 5), mud represented the highest sediment fraction (>80%). The classification of most stations was 'slightly gravelly sand' (stations 3, 4, 7 - 21, 23), 'slightly gravelly muddy sand' (station 6), and 'sand' (station 22). The stations 1, 2, and 5, which had a higher content of mud, were classified as 'sandy mud'. See Appendix B for full PSA results for replicate samples.

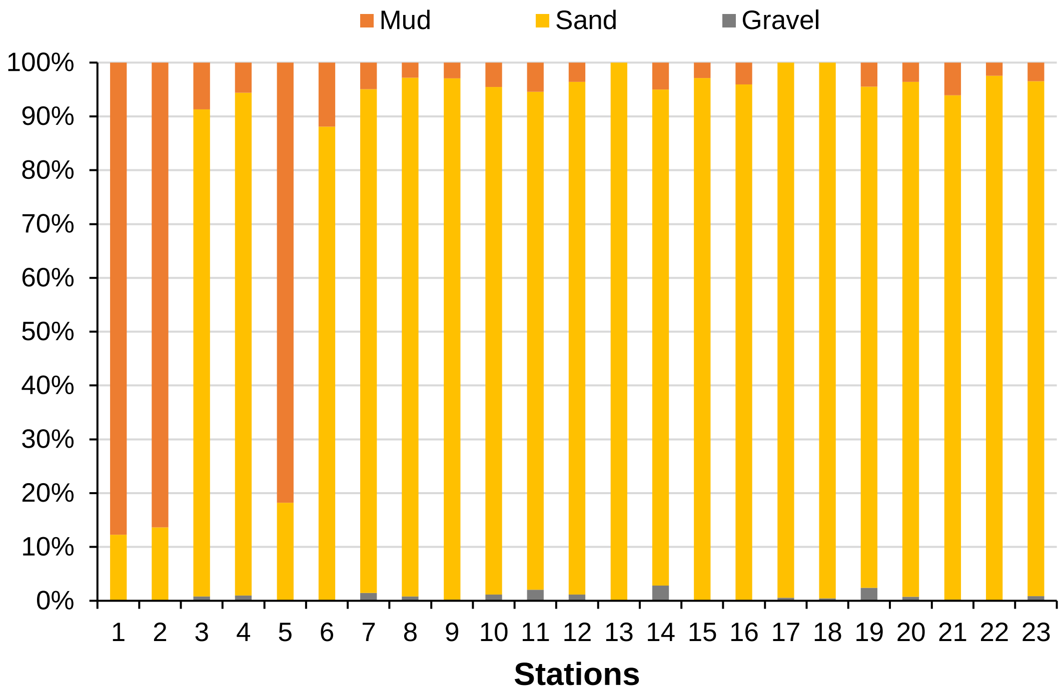


Figure 14D-2: Major sediment fractions (%) at each sampling station (replicate data averaged)

Table 14D-5: Summarised PSA data as classified by Folk (1954) (replicate data averaged)

Station no.	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Sediment Classification	Modified Folk
1	Medium Silt	Very Poorly Sorted	34.4	6.15	Sandy Mud	sM
2	Coarse Silt	Very Poorly Sorted	36.0	6.09	Sandy Mud	sM
3	Fine Sand	Moderately Sorted	193.6	3.07	Slightly Gravelly Sand	(g)S
4	Fine Sand	Moderately Well Sorted	208.5	2.98	Slightly Gravelly Sand	(g)S
5	Coarse Silt	Very Poorly Sorted	42.06	5.92	Sandy Mud	sM
6	Fine Sand	Poorly Sorted	160.6	3.18	Slightly Gravelly Muddy Sand	(g)mS
7	Fine Sand	Moderately Sorted	290.5	2.70	Slightly Gravelly Sand	(g)S
8	Fine Sand	Moderately Well Sorted	294.4	2.44	Slightly Gravelly Sand	(g)S
9	Fine Sand	Poorly Sorted	336.7	2.18	Slightly Gravelly Sand	(g)S
10	Fine Sand	Moderately Sorted	279.2	2.64	Slightly Gravelly Sand	(g)S
11	Fine Sand	Moderately Sorted	323.8	2.70	Slightly Gravelly Sand	(g)S
12	Fine Sand	Moderately Sorted	336.9	2.58	Slightly Gravelly Sand	(g)S
13	Fine Sand	Moderately Sorted	298.6	2.08	Slightly Gravelly Sand	(g)S
14	Fine Sand	Moderately Sorted	567.4	2.67	Slightly Gravelly Sand	(g)S
15	Fine Sand	Moderately Well Sorted	212.5	2.61	Slightly Gravelly Sand	(g)S
16	Fine Sand	Moderately Well Sorted	195.8	2.71	Slightly Gravelly Sand	(g)S
17	Fine Sand	Moderately Well Sorted	276.0	2.18	Slightly Gravelly Sand	(g)S
18	Fine Sand	Moderately Well Sorted	270.9	2.20	Slightly Gravelly Sand	(g)S
19	Fine Sand	Poorly Sorted	419.0	2.46	Slightly Gravelly Sand	(g)S
20	Fine Sand	Moderately Well Sorted	342.2	2.60	Slightly Gravelly Sand	(g)S
21	Fine Sand	Moderately Sorted	165.8	3.01	Slightly Gravelly Sand	(g)S
22	Fine Sand	Moderately Sorted	235.4	2.44	Sand	S
23	Fine Sand	Poorly Sorted	361.6	2.42	Slightly Gravelly Sand	(g)S

Sediment Chemistry

14.3.2 Sediment samples for contaminant analysis were collected at 10 of the 23 subtidal sampling stations (Table 14D-1: Station locations and rationale). Samples were analysed for heavy and trace metals, Polycyclic Aromatic Hydrocarbons (PAHs), Total Hydrocarbon Content (THC), Organotins, Polychlorinated Biphenyls (PCB) and Organochlorine concentrations. The full results of the sediment chemical analysis can be found in Appendix C.

Heavy and Trace Metals

14.3.3 Concentrations of eight heavy and trace metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) were analysed for each of the 10 subtidal sampling stations. In the absence of any statutory thresholds, sediment concentrations have been compared to guidelines published by the Centre for Environment, Fisheries and Aquaculture Science (Cefas, 2003), and the Canadian Council of Ministers of the Environment (CCME, 1999) where applicable (i.e. no Cefas threshold available), to determine whether there is evidence of contamination.

14.3.4 The Cefas guidelines relate to the disposal of dredge material. There are two Cefas threshold levels; Action Level 1 (AL1) and Action Level 2 (AL2). In general, contaminant levels in dredged material which fall below (AL1) are of no concern. Levels above AL2 generally suggest that the dredged material is not suitable for sea disposal. Contaminant levels between AL1 and AL2 typically require further investigation.

14.3.5 The Canadian sediment quality guidelines consist of Threshold Effects Levels (TELs) and Probable Effects Level (PELs) (CCME, 1999). These thresholds have been derived from field research investigating the associations between chemicals and biological effects and the establishment of cause and effect relationships in certain marine organisms. At levels above the TEL, adverse effects may occasionally occur and at levels above the PEL, adverse effects may occur frequently (CCME, 1999).

14.3.6 Elevated levels of trace metals were recorded at stations 1 and 2, where the concentrations of all metals analysed, with the exception of cadmium, were greater than the Canadian guideline TEL. Concentrations of arsenic, chromium, nickel, lead, and zinc at stations 1 and 2 were also greater than the CEFAS guideline AL1. All other stations had relatively low levels of trace metals, with the exception of stations 10 and 11 for which concentrations of arsenic were greater than the Canadian guideline TEL. Of the trace metals recorded, no stations had concentrations which were greater than the respective CEFAS AL2 or the Canadian PEL thresholds.

Hydrocarbon Concentrations (PAHs and THC)

14.3.7 Where available, PAH concentrations were compared to Effects Range Low (ERL) and Effects Range Medium (ERM) levels published by Long *et al*. (1995) as well as the Canadian TEL and PEL thresholds (CCME, 1999).

14.3.8 ERL and ERM concentrations are not thresholds of toxicity but delineate concentration ranges with associated probabilities of toxicity. Concentrations below the ERL represent a range in which detrimental effects on marine ecology would rarely be observed. Concentrations equal to or above the

ERL, but below the ERM, represent a range within which effects could be occasionally expected. Finally, concentrations equalling or exceeding the ERM represent a range within which effects could frequently be expected.

14.3.9 Similarly, Canadian TEL and PEL concentrations can be used as an assessment tool for identifying sediments in which adverse biological effects may occur (CCME, 1999). However, TELs and PELs should be treated as indicative, as they have been designed specifically for Canada and are based on the protection of pristine environments and species which may have different sensitivities to those in the North Sea.

14.3.10 Concentrations of PAHs were considerably higher at stations 1 and 2 compared to all other stations (see Table C-2 in Appendix C). At these stations, the concentrations of acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, diben[ah]anthracene, fluoranthene, and pyrene were all greater than the TELs and ERLs, whilst benzo[ghi]perylene and indeno[1,2,3-cd]pyrene were greater than the ERL only (this was the only standard available for these analytes). In addition to this, the concentrations of acenaphthene, fluorene, naphthalene, and phenanthrene were all greater than their respective PELs. The concentrations of naphthalene (station 1: 1,190 µm/kg, station 2: 1,410 µm/kg) and phenanthrene (station 1: 1,310 µm/kg, station 2: 1,440 µm/kg) in particular, were considerably higher than the PEL and close to the ERM, which was 2100 µm/kg and 1500 µm/kg, respectively. Furthermore, the concentration of chrysene at station 1 and 2 of 491 µm/kg and 515 µm/kg, respectively, was above the ERM (384 µm/kg). At all other stations, the concentrations of PAHs were below the standards presented, with the exception of naphthalene at station 11 which was above the TEL.

14.3.11 As with PAHs and trace metals, levels of THC at stations 1 and 2 were considerably higher than all other stations where concentrations were generally low. The United Kingdom Offshore Operators Association regards a value of 50 mg/kg to be the lower limit for a biological effect for THC (UKOOA, 2002). THC concentrations at stations 1 and 2, with concentrations of 581 and 334 respectively, were an order of magnitude higher than this.

Organotins

14.3.12 Samples collected for contaminant analysis were analysed for the organotins: dibutyltin and tributyltin. All concentrations of organotins were found to be below the limit of detection of <0.001 mg/kg.

Polychlorinated Biphenyls (PCBs)

14.3.13 All total PCB concentrations sampled were below Cefas AL1 (0.01 mg/kg dry weight), except for station 2 which had a concentration of 0.011 mg/kg. In addition, all concentrations were below the Canadian TELs (21.5 mg/kg dry weight).

Organochlorines

14.3.14 Organochlorines were compared to Cefas AL1 thresholds as well as OSPAR Background Concentration (BC) levels (OSPAR, 1998). BCs are assessment tools intended to represent the concentrations of certain hazardous substances that would be expected in the North-East Atlantic if certain industrial developments had not happened. They represent the concentrations of those substances at “remote” sites, or in “pristine” conditions based on contemporary or historical data respectively, in the absence of significant mineralisation and/or oceanographic influences.

14.3.15 At the majority of stations, organochlorine concentrations fell below the limit of detection. This was with the exception of some organochlorine analytes at stations 1 and 2. However, concentrations of organochlorines at all stations remained below the OSPAR BC thresholds (0.050 mg/kg dry weight) and comparative Cefas AL thresholds.

Macrobenthos

14.3.16 In total, 111 infaunal taxa were recorded across all 23 stations sampled. The macrobenthic community had a mean species richness of 14.4 (stdev = ± 5.1; ranging from 2 to 28 per sample). The mean abundance across all samples was 787.5 individuals/m^2 (stdev = ± 504.5) whilst the average biomass was 6.12 g/m^2 (stdev = ± 12.98).

14.3.17 Annelida were the most abundant fauna recorded, representing 75.3% of the total average abundance across all the samples (Figure 14D-3). Crustacea and Mollusca exhibited the second and third highest average abundances, measuring 87.2 individuals/m^2 (11.1%) and 86.8 individuals/m2 (11.1%), respectively. Echinodermata accounted for just 1.3% of the total average abundance, whilst the ‘other’ category contributed 1.3%. Phyla such as Platyhelminths and Nematoda, as well as phyla Nemertea and Phoronida were proportionally dominant within the ‘other’ group.

14.3.18 The average biomass across all samples, presented in Figure 14D-3, showed a similar pattern to abundance with the phylum Annelida contributing the greatest proportion to average biomass (34.2%) followed by Crustacea (27.8%), Mollusca (25.1%) and Echinodermata (10.0%). ‘Other’ contributed the lowest to average biomass overall, representing 0.2 g/m^2 (3.0%).

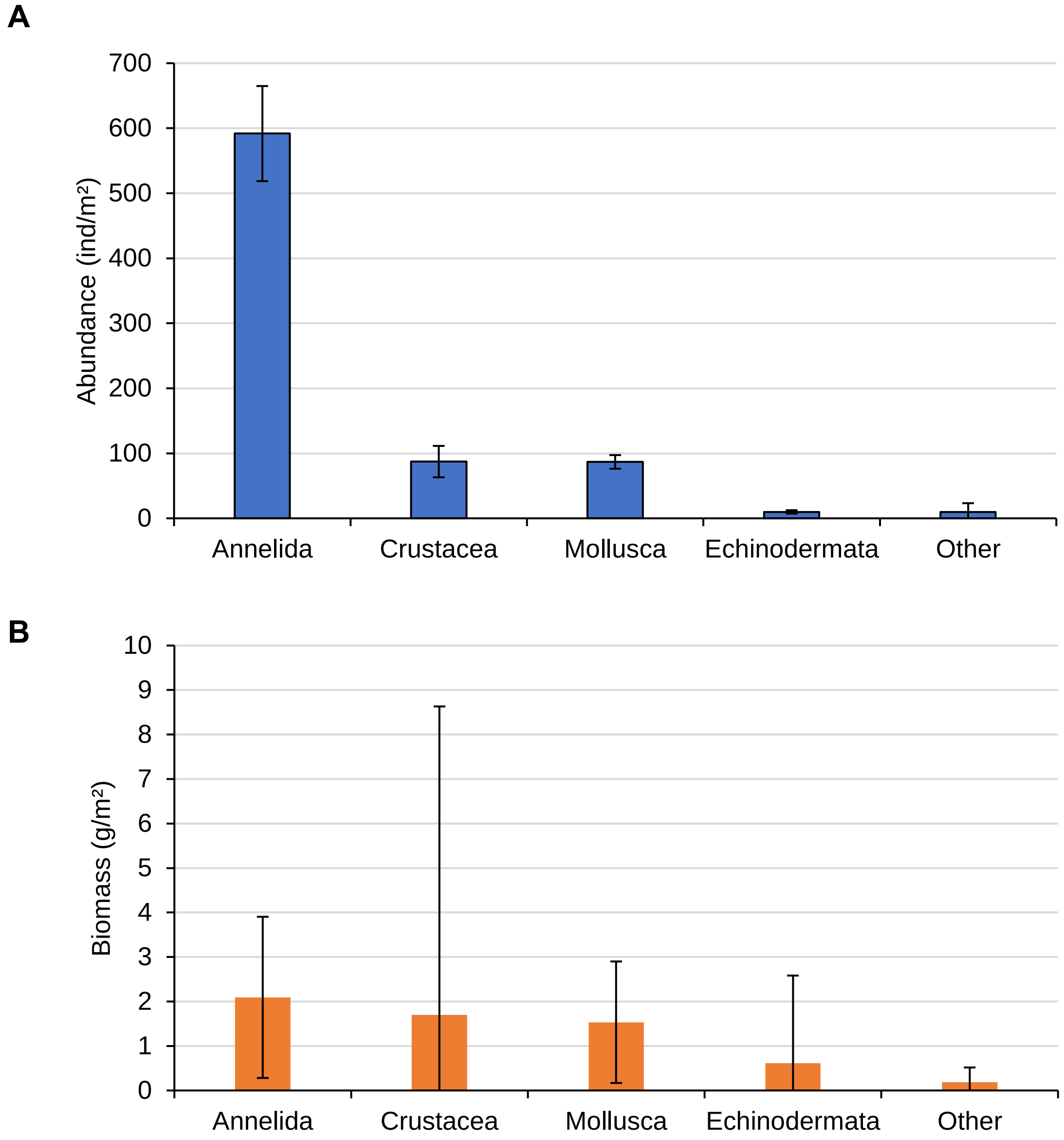


Figure 14D-3: Average abundance (individuals/m^2) (A) and biomass (g/m^2) (B) across all sampling stations for each phylum recorded

14.3.19 Macrobenthic communities were found to be dominated by the polychaete *Magelona johnstoni* with this species representing 53.0% of the overall abundance recorded and an average abundance of 416.4 individuals/m^2 across the 23 stations sampled (Figure 14D-4). This species had an average abundance of 416.4 individuals/m^2, which represented the highest proportion of abundance overall (53.0%). All other taxa each contributed less than 10% to the total average abundance, demonstrating the low abundance but relatively high diversity of samples.

14.3.20 Two amphipod crustacean species were recorded in the top ten most abundant taxa including *Bathyporeia guilliamsoniana* and *Bathyporeia elegans*, with the former representing the second highest average abundance (52.5 individuals/m^2) of all species sampled. The mollusc bivalve, *Fabulina fabula*, was the fourth most abundant species, with an average of 23.0 individuals/m^2 recorded. The bivalve and polychaeta genus, *Spisula* sp. and *Nephtys* sp. (respectively), are comprised of juvenile individuals which may explain their relatively high proportions of abundance compared to other taxa. Appendix E presents the abundance of each taxon and biomass per major group (Annelida, Crustacea, Mollusca, Echinodermata and Others) in all samples collected across the survey area.

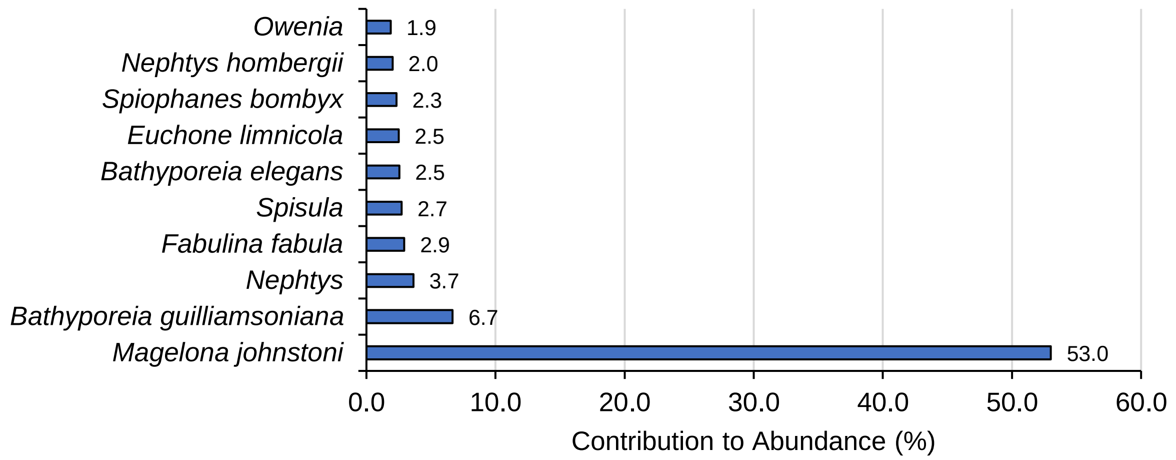


Figure 14D-4: Percentage (%) contribution of the ten highest recorded taxa to average abundance across all sampling stations

14.3.21 The species richness (total number of species, S) and diversity (Shannon diversity index, H') at each station is presented in Figure 14D-5. Species richness was highest at station 11 (S = 37), where diversity was also relatively high (H' = 2.303). The highest diversity of species was recorded at station 5 (H' = 2.854), which is located within the mouth of the Tees estuary. Stations 1 and 2 in this area also had values of diversity which were above average (H' = 1.962 and 2.305, respectively), although species richness recorded at station 1 had the fourth lowest value of species richness across all sites (S = 17). Species diversity was lowest at stations 22, 13 and 16, where values (H') of 1.296, 1.293, 1.275 was recorded, respectively. The lowest species richness was recorded at station 9 (S = 11), 13 (S = 11), and 17 (S = 8), which were all situated close to the shore (Figure 14D-5).

Priority Species and INNS

14.3.22 No species afforded conservation protection were recorded during the subtidal benthic grab surveys. Furthermore, no Invasive Non-Native Species (INNS) were recorded in any of the samples.

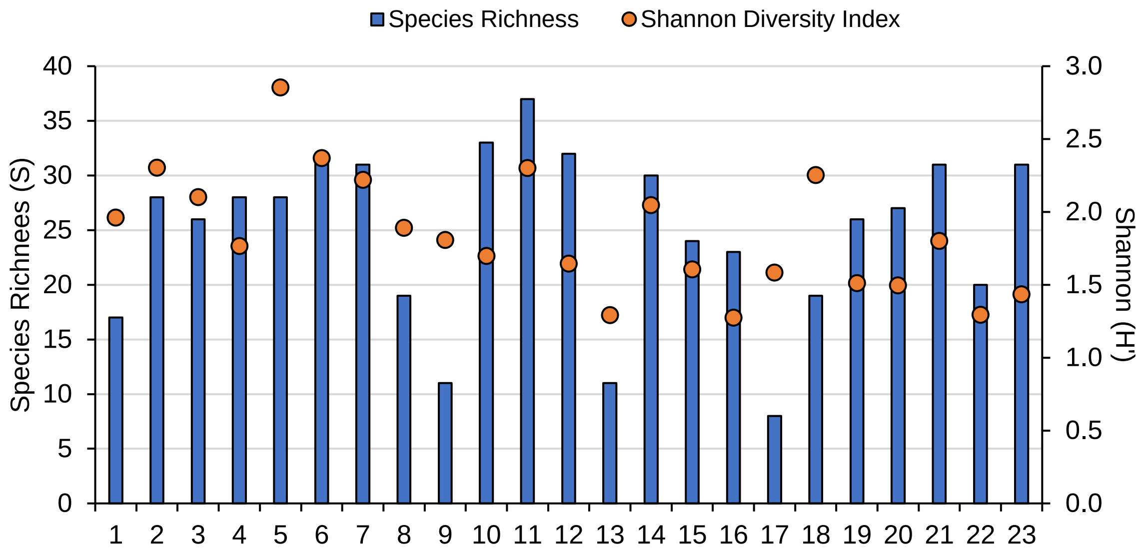


Figure 14D-5: Average species richness (S) and Shannon diversity index (H') recorded at each subtidal station

Multivariate Analysis

14.3.23 Figure 14D-6 shows the non-metric MDS plot[5] of the community abundance data (square root transformed) from each sampling station, following the Bray-Curtis dissimilarity analysis. Samples with greater similarities in species composition are placed closer to one another on the plot with more dissimilar samples placed further away.

14.3.24 The MDS plot shows a clustering of the majority of samples, but with a high level of dissimilarity to the community composition of samples taken from stations 1, 2, and 5, which are located in the mouth of the Tees estuary. Some dissimilarity in faunal communities compared to other samples is also evident for stations 9, 13, and 17 and to a lesser extent, stations 8 and 18.

14.3.25 Cluster analysis and a SIMPROF test has identified 11 discrete groups of samples. The results of these tests have been overlaid on the MDS plot (Figure 14D-6) and are reported in full on a cluster dendrogram in Figure 14D-7. These analyses show conformity between most stations (44 from a total of 69) assigned as group 'g', 'h', 'i' and 'f'. Group 'c' highlights the distinction of samples from stations 1, 2 and 5, although two replicates (1c and 5a) were not significantly similar ($P < 0.05$), falling within group 'b' and 'e', respectively. Stations 13 and 17 have been segregated, falling within group 'd', whilst additional clustering is apparent of stations 8 and 18, assigned to group 'j', and all samples from station 6 which comprise group 'i'.

[5] A multi-dimensional scaling (MDS) plots gives a 2-dimensional representation of the similarity between samples.

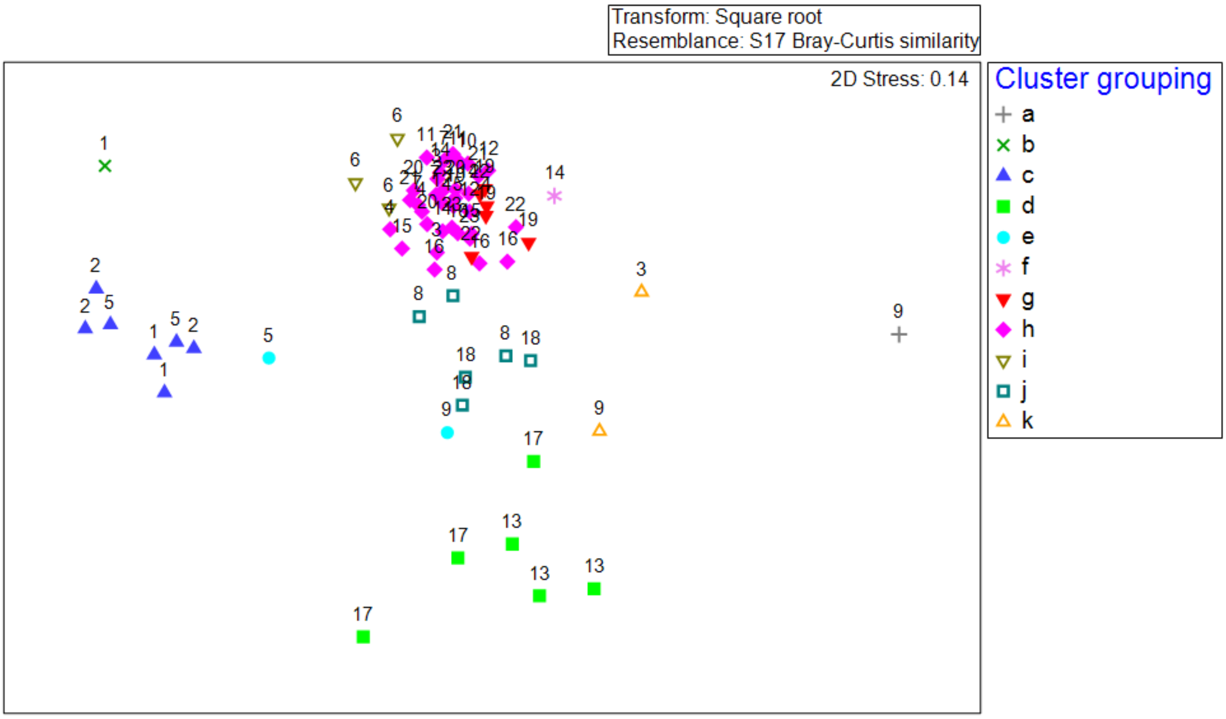


Figure 14D-6: Non-metric MDS plot of community abundance data (square root transformed), with results of SIMPROF cluster analysis overlaid

14.3.26 SIMPER analysis has identified the key taxa which contribute the most to within group similarity in community composition. The results of the analysis are presented in Table 14D-6. The species *Magelona johnstoni* contributed the most to similarity in groups ‘d’, ‘e’, ‘g’, ‘h’, ‘j’ and ‘k’, with percentages ranging from 24.8% to 55.1%. *Bathyporeia* sp. were also dominant in four out of 11 groups, *Bathyporei guilliamsoniana* contributed highly to similarity in group ‘h’ and ‘j’. The bivalve *Fabulina fabula* also was highlighted by the SIMPER analysis for groups ‘h’ and ‘i’. Polychaete worms of the genus *Nephtys*, including *Nephtys cirrosa* and *Nephtys hombergii*, were of particular note in groups ‘a’, ‘b’, ‘c’, ‘e’, ‘g’, ‘h’, ‘I’ and ‘j’.

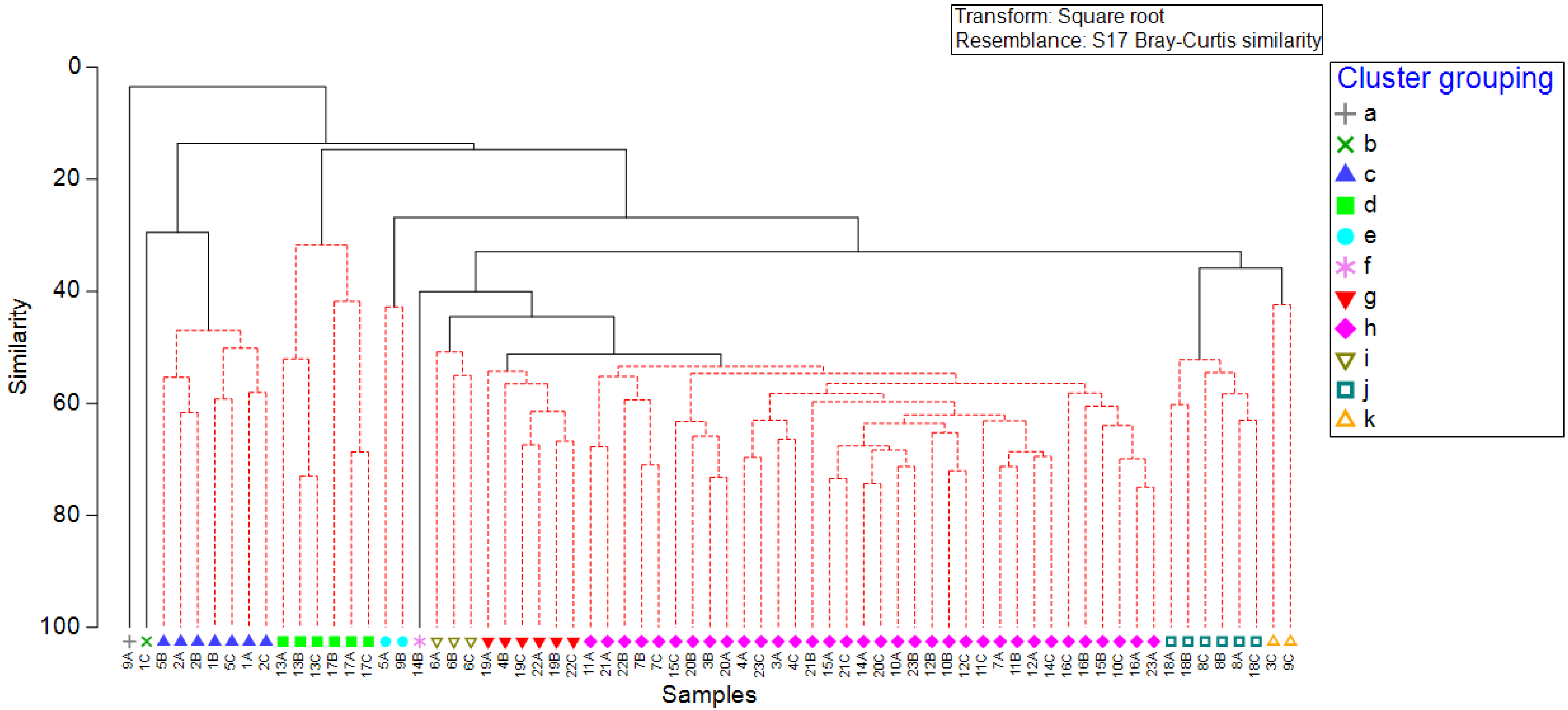


Figure 14D-7: Cluster dendrogram of community abundance data (square root transformed), with results of SIMPROF cluster analysis overlaid

Table 14D-6: Results of SIMPER analysis, comparing within cluster group similarity

Group A*	Group B*	Group C	Group D
Pisione remota	*Nephtys hombergii*	*Euchone limnicola* (21.14%)	*Magelona johnstoni* (35.72%)
Glycera lapidum	*Eteone longa*	*Nephtys* sp. (juv) (20.69%)	*Bathyporeia elegans* (31.59%)
Nephtys cirrosa	*Nephtys* sp. (juv)	*Eteone longa* (10.94%)	*Pontocrates altamarinus* (18.06%)
		Nephtys hombergii (9.63%)	
		Prionospio fallax (7.78%)	
Group E	**Group F***	**Group G**	**Group H**
Magelona johnstoni (55.05%)	*Bathyporeia elegans*	*Magelona johnstoni* (50.22%)	*Magelona johnstoni* (36.31%)
Nephtys sp. (juv) (22.47%)	*Magelona johnstoni*	*Nephtys cirrosa* (9.05%)	*Bathyporeia guilliamsoniana* (10.34%)
	Spisula sp. (juv)	Nemertea (7.41%)	*Spisula* sp. (juv) (8.12%)
		Chaetozone christiei (6.44%)	*Fabulina fabula* (5.34%)
			Owenia sp. (5.25%)
			Nephtys sp. (juv) (4.93%)
Group I	**Group J**	**Group K**	
Magelona johnstoni (24.76%)	*Magelona johnstoni* (35.07%)	*Magelona johnstoni* (52.29%)	
Fabulina fabula (22.25%)	*Bathyporeia guilliamsoniana* (17.04%)	*Diastylis bradyi* (27.95%)	
Spiophanes bombyx (7.92%)	*Nephtys cirrosa* (13.91%)		
Owenia sp. (7.92%)	*Macomangulus tenuis* (9.87%)		
Nephtys sp. (juv) (6.92%)			
Nephtys assimilis (6.92%)			

**Less than two samples present in group and therefore no SIMPER results were produced. The species shown signify those that dominated the total abundance for that sample.*

Environmental Data

14.3.27 The non-metric MDS plot for sediment data, presented in Figure 14D-8, shows the Folk (1954) classifications of each sample overlaid on the faunal MDS plot. This gives a description of the sediment characteristics at each station, providing some explanation as to the difference in the benthic species assemblage for each sample.

14.3.28 A clustering of samples classified as 'sandy mud' which were taken from stations 1, 2, and 5 (cluster groups 'b', 'c', and 'e') is evident. The substrate composition of the remaining samples was characterised by predominantly 'sand', with a small proportion of gravel or gravel with mud in some cases. These subtle differences in substrate composition did not appear to explain dissimilarity between the remaining samples. For example, samples belonging to cluster group 'd' represented the same substrate types (i.e. 'slightly gravelly sand' and 'sand') as the remaining cluster groups ('a', 'g', 'h', 'i' and 'f'), yet macrofaunal communities differed between these groups as indicated by the spatial separation of points shown on the faunal MDS plot.

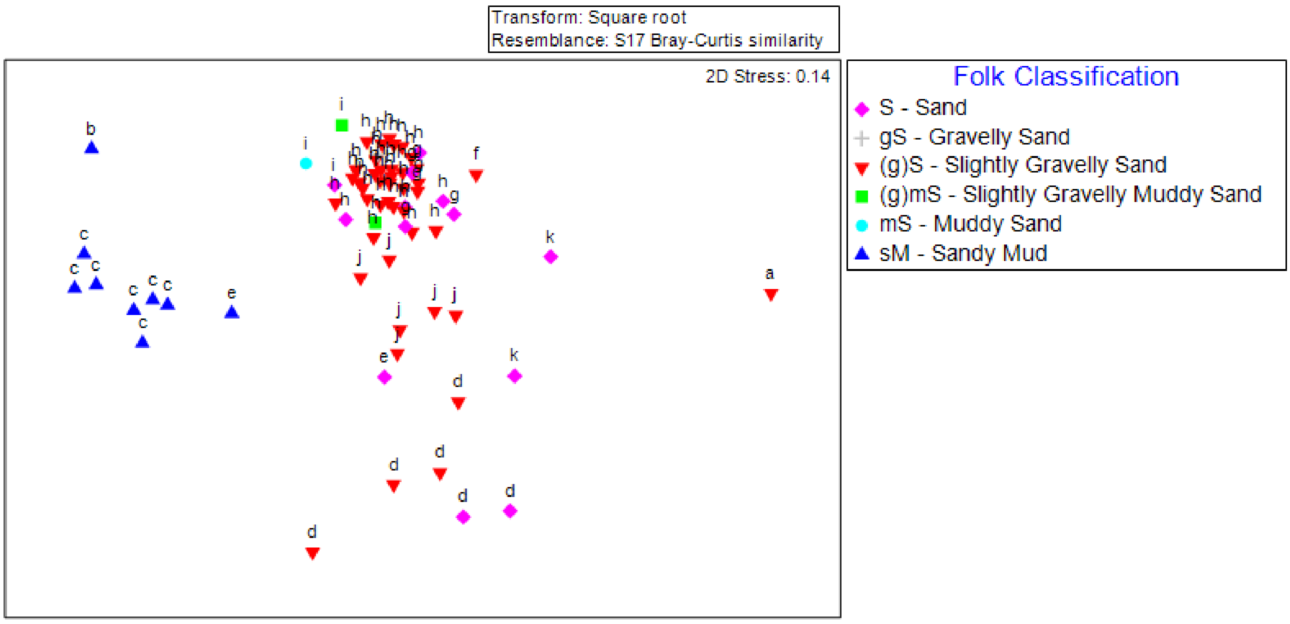


Figure 14D-8: Non-metric MDS plot of community abundance data (square root transformed), with respect to Folk (1954) classification[6] for each sample

14.3.29 A BEST analysis, using the BIOENV method, was undertaken to determine if various abiotic factors could explain the dissimilarity between samples. An initial analysis was run looking at both mean particle size, depth, and the percentage content of mud, sand, and gravel in the sediment of each sample. The results of the Global BEST Test indicated that a combination of both the percentage sediment content of mud and water depth provided the best explanation for faunal community dissimilarity ($\rho = 0.679$). The next best explanation for dissimilarity was depth and the percentage sediment content of sand ($\rho = 0.678$). Looking at each variable individually, the percentage

[6] S = 'sand', gS = 'gravelly sand', (g)S = 'slightly gravelly sand', (g)mS = 'slightly gravelly muddy sand', mS = 'muddy sand', sM = 'sandy mud',

sediment content of mud has the highest correlation value overall (ρ = 0.613).

14.3.30 An additional BEST analysis was performed, testing a greater range of abiotic variables as follows: mean particle size, depth, percentage sediment content of mud, sand, and gravel, trace metals, and PAHs. Due to the methods of the sediment chemical analysis, the test could only be completed for stations 1, 2, 9, 10-15, and 17, for which an average per station was analysed. The Global BEST Test found that a combination of the PAHs (diben[ah]anthracene, phenanthrene, and pyrene), provided the greatest overall explanation (ρ = 0.892) for the dissimilarity in species composition between stations. For each variable individually, the BEST analysis found c1-phenanthrene to have the highest value of correlation (ρ = 0.883). Depth and the percentage sediment content of mud also provided some explanation to the variation between community assemblages (ρ = 0.874 and ρ = 0.823, respectively).

14.3.31 Stations 1 and 2 exhibited elevated levels of PAHs compared to other stations but also had different sediment types and exposure regimes, being located in the mouth of the Tees Estuary. It should be noted that correlation does not always indicate causal effect, and it is likely a combination of variables is driving community dissimilarity.

Ecological Quality

14.3.32 An EQR value has been calculated, providing an overall infaunal quality index (IQI) status using Water Framework Directive (WFD) classification metrics, which includes a combination of AZTI Marine Biotic Index (AMBI) scores (ecological groupings, AMBI-EG's I-V, of sensitive and opportunistic species), Simpson's evenness, and environmental data (sediment PSA and salinity) (WFD TAG, 2008; Phillips *et al.,* 2014). The results of these calculations are presented in Figure 14D-9.

14.3.33 Almost all stations were categorised as having 'Good' IQI status. There were two stations with a High IQI status and two with 'Moderate' (Figure 14D-9). Stations 2 and 5 which had a 'High' IQI status overall. These stations are located in the mouth of the Tees estuary and were characterised by the presence of *Nephtys hombergii, Nephtys* sp. and *Euchone sp.*, which are all assigned to AMBI-EG's II ('species indifferent'). Stations 13 and 17 which are located further inshore had an IQI status of 'Moderate'.

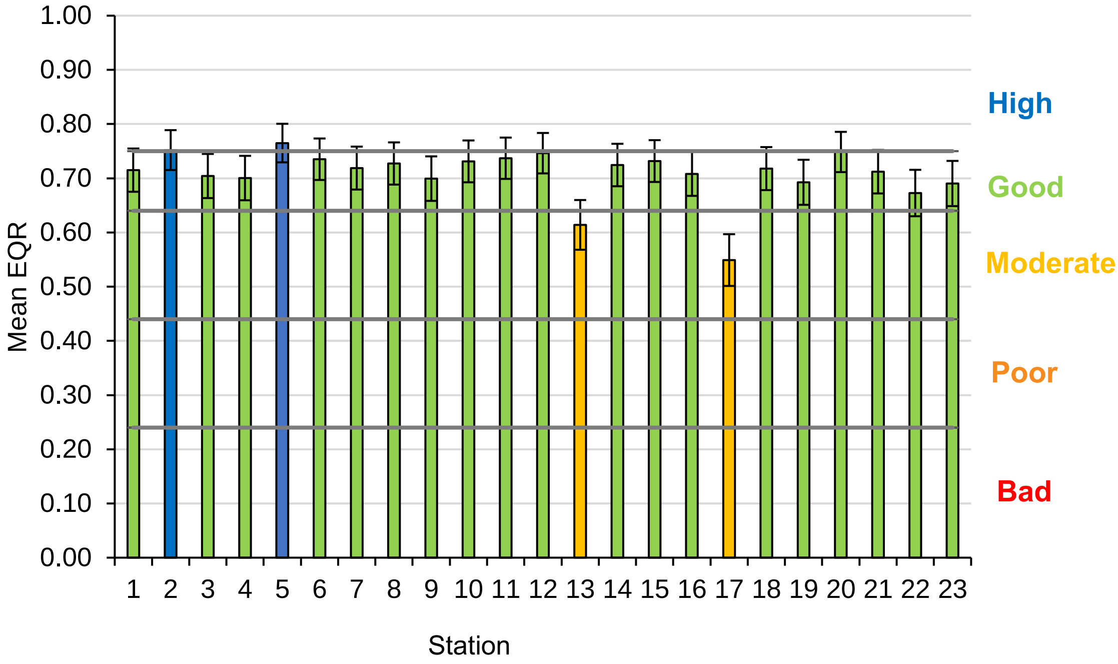


Figure 14D-9: Mean ecological quality ratio (EQR) scores (error bars represent standard error) at each station to inform the overall infaunal quality index (IQI) status

Key Habitats and Species

14.3.34 Across the subtidal benthic sampling stations, and based on the sediment PSA, three broad scale habitats were recorded. The stations which were coastal and dominated by a high content of sand, were classified as 'sublittoral sand' (A5.2). The stations in the mouth of the Tees Estuary, where the sediment content was high in mud, were classified as 'sublittoral mud' (A5.3). Variability in the species assemblage at each station and abiotic factors such as the composition of substrate, resulted in the ascription of three different biotopes:

- '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233; SS.SSa.IFiSa.NcirBat);
- '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (A5.242; SS.SSa.IMuSa.FfabMag); and
- '*Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud' (A5.331; SS.SMu.ISaMu.NhomMac).

14.3.35 A description of these biotopes is presented in the section 'Biotope Descriptions' below and a biotope summary table is provided in Appendix D. A habitat classification map is presented in Figure 14D-10.

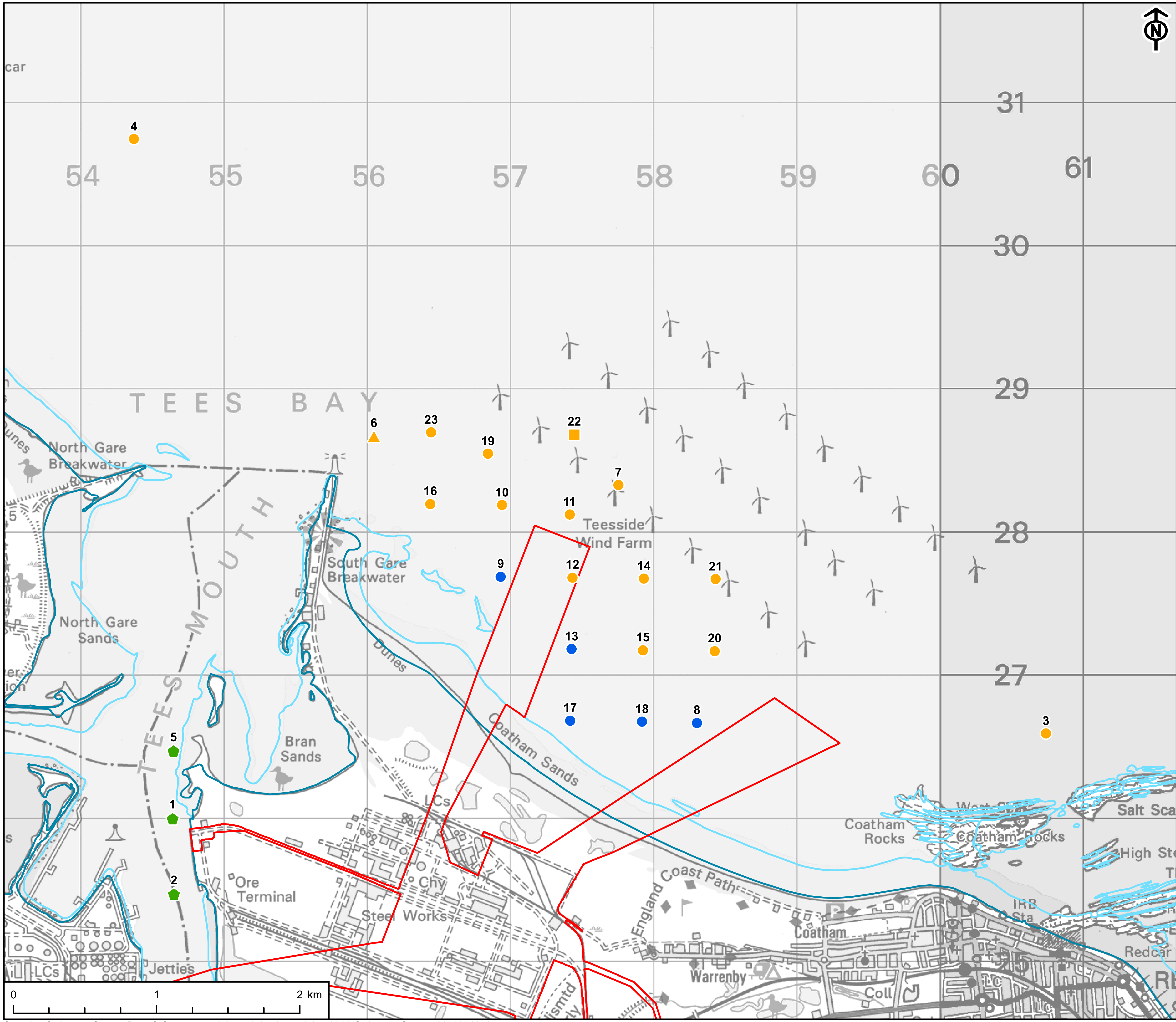
14.3.36 Located in the mouth of the Tees Estuary, stations 1, 2, and 5 were classified as the biotope A5.331, falling within the biotope complex 'infralittoral sandy mud'. The sediment content in these areas were high in mud and supported relatively high abundances of the polychaete genus *Nephtys* sp., particularly *Nephtys hombergii* which is characteristic of this biotope. The bivalve *Abra alba* was also recorded, but in lower abundances. The biotope assigned to these stations is typically associated with slightly reduced salinity estuarine conditions.

14.3.37 The second biotope recorded was A5.233, which is synonymous with sediment that has a high content of sand, with little to no fractions of mud ('infralittoral fine sand'). Stations 8, 9, 13, 17, and 18, which are located closest to the shore, were all classified as this biotope. This biotope is associated with sediments which are subject to higher levels of physical disturbance, as a result of wave action. The amphipod *Bathyporeia* sp. and polychaete *Nephtys cirrosa* are typical of this biotope and dominated the abundance of these stations. In particular, *Bathyporeia elegans* and *Bathyporeia guilliamsoniana* were found in high abundance. Magelonid polychaeta would be expected for this biotope, as demonstrated by the species *Magelona johnstoni* being recorded in high abundance at these stations.

14.3.38 The remaining stations were classified as the biotope complex 'infralittoral muddy sand', having dominant fractions of sand with a silt/clay component between 5% and 20%. Taking into consideration the community composition of these stations, the biotope A5.242 was ascribed. For example, stations 3 and 4, which were the furthest stations located to the southeast and northwest, respectively, were identified as this biotope, as were the stations located further offshore. This biotope is typically found in less exposed areas compared to the biotope A5.233, 'extending from the extreme lower shore down to more stable circalittoral zone at about 15-20 m' (EEA, 2019). Due to the higher content of mud for this biotope, a greater dominance of venerid bivalves is expected, as well as the bivalve species *Fabulina fabula* and the polychaete genus *Magelona* sp.. Both *Fabulina fabula and Magelona johnstoni* dominated the abundances at the stations classified as this biotope. Juvenile individuals of the bivalve genus *Spisula* were also recorded at some stations identified as this biotope.

14.3.39 Two of the biotopes identified (A5.233 and A5.242) qualify as habitats of principal importance being listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 and belong to the habitat type, 'subtidal sands and gravels'. However, these habitats are not a qualifying feature of any nearby designated site.

Figure 14D-10: Subtidal benthic EUNIS biotope and sediment classifications map



Project Management Initials: RL Designer: LC Checked: AR Approved: RG

Scale @ A3 1:25,000

AECOM

PROJECT

NET ZERO TEESSIDE PROJECT

Net Zero Teesside

APPLICANTS

NZT POWER LTD. AND NZNS STORAGE LTD.

KEY

- Site Boundary
- Mean Low Water
- Mean High Water

Subtidal Sampling Location

Folk Classification Biotope - Symbol Shape

- ● (g)S – Slightly Gravelly Sand
- ▲ (g)mS – Slightly Gravelly Muddy Sand
- ■ S – Sand
- ⬟ sM – Sandy Mud

EUNIS Biotope - Symbol Colour

- A5.233 (SS.SSa.IFiSa.NcirBat) – *'Nephtys cirrosa and Bathyporeia spp. in infralittoral sand'*
- A5.242 (SS.SSa.IMuSa.FfabMag) – *'Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'*
- A5.331 (SS.SMu.ISaMu.NhomMac) – *'Nephtys hombergii and Macoma balthica in infralittoral sandy mud'*

TITLE

FIGURE 14D-2
SUBTIDAL BENTHIC EUNIS BIOTOPE AND SEDIMENT CLASSIFICATION MAP

REFERENCE

NZT_210511_SBS_14D-2_v6

SHEET NUMBER: 1 of 1

DATE: 11/05/21

Biotope Descriptions

14.3.40 The following descriptions are based upon those outlined within the EUNIS habitat classification system (EEA, 2012). See Appendix D for full summary table of station biotopes.

Infralittoral Fine Sand

<u>A5.233 - Nephtys cirrosa and Bathyporeia spp. in infralittoral sand</u>

MHCBI: SS.SSa.IFiSa.NcirBat

Stations: 8, 9, 13, 17, 18

Infaunal multivariate clusters: a, d, e, j, k

Depth Range: 0 – 30 m

Descriptions: Characterised by *Nephtys cirrosa* and *Bathyporeia* spp. (and sometimes *Pontocrates* spp.), found from the shallow sublittoral to at least 30 m depth. This biotope occurs within well-sorted medium and fine sands which are subject to physical disturbance, such as wave action. Compared to less disturbed biotopes, the faunal diversity is reduced, consisting of more actively-swimming amphipods.

Figure 14D-11: Biotope A5.233 at station 17, sample C

Infralittoral Muddy Sand

<u>A5.242 - Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand</u>

MHCBI: SS.SSa.IMuSa.FfabMag

Stations: 3, 4, 6, 7, 10, 11, 12, 14, 15, 16, 19, 20, 21, 22, 23

Infaunal multivariate clusters: f, g, h, i, k

Depth Range: 0 – 20 m

Descriptions: Communities are dominated by venerid bivalves such as Chamelea gallina and may be characterised by a prevalence of Fabulina fabula and Magelona mirabilis or other species of Magelona (e.g. M. filiformis). Other taxa which are commonly recorded include: the amphipod Bathyporeia spp. and polychaetes such as Chaetozone setosa, Spiophanes bombyx and Nephtys spp.. This biotope is typically found in stable, fine, compacted sands and slightly muddy sands in the infralittoral and littoral fringe.

Figure 14D-12: Biotope A5.233 at station 11, sample C

Infralittoral Sandy Mud

A5.331 - Nephtys hombergii and Limecola balthica in infralittoral sandy mud

MHCBI: SS.SMu.ISaMu.NhomMac

Stations: 1, 2, 5

Infaunal multivariate clusters: b, c, e

Depth Range: 0 – 20 m

Descriptions: This biotope occurs in predominantly near-shore muds and sandy muds but can also found in mixed sediments. The substratum is typically rich in organic content and the community is often quite stable. The presence of the polychaete Nephtys hombergii and the bivalve Limecola balthica characterise this biotope. Other species which may be important include Abra alba and Nucula nitidoasa, although they may not necessarily occur at the same time or in high numbers. The taxa Spiophanes bombyx, Lagis koreni, and Echinocardium cordatum may also be present. In addition, this biotope can occur in estuaries where salinities may be slightly reduced and where Mya sp. may form a significant part of the community.

Figure 14D-13: Biotope A5.233 at station 5, sample B

14.4 Discussion

14.4.1 Three biotope complexes were recorded across the 21 sampling stations and these were found to represent three spatially discrete areas characterised by sediments of varying composition. Exposure is also likely to have been a contributing factor.

14.4.2 Stations sampled on the south bank of the River Tees within the mouth of the estuary were characterised by the biotope complex '*Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud'. Here conditions were found to be relatively sheltered with weak tidal streams (>1 knot) which enable the build-up of muds which providing optimum habitat for the taxa *Nephtys* sp., in particular *Nephtys hombergii*.

14.4.3 Sampling stations out in the Tees Bay were classified as either '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' or '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'. The former biotope complex was found in the shallow inshore area which is characterised by moderate to high exposure and sediments possessing a low clay/silt content. The latter biotope complex characterised stations which were located in most cases, in slightly deeper waters and were less exposed and exhibited a percentage of silt/clay.

14.4.4 Stations 6, 7, and 8 corresponded to those sampled in 2010 as part of a benthic survey undertaken for the Teesside OWF development (Entec UK Limited, 2011) and so the biotope classifications can be compared. Biotope classifications remained consistent at stations 7 and 8. However, at station 6 an increase in mud content within sediments had led to a shift in biotope from 'infralittoral mobile clean sand with sparse fauna' recorded in 2010 to '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'. Given the anticipated mobility of sediment in this area, as a result of the varying levels of exposure along this coast, this change is not unexpected.

14.4.5 The Proposed Development includes the option to construct a replacement Water Discharge Corridor into the eastern end of Coatham Sands bay, alongside the proposed CO_2 Export Pipeline. Further consideration has therefore been given to samples taken as part of the Teesside OWF development, some of which spatially overlap with sampling undertaken for the Proposed Development. A full review and summary of this data is presented in Appendix F.

14.4.6 The data from 16 OWF grab samples (which encompass the area to the South East of Tees Bay) show that the biotopes at these stations are consistent with those found in the 2019 project subtidal survey. The biotopes found were either '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233; SS.SSa.IFiSa.NcirBat) or '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (A5.242; SS.SSa.IMuSa.FfabMag), distributed depending on water depth gradients and mud content. This data shows that these two biotopes are consistently distributed across the bay and that the benthic communities observed in 2019 are comparable to those observed in 2010 (details of the analysis undertaken are provided below), indicating the infaunal communities across the bay are consistent spatially and temporarily.

14.4.7 The OWF benthic surveys recorded a number of individuals and colonies of *Sabellaria spinulosa.* This species forms biogenic reefs which is an Annex 1 habitat under the Habitats Directive, as well as being a priority habitat of principal importance being listed under Section 41 of the NERC Act 2006. The results of the OWF benthic surveys concluded that the abundance of *Sabellaria spinulosa* was not great enough to represent biogenic reef. No individuals of *Sabellaria spinulosa* were recorded at any of the subtidal benthic stations sampled in 2019.

14.4.8 Multivariate analysis determined that the grouping of the subtidal benthic communities within the Study Area can be explained in part by the sediment classification of the samples, in particular the percentage sediment content of mud. Physical environmental factors, such as general circulation, tidal currents and wave exposure play an important part in determining the local nature of sediments via the processes of siltation and erosion though biotic factors such as inhabiting species which stabilise the sediment are also important (Thrush, 1991).

14.4.9 The stations located on the coast are generally more exposed, where fine particulate matter is more likely to be winnowed away, accounting for the greater proportion of ‘sand’ in this area. The sediment particle distribution can determine the favourability of a particular environment to certain species (Dauvin *et al.,* 2004). Therefore, to a certain extent the differences seen in the faunal community at stations 1, 2, and 5 compared to other stations, can be attributed to the higher content of mud in this area. These muddy stations exhibited greater diversity than most other stations.

14.4.10 In contrast, stations 13, 17, and 18, which were located close to the shore at depths of <2.5 m, had sediment which contained no fractions of mud. In exposed shallow coastal waters, wave action, surge and storms in particular can be a source of natural physical disturbance to soft sediment macrobenthos species (Dolbeth *et al.,* 2009). At lower depths, changes in hydrodynamics and higher near-bed flow can influence food availability, sediment characteristics, sediment organic matter content, pore-water chemistry, microbial content, and larval supply (Incera *et al.*, 2003; Snelgrove and Butman, 1994). Higher levels of exposure are probable at these lower depth stations, apparent from the sediment classifications in these areas which were identified as being ‘sand’ and ‘slightly gravelly sand’. This has likely altered the macrobenthos community in these areas compared to other stations.

14.4.11 Of the physical factors the percentage content of mud within the sediment, in combination with water depth, were the factors that best explained the differences in benthic community composition between stations. The gradients of abiotic factors such as light, water movement, nutrient availability, sedimentation and temperature can be predicted using depth (Garrabou *et al.*, 2002) and therefore depth is a variable which may be a proxy for many of these environmental conditions.

14.4.12 Sediment chemistry however, was also found to be an important factor the correlated with the nature of the benthic communities. There were elevated levels of both trace metals and PAHs identified at stations 1 and 2, in the estuary with some above environmental thresholds. These elevated contaminants reflect the history and nature of the subtidal Study Area as a highly industrial region, with a broad variety of industries, including steelmaking and chemical manufacture, utilising land and resources within close proximity to the marine environment.

14.4.13 The concentrations of PAHs were compared against the sediment chemical analysis undertaken in 2015 to inform the PD Teesport Ltd maintenance dredging Marine Licence (MLP/2015/00094) (PD Teesport Ltd, 2015). At the sites analysed PAHs were also elevated (e.g. chrysene between 259 – 2,470 µg/kg) and encompassed the values recorded in 2019 at stations 1 and 2 (491 µg/kg and 515 µg/kg respectively). High levels of trace metals and PAHs can have toxic effects on infaunal communities, which can lead to long term changes, often reflected in the polychaete community assemblage (Papageorgiou *et al.*, 2006). The concentration of PAH, particularly the analyte c1-phenanthrene, was found to be the contaminant most correlated with distribution of the benthic communities.

14.4.14 Despite there being evidence of localised contamination, the ecological status of macrobenthic infaunal invertebrate assemblages at station 2 and 5 were both 'High', and at station 1 the status was 'Good'. Communities classified as 'High' are generally characterised by the presence of disturbance-sensitive taxa and levels of diversity and abundance associated with undisturbed conditions (Phillips *et al.*, 2014). Those assigned as having a 'Good' IQI status represents habitats which are only slightly disturbed. Both trace metals and PAHs adhere to sediment particles and are rapidly absorbed into the sediment following run-off into coastal waters (Dean, 2008). This reduces the bioavailability of these chemicals and their subsequent ingestion, which can provide a degree of protection to some infaunal taxa (Dean, 2008). Therefore, elevated sediment contaminant concentrations do not necessarily imply toxicity to benthic communities (Rees *et al.,* 2007) as the bioavailability of these chemicals is often more important than simply concentration levels.

14.4.15 Stations 13 and 17, identified as having both low species richness and diversity compared to other stations, had an ecological status of 'Moderate'. All other stations were found to be of 'Good' ecological status.

14.4.16 Two of the biotopes identified (A5.233 and A5.242) qualify as habitats of principal importance being listed under Section 41 of the NERC Act 2006 and belong to the habitat type, 'subtidal sands and gravels'. However, these habitats are not a qualifying feature of any nearby designated site.

14.4.17 No species afforded conservation protection were recorded during the subtidal benthic grab surveys. Furthermore, no INNS were recorded in any of the samples.

14.5 Baseline Evolution

14.5.1 Benthic ecology baseline conditions can be influenced by a variety of factors including pollution, coastal development and climate change. These factors can influence not only the distribution of habitats and the abundance of associated flora and fauna but also life history processes such as growth and reproduction.

14.5.2 Within the Study Area, climate change impacts are likely to include factors such as warming sea temperatures, ocean acidification, sea-level rise, alterations in salinity and oceanographic patterns, and increased numbers of storms and marine heatwaves (Stocker, 2013). Sea temperature rise in particular, is considered to be the principle way in which subtidal benthic baseline conditions are likely to evolve during the life cycle of the Project and is therefore considered in further detail below.

14.5.3 Future UK Climate Projections 2018 (UKCP18) from the Met Office for the Stockton-on-Tees area (The Met Office, 2019), based on a 1981 – 2000 baseline[7], uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform different future emission trends. RCP 8.5 has been used for the purposes of this assessment as a worst-case scenario.

14.5.4 Under RCP 8.5 a rise in global sea surface temperatures of 1.5˚C by 2050 is predicted, increasing to a 3.2°C rise by 2100 relative to 1870 – 1899 temperatures. In UK waters, mean annual sea temperatures have risen by 0.8°C since 1870 and have continued to show consistent warming trends since the 1970s onwards (Genner *et al*., 2017). According to Lowe *et al*. (2009), the seas around the UK are projected to be 1.5 – 4 ºC warmer by 2100.

14.5.5 Increased sea temperatures have already had effects on marine communities in UK waters. In the North Sea, increasing temperatures and changes in pelagic primary production have resulted in the variation in community structure of benthic species (Moore and Smale, 2020). A northern distributional shift of species in the North Sea, as well some species moving into deeper waters, coinciding with increasing sea temperatures has also been observed (Hiddink *et al.,* 2015). Southern species which are expanding in extent have done so faster than those further north which have shown signs of retreat (Moore and Smale, 2020). An Ecological Niche Model has been produced for infauna species in the North Sea, based on a mean temperature increase of 2.8ºC, which has predicted future infaunal distribution shifts (Weinert *et al*., 2016). Overall, 60% of the infaunal species analysed were predicted to shift towards the north with ranges of 10 – 50 km. Furthermore, a 72% reduction in suitable habitat was anticipated for subtidal infauna species.

14.5.6 However, the evidence of the effects of climate change on subtidal benthic communities is limited, most studies being restricted to a very specific area, comparing the difference between two time periods (Moore and Smale, 2020). Most species and habitats are subject to a range of drivers of change

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[7] This baseline has been selected as it provides projections for 20-year time periods (e.g. 2020 – 2039).

and therefore determining the significance of one stressor such as increasing sea temperature is limited (Moore and Smale, 2020). Furthermore, given the location of the Proposed Development, subtidal benthic species found to be present within the Study Area are unlikely to be at the extent of their distributional range. As a result, it is not anticipated that distributional shifts would be easily observed. Therefore, it is currently difficult to predict what localised changes, if any, may occur within the vicinity of the Proposed Development as a result of increasing sea temperatures and climate change overall.

14.6 Summary of Findings

14.6.1 The subtidal benthic Study Area can be divided into three biologically distinct areas, the sediment content, and the putative level of exposure, being important determining variables. The three areas are the stations in the mouth of the Tees Estuary, classified as the biotope complex 'infralittoral sandy mud'; the coastal stations located close to the shore, classified as 'infralittoral fine sand'; and the stations located further offshore or are far field, classified as 'infralittoral muddy sand'.

14.6.2 Three biotopes were recorded, those being: '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (A5.242); '*Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud' (A5.331); and '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233).

14.6.3 Two of the biotopes identified (A5.233 and A5.242) qualify as 'Habitats of Principle Importance' and 'Habitats of Conservation Interest'. However, the habitat types at each station were not a qualifying feature of any nearby designated site.

14.6.4 The subtidal Study Area is situated within a highly industrial region, with a broad variety of industries, including steelmaking and chemical manufacture, utilising land and resources within close proximity to the marine environment. Elevated levels of PAHs and trace metals were recorded at stations 1 and 2, and in some instances were greater than guideline concentration standards (Canadian guideline PEL and ERM defined by Long *et al.* (1995)).

14.6.5 The majority of stations were classified as having 'Good' IQI status, representing habitats that were only slightly disturbed. Stations located in the mouth of the Tees Estuary (2 and 5), were classified as having a 'High' IQI Status. In contrast, stations 13 and 17, located close to the shore where species richness and diversity was relatively low compared to other stations, had an IQI status of 'moderate'.

14.6.6 No species of any conservation designation or importance were recorded during the subtidal benthic grab surveys. Furthermore, no Invasive Non-Native Species (INNS) were recorded in any of the samples.

14.6.7 Prior to and during the construction and operational phase of the Proposed Development, the subtidal benthic baseline is likely to evolve as a result of climate change due to increases to both sea level and sea temperatures. This baseline evolution could result in a shift in the distribution of subtidal benthic species as well as a decrease in the availability of suitable habitat.

However, it is not possible to predict with any certainty the magnitude of potential changes to baseline conditions as a result of climate change or any other pressure.

14.7 References

Blott, S. (2010). Grain Size Distribution and Statistics Packages for the Analysis of Unconsolidated Sediment by Sieving or Laser Granulometer. Kenneth Pye Assoc Ltd, UK.

Canadian Council of Ministers of the Environment (CCME). (1999). Canadian sediment quality guidelines for the protection of aquatic life. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Centre for Environment, Fisheries and Aquaculture Science (Cefas). (2003). The use of Action Levels in the Assessment of Dredged Material Placement at Sea and in Estuarine Areas under FEPA (II), Final Project Report.

Clarke, K.R. and Gorley, R.N. (2015). Getting started with PRIMER v7. PRIMER-E: Plymouth, Plymouth Marine Laboratory.

Dauvin, J.C., Thiébaut, E., Gesteira, J.L.G., Ghertsos, K., Gentil, F., Ropert, M. and Sylvand, B. (2004). Spatial structure of a subtidal macrobenthic community in the Bay of Veys (western Bay of Seine, English Channel). Journal of Experimental Marine Biology and Ecology, 307(2), 217 – 235.

Dean, H.K. (2008). The use of polychaetes (Annelida) as indicator species of marine pollution: a review. Revista de Biología Tropical, 56(4), 11 – 38.

Dolbeth, M., Teixeira, H., Marques, J.C. and Pardal, M.Â. (2009). Feeding guild composition of a macrobenthic subtidal community along a depth gradient. Scientia Marina, 73(2), 225 – 237.

Entek UK Limited (2011). Teesside Windfarm Ltd, Teesside Offshore Wind Farm FEPA Monitoring, Benthic Survey Report 2010.

European Environment Agency (EEA). (2012). EUNIS habitat classification. [Online]. Available at: https://eunis.eea.europa.eu/index.jsp [Accessed: 18/02/2020].

Eleftheriou, A. and Basford, D.J. (1989). The macrobenthic infauna of the offshore northern North Sea. Journal of the Marine Biological Association of the United Kingdom, 69(1), 123 – 143.

European Environment Agency (EEA). (2019). Infralittoral muddy sand. [Online]. Available at: https://eunis.eea.europa.eu/habitats/595 [Accessed: 19/02/2020].

Folk R. (1954). The distribution between grain size and mineral composition in sedimentary rock nomenclature. The Journal of Geology, 62(4), 344 – 359.

Garrabou, J., Ballesteros, E. and Zabala, M. (2002). Structure and dynamics of north-western Mediterranean rocky benthic communities along a depth gradient. Estuarine, Coastal and Shelf Science, 55(3), 493 – 508.

Genner, M.J., Freer, J.J. and Rutterford, A.L. (2017). Future of the Sea: Biological Responses to Ocean Warming. Foresight, Government Office for Science.

Hiddink, J.G., Burrows, M.T. and García Molinos, J. (2015). Temperature tracking by North Sea benthic invertebrates in response to climate change. Global Change Biology, 21(1), pp.117-129.

Incera, M., Cividanes, S.P., López, J. and Costas, R. (2003). Role of hydrodynamic conditions on quantity and biochemical composition of sediment organic matter in sandy intertidal sediments (NW Atlantic coast, Iberian Peninsula). Hydrobiologia, 497(1-3), 39 – 51.

International Maritime Organisation (IMO). Sampling of Dredged Material – Guidelines for the Sampling and Analysis of Dredged Material Intended for Disposal at Sea 2005.

Long, E.R., Macdonald, D.D., Smith, S.L. and Calder, F.D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental management, 19(1), 81 – 97.

Lowe, J. A., Howard, T.P., Pardaens, A., Tinker, J., Holt, J., Wakelin, S. Milne, G., Leake, J., Wolf, J., Horsburgh, K., Reeder, T., Jenkins, G., Ridley, J., Dye, S. and Bradley, S. (2009). UK Climate Projections Science Report: Marine and coastal projections. Met Office Hadley Centre.

Marine Management Organisation (MMO). (2018). Marine Licensing: sediment analysis and sample plans. [Online]. Available at: https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans [Accessed: 09/03/2020].

Mason, C. (2016). NMBAQC's Best Practice Guidance - Particle Size Analysis (PSA) for Supporting Biological Analysis.

The Met Office (2018). UK Climate Projections (UKCP) User Interface. [Online] Available at: https://ukclimateprojections-ui.metoffice.gov.uk/ [Accessed: 27/02/2020].

Moore, P.J. and Smale, D.A. (2020). Impacts of climate change on shallow and shelf subtidal habitats, relevant to the coastal and marine environment around the UK. MCCIP Science Review 2020, 272 – 292.

OSPAR. (1998). OSPAR Guidelines for the Management of Dredged Material. Ministerial Meeting of the OSPAR Commission. Summary Record OSPAR 98/14/1-E, Annex 43.

Papageorgiou, N., Arvanitidis, C. and Eleftheriou, A. (2006). Multicausal environmental severity: A flexible framework for microtidal sandy beaches and the role of polychaetes as an indicator taxon. Estuarine, Coastal and Shelf Science, 70(4), 643 – 653.

Phillips, G.R., Anwar, A., Brooks, L., Martina, L.J., Miles, A.C. and Prior, A. (2014). Infaunal quality index: Water Framework Directive classification scheme for marine benthic invertebrates. Environment Agency, United Kingdom.

PD Teesport Ltd. (2015). Sediment Sampling Results 2015.

Rees, H.L., Eggleton, J.D., Rachor, E., Berghe, E. and Vanden Berghe, E. (2007). Structure and Dynamics of the North Sea Benthos. ICES Cooperative Research Report No. 288. 258 pp.

Snelgrove, P.V.R. and Butman, C.A. (1994). Animal-sediment relationships revisited: Cause versus effect: Oceanography and Marine Biology Annual Review, v. 32.

Stocker, T.F., Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P.M. (2013). IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1535.

Thrush, S.F. (1991). Spatial patterns in soft-bottom communities. Trends in Ecology & Evolution, 6(3), 75 – 79.

United Kingdom Offshore Operators Association (UKOOA). (2002). UKOOA Drill Cutting Initiative Final Report. [Online] Available at: http://rodadas.anp.gov.br/arquivos/Round8/perfuracao_R8/Bibliografia/UKOOACASCALHO.PDF [Accessed: 20/02/2020].

Water Framework Directive (WFD). (2008). UK Technical Advisory Group of the Water Framework Directive. UK Environmental Standards and Conditions. Final Report.

Weinert, M., Mathis, M., Kroencke, I., Neumann, H., Pohlmann, T. and Reiss, H. (2016). Modelling climate change effects on benthos: Distributional shifts in the North Sea from 2001 to 2099. Estuarine, Coastal and Shelf Science, 175, 157 – 168.

Wentworth, C.K. (1922). A scale of grade and class terms for clastic sediments. The Journal of Geology, 30(5), 377 – 392.

Worsfold, T. and Hall, D. (2010). Guidelines for processing marine macrobenthic invertebrate sample: A processing requirements protocol. National Marine Biological Quality Control Science, England.

Appendix A : Particle Size Distribution (PSD) analysis methodologies

Introduction

The method used involved drying all sediments at 80°C for at least 24 hours prior to dry-sieving all samples and only laser sizing the <2 mm fraction if >5 % of the whole sample was found to be <63 µm. Oven drying sediment causes the aggregation of particles in muddy sediments (>5 % mud) and for these reasons, such sediments should not be oven dried prior to particle size analysis (Mason, 2016). Therefore, a visual assessment of all thawed sediment samples was undertaken prior to drying to ensure the optimal analysis technique was used. Due to the obvious presence of mud in a large proportion of samples, some with a considerable mud content in excess of 5 %, all samples were analysed via a combination of both dry sieving (>1 mm fraction) and laser sizing (<1 mm fraction).

Sample Preparation

Frozen sediment samples were first transferred to a drying oven and thawed at 80°C for at least six hours prior to visual assessment of sediment type and wet sieving over a 1 mm sieve. Before any further processing (e.g. sieving or sub-sample removal), samples were mixed thoroughly with a spatula and all conspicuous fauna (>1 mm) which appeared to have been alive at the time of sampling were removed from the sample.

Dry Sieving

The >1 mm fraction was then returned to a drying oven and dried at 80°C for at least 24 hours prior to dry sieving. Once dry, the sediment sample was run through a series of Endecott BS 410 test sieves (nested at 0.5 φ intervals) using a Retsch AS200 sieve shaker to fractionate the samples into particle size classes. The dry sieve mesh apertures used are given in Table A-1.

Table A-1: Sieve series employed for Particle Size Distribution (PSD) analysis by dry sieving (mesh size in mm)

Sieve aperture (mm)											
63	45	31.5	16	11.2	8	5.6	4	2.8	2	1.4	1

The sample was transferred onto the coarsest sieve at the top of the sieve stack, which was then shaken for a standardised period of 20 minutes. The sieve stack was then checked to ensure the components of the sample had been fractioned as far down the sieve stack as their diameter would allow. A further 10 minutes of shaking was undertaken if there was evidence that particles had not been properly sorted (e.g. veneers of silt overlying coarse fractions).

Laser Diffraction

The fine fraction residue (<1 mm sediments) was transferred to a suitable container and allowed to settle for 24 hours before excess water was syphoned from above the sediment surface. The fine fraction was analysed by laser diffraction using a wet element Beckman Coulter LS 13320. Due to the silty nature of the sediments, ultrasound was used to agitate particles and prevent aggregation of fines.

Appendix B :Particle Size Distribution (PSD) Data

Table B-1: Summarised PSD data for all stations and replicate data, as classified by Folk (1954)

Station/ Replicate no.	Textural Group Classification	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Major Sediment Fractions (%)			Modified Folk
						Gravel	Sand	Mud	
1A	Sandy Mud	Medium Silt	Poorly Sorted	32	6.14	0.00	10.69	89.31	sM
1B	Sandy Mud	Medium Silt	Very Poorly Sorted	33	6.24	0.00	10.60	89.40	sM
1C	Sandy Mud	Coarse Silt	Very Poorly Sorted	39	6.07	0.00	15.45	84.55	sM
2A	Sandy Mud	Medium Silt	Very Poorly Sorted	34	6.20	0.00	11.88	88.12	sM
2B	Sandy Mud	Coarse Silt	Very Poorly Sorted	43	5.87	0.00	19.72	80.28	sM
2C	Sandy Mud	Medium Silt	Poorly Sorted	31	6.19	0.00	9.31	90.69	sM
3A	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	155	3.08	0.11	92.26	7.62	(g)S
3B	Slightly Gravelly Muddy Sand	Fine Sand	Moderately Sorted	274	3.06	2.29	87.65	10.06	(g)mS
3C	Sand	Fine Sand	Moderately Sorted	152	3.08	0.00	91.55	8.45	S
4A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	273	2.93	1.82	93.08	5.10	(g)S
4B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	178	3.01	0.60	93.51	5.89	(g)S
4C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	174	3.01	0.50	93.69	5.81	(g)S
5A	Sandy Mud	Coarse Silt	Very Poorly Sorted	39	5.93	0.00	16.37	83.63	sM
5B	Sandy Mud	Coarse Silt	Very Poorly Sorted	42	6.01	0.00	17.03	82.97	sM
5C	Sandy Mud	Coarse Silt	Very Poorly Sorted	45	5.81	0.00	21.31	78.69	sM
6A	Muddy Sand	Fine Sand	Poorly Sorted	148	3.24	0.00	87.25	12.75	mS
6B	Slightly Gravelly Muddy Sand	Very Fine Sand	Poorly Sorted	152	3.28	0.09	85.90	14.01	(g)mS
6C	Sand	Fine Sand	Moderately Sorted	182	3.03	0.00	91.01	8.99	S
7A	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	309	2.64	1.59	94.05	4.37	(g)S
7B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	210	2.89	0.51	93.26	6.23	(g)S

Station/ Replicate no.	Textural Group Classification	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Major Sediment Fractions (%)			Modified Folk
						Gravel	Sand	Mud	
7C	Slightly Gravelly Sand	Fine Sand	Poorly Sorted	353	2.57	2.19	93.51	4.30	(g)S
8A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	231	2.47	0.16	97.06	2.78	(g)S
8B	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	300	2.45	0.88	96.61	2.51	(g)S
8C	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	352	2.42	1.41	95.50	3.09	(g)S
9A	Slightly Gravelly Sand	Coarse Sand	Moderately Sorted	657	1.04	0.71	96.31	2.98	(g)S
9B	Sand	Fine Sand	Moderately Well Sorted	181	2.71	0.00	97.24	2.76	S
9C	Sand	Fine Sand	Moderately Well Sorted	172	2.78	0.00	96.90	3.10	S
10A	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	274	2.68	1.27	93.75	4.98	(g)S
10B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	288	2.63	1.37	93.89	4.75	(g)S
10C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	276	2.60	0.92	95.20	3.88	(g)S
11A	Slightly Gravelly Sand	Fine Sand	Poorly Sorted	394	2.58	3.51	90.74	5.75	(g)S
11B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	352	2.70	1.65	93.08	5.27	(g)S
11C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	226	2.80	0.92	93.86	5.22	(g)S
12A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	503	2.47	2.72	94.08	3.20	(g)S
12B	Sand	Fine Sand	Moderately Sorted	258	2.53	0.00	96.37	3.63	S
12C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	250	2.74	0.78	95.31	3.91	(g)S
13A	Sand	Fine Sand	Moderately Sorted	294	2.11	0.00	100.00	0.00	S
13B	Sand	Fine Sand	Moderately Sorted	303	2.10	0.00	100.00	0.00	S
13C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	299	2.02	0.16	99.84	0.00	(g)S
14A	Gravelly Sand	Fine Sand	Poorly Sorted	1242	2.39	6.92	88.09	5.00	gS
14B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	221	2.85	0.70	93.79	5.51	(g)S
14C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	239	2.78	0.92	94.57	4.51	(g)S
15A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	220	2.57	0.24	97.08	2.68	(g)S
15B	Sand	Fine Sand	Moderately Well Sorted	224	2.59	0.00	97.28	2.72	S
15C	Sand	Fine Sand	Moderately Well Sorted	194	2.67	0.00	96.86	3.14	S

Station/ Replicate no.	Textural Group Classification	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Major Sediment Fractions (%)			Modified Folk
						Gravel	Sand	Mud	
16A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	203	2.63	0.07	96.08	3.85	(g)S
16B	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	206	2.64	0.13	96.45	3.42	(g)S
16C	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	179	2.85	0.20	94.93	4.87	(g)S
17A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	280	2.14	0.45	99.55	0.00	(g)S
17B	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	282	2.18	0.71	99.29	0.00	(g)S
17C	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	266	2.23	0.49	99.51	0.00	(g)S
18A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	278	2.17	0.58	99.42	0.00	(g)S
18B	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	267	2.22	0.42	99.58	0.00	(g)S
18C	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	268	2.20	0.33	99.67	0.00	(g)S
19A	Sand	Fine Sand	Poorly Sorted	270	2.51	0.00	93.83	6.17	S
19B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	489	2.45	3.31	93.37	3.32	(g)S
19C	Slightly Gravelly Sand	Fine Sand	Poorly Sorted	498	2.40	3.85	92.17	3.98	(g)S
20A	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	608	2.53	1.79	94.39	3.82	(g)S
20B	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	214	2.63	0.33	96.54	3.14	(g)S
20C	Slightly Gravelly Sand	Fine Sand	Moderately Well Sorted	205	2.63	0.08	96.09	3.83	(g)S
21A	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	164	3.00	0.11	93.65	6.23	(g)S
21B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	156	3.04	0.14	94.00	5.86	(g)S
21C	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	177	3.00	0.35	93.43	6.23	(g)S
22A	Sand	Fine Sand	Moderately Sorted	244	2.43	0.00	97.49	2.51	S
22B	Sand	Fine Sand	Moderately Sorted	229	2.45	0.00	97.34	2.66	S
22C	Sand	Fine Sand	Moderately Sorted	233	2.43	0.00	97.75	2.25	S
23A	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	356	2.54	1.94	94.39	3.67	(g)S
23B	Slightly Gravelly Sand	Fine Sand	Moderately Sorted	216	2.75	0.44	95.62	3.95	(g)S
23C	Slightly Gravelly Sand	Medium Sand	Poorly Sorted	513	1.97	0.24	97.00	2.76	(g)S

Appendix C : Sediment Chemical Analysis Results

Table C-1: Trace and heavy metal sediment concentrations against Cefas (2003) and Canadian guidelines (CCME, 1999)

			Sites										UK CEFAS Guidelines		Canadian Guidelines	
Units	Limit of Detection	Matrix	1	2	9	10	11	12	13	14	15	17	AL1	AL2	TEL	PEL
mg/kg (Dry Weight)	0.5	Arsenic	25.5	26.7	6.5	7.5	7.7	7.1	6.7	5.8	6.9	5.7	20	100	7.24	41.60
	0.04	Cadmium	0.24	0.26	0.04	0.09	0.13	0.06	0.06	0.06	0.06	<0.04	0.4	5.0	0.7	4.2
	0.5	Chromium	45.9	41.6	7.7	11.8	11.6	10.6	9.2	8.2	8.2	5.9	40	400	52.3	160
	0.5	Copper	37.7	36.3	12.0	12.4	8.6	11.0	12.1	9.7	9.5	9.1	40	400	18.7	108
	0.015	Mercury	0.27	0.26	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.04	0.3	3.0	0.13	0.70
	0.5	Nickel	27.1	26.0	5.9	8.1	7.6	7.5	6.7	5.8	5.9	4.7	20	200	15.9	42.8
	0.5	Lead	78.1	81.0	13.0	19.6	18.9	14.7	14.2	12.0	13.2	9.3	50	500	30.2	112
	2	Zinc	132	141	40.1	50.0	49.0	43.1	41.6	33.4	36.1	27.0	130	800	124	271

Values exceeding sediment concentrations highlighted in corresponding colour

Table C-2: PAH sediment concentrations against Canadian guidelines (CCME, 1999) and ERLs/ ERMs (Long *et al.*, 1995)

			Sites										Canadian Guidelines		Long *et al.* (1995)	
Units	**Limit of Detection**	**Matrix**	**1**	**2**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**17**	**TEL**	**PEL**	**ERL**	**ERM**
µg/kg (Dry Weight)	1.0	**Acenaphthene**	**158**	**172**	**<1**	**2.0**	**3.6**	**2.7**	**<1**	**2.1**	**1.8**	**<1**	**6.71**	**88.9**	**16**	**500**
		Acenaphthylene	**80.9**	**85.3**	**<1**	**<1**	**2.0**	**<1**	**<1**	**<1**	**<1**	**<1**	**5.87**	**128**	**44**	**640**
		Anthracene	**228**	**230**	**1.4**	**2.4**	**6.0**	**3.9**	**<1**	**3.0**	**2.8**	**<1**	**46.9**	**245**	**85**	**1100**
		Benzo[a]anthracene	**461**	**455**	**2.7**	**4.2**	**8.4**	**6.0**	**<1**	**4.7**	**5.1**	**1.3**	**74.8**	**693**	**261**	**1600**
		Benzo[a]pyrene	**476**	**461**	**2.7**	**4.2**	**8.9**	**6.6**	**<1**	**4.7**	**4.8**	**<1**	**88.8**	**763**	**430**	**1600**
		Benzo[b]fluoranthene	**470**	**439**	**3.3**	**4.0**	**7.4**	**6.6**	**1.4**	**5.1**	**4.5**	**<1**	**-**	**-**	**-**	**-**
		Benzo[ghi]perylene	**450**	**463**	**2.8**	**4.6**	**8.9**	**6.3**	**<1**	**4.9**	**4.8**	**<1**	**-**	**-**	**85**	**-**
		Benzo[e]pyrene	**469**	**486**	**3.0**	**5.4**	**8.9**	**7.5**	**1.3**	**5.6**	**5.4**	**1.5**	**-**	**-**	**-**	**-**
		Benzo[k]fluoranthene	**239**	**258**	**1.5**	**2.2**	**3.8**	**3.5**	**<1**	**1.9**	**2.6**	**<1**	**-**	**-**	**-**	**-**
		C1-naphthalenes	**3520**	**4020**	**19.0**	**44.4**	**105**	**58.0**	**3.8**	**48.2**	**40.3**	**8.7**	**-**	**-**	**-**	**-**
		C1-phenanthrene	**1590**	**1730**	**7.9**	**22.5**	**38.9**	**23.9**	**2.7**	**19.7**	**20.5**	**4.8**	**-**	**-**	**-**	**-**
		C2-naphthalenes	**2870**	**3220**	**15.4**	**41.8**	**79.6**	**44.7**	**4.6**	**39.1**	**36.6**	**10.3**	**-**	**-**	**-**	**-**
		C3-naphthalenes	**2690**	**2900**	**12.5**	**36.9**	**65.9**	**40.3**	**3.0**	**31.7**	**32.1**	**8.7**	**-**	**-**	**-**	**-**
		Chrysene	**491**	**515**	**3.0**	**5.4**	**9.7**	**7.1**	**<1**	**5.4**	**6.0**	**1.9**	**108**	**846**	**-**	**384**

			Sites										Canadian Guidelines		Long *et al.* (1995)	
		Diben[ah]anthracene	69.9	82.4	<1	<1	<1	<1	<1	<1	<1	<1	6.22	135	63	260
		Fluoranthene	812	838	6.1	8.3	13.3	9.8	2.3	10.0	10.4	2.9	113	1494	600	5100
		Fluorene	268	296	1.5	3.2	5.9	4.3	<1	3.6	3.1	<1	21.2	144	19	540
		Indeno[1,2,3-cd]pyrene	319	322	1.8	2.5	4.9	4.0	<1	2.9	2.8	<1	-	-	240	-
		Naphthalene	1190	1410	5.6	13.4	36.9	19.4	1.7	15.3	13.6	3.1	34.6	391	160	2100
		Perylene	120	117	<1	<1	2.3	2.2	<1	1.5	1.5	<1	-	-	-	-
		Phenanthrene	1310	1440	6.7	18.5	31.8	19.2	2.0	17.2	16.6	4.1	86.7	544	240	1500
		Pyrene	782	810	5.9	9.5	15.4	10.3	2.5	10.1	10.2	3.2	153	1398	665	2600
mg/kg	1.0	**Total Hydrocarbon Content**	581	334	1.5	22.7	11.7	6.4	<1	4.6	2.9	<1	-	-	-	-

Values exceeding sediment concentrations highlighted in corresponding colour

Table C-3: Organotin sediment concentrations against Cefas (2003) standards

			Sites										UK CEFAS Guidelines	
Units	**Limit of Detection**	**Matrix**	**1**	**2**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**17**	**AL1**	**AL2**
mg/kg (Dry Weight)	0.001	**Dibutyltin**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.1**	**1.0**
		Tributyltin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.1**	**1.0**

Values exceeding sediment concentrations highlighted in corresponding colour

Table C-4: PCB sediment concentrations against Cefas (2003) and Canadian guidelines (CCME 1999)

			Sites										CEFAS		Canadian Guidelines	
Units	**Limit of Detection**	**Matrix**	**1**	**2**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**17**	**AL1**	**AL2**	**TEL**	**PEL**
mg/kg (Dry Weight)	0.00008	**Total PCBs**	0.00672	0.01098	0.00002	0.00009	<0.00008	<0.00008	<0.00008	0.00046	0.00092	<0.00008	**0.01**	**0.20**	**21.5**	**189**

Values exceeding sediment concentrations highlighted in corresponding colour

Table C-5: Organochlorine sediment concentrations against Cefas (2003) standards and OSPAR BCs (OSPAR, 1998)

			Stations										CEFAS	OSPAR
Units	**Limit of Detection**	**Matrix**	**1**	**2**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**17**	**AL1**	**BC**
mg/kg (Dry Weight)	0.0001	**alpha-Hexachlorcyclohexane**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**-**	**0.050**
		beta-Hexachlorcyclohexane	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**-**	**-**
		gamma-Hexachlorcyclohexane	**<0.00010**	**0.0001**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**-**	**0.050**
		Dieldrin	**<0.00010**	**0.0002**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**0.005**	**0.050**
		Hexachlorobenzene	**0.0007**	**0.0009**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**-**	**0.050**
		p,p'-Dichorodiphenyldicloroethane	**0.0007**	**0.0011**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**-**	**-**
		p,p'-Dichorodiphenyldicloroethylene	**0.0004**	**0.0007**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**-**	**0.050**
		p,p'-Dichorodiphenyltrichloroethane	**0.0002**	**0.0002**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**<0.00010**	**0.001**	**-**

Values exceeding sediment concentrations highlighted in corresponding colour

Appendix D : Sample Biotope Summary Table

Table D- 1: Biotope summary table for each station, ordered by cluster group

Cluster Group	Station	Modified Folk	Zone	Broad Substrate	Characterising Species[8]	EUNIS level 3[9]	EUNIS Biotope Code[10]	MHCBI Biotope Code
a	9a	(g)S	Infralittoral	Sand	*Pisione remota* *Glycera lapidum* *Nephtys cirrosa*	A5.2	A5.233	SS.SSa.IFiSa.NcirBat
b	1c	sM	Infralittoral	Mud	*Nephtys hombergii* *Eteone longa* *Nephtys* sp. (juv)	A5.3	A5.331	SS.SMu.ISaMu.NhomMac
c	1a	sM	Infralittoral	Mud	*Euchone limnicola* *Nephtys* sp. (juv) *Eteone longa* *Nephtys hombergii* *Prionospio fallax*	A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	1b	sM	Infralittoral	Mud		A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	2a	sM	Infralittoral	Mud		A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	2b	sM	Infralittoral	Mud		A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	2c	sM	Infralittoral	Mud		A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	5b	sM	Infralittoral	Mud		A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	5c	sM	Infralittoral	Mud		A5.3	A5.331	SS.SMu.ISaMu.NhomMac
d	13a	S	Infralittoral	Sand	*Magelona johnstoni* *Bathyporeia elegans* *Pontocrates altamarinus*	A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	13b	S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	13c	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat

[8] **Species taken from results of SIMPER analysis. Where less than two samples present the species shown signify those that dominated the total abundance for that sample.*

[9] A5.2 = ‘Sublittoral sand’; A5.3 = ‘Sublittoral mud’.
[10] A5.233 = ‘*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand’; A5.242 = ‘*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’; A5.331 = ‘*Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud’.

Cluster Group	Station	Modified Folk	Zone	Broad Substrate	Characterising Species[8]	EUNIS level 3[9]	EUNIS Biotope Code[10]	MHCBI Biotope Code
	17a	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	17b	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	17c	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
e	5a	sM	Infralittoral	Mud	*Magelona johnstoni* *Nephtys* sp. (juv)	A5.3	A5.331	SS.SMu.ISaMu.NhomMac
	9b	S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
f	14b	(g)S	Infralittoral	Sand	*Bathyporeia elegans* *Magelona johnstoni* *Spisula* sp. (juv)	A5.2	A5.242	SS.SSa.IMuSa.FfabMag
g	4b	(g)S	Infralittoral	Sand	*Magelona johnstoni* *Nephtys cirrosa* Nemertea *Chaetozone christiei*	A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	19a	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	19b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	19c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	22a	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	22c	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
h	3a	(g)S	Infralittoral	Sand	*Magelona johnstoni* *Bathyporeia guilliamsoniana* *Spisula* sp. (juv) *Fabulina fabula* *Owenia* sp. *Nephtys* sp. (juv)	A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	3b	(g)mS	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	4a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	4c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	7a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag

Cluster Group	Station	Modified Folk	Zone	Broad Substrate	Characterising Species[8]	EUNIS level 3[9]	EUNIS Biotope Code[10]	MHCBI Biotope Code
	7b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	7c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	10a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	10b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	10c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	11a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	11b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	11c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	12a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	12b	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	12c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	14a	gS	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	14c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	15a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	15b	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	15c	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	16a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	16b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	16c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag

Cluster Group	Station	Modified Folk	Zone	Broad Substrate	Characterising Species[8]	EUNIS level 3[9]	EUNIS Biotope Code[10]	MHCBI Biotope Code
	20a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	20b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	20c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	21a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	21b	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	21c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	22	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	23a	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	23b	(g)S		Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	23c	(g)S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
i	6a	mS	Infralittoral	Sand	*Magelona johnstoni* *Fabulina fabula* *Spiophanes bombyx* *Owenia* sp. *Nephtys* sp. (juv) *Nephtys assimilis*	A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	6b	(g)mS	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	6c	S	Infralittoral	Sand		A5.2	A5.242	SS.SSa.IMuSa.FfabMag
j	8a	(g)S	Infralittoral	Sand	*Magelona johnstoni* *Bathyporeia guilliamsoniana* *Nephtys cirrosa* *Macomangulus tenuis*	A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	8b	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	8c	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	18a	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat

Cluster Group	Station	Modified Folk	Zone	Broad Substrate	Characterising Species[8]	EUNIS level 3[9]	EUNIS Biotope Code[10]	MHCBI Biotope Code
	18b	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
	18c	(g)S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat
k	3c	S	Infralittoral	Sand	*Magelona johnstoni* *Diastylis bradyi*	A5.2	A5.242	SS.SSa.IMuSa.FfabMag
	9c	S	Infralittoral	Sand		A5.2	A5.233	SS.SSa.IFiSa.NcirBat

Appendix E : Macrofauna Data

Table E-1: Average macrofauna abundance (individuals/m^2) per station. 'P' denotes presence only

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Annelida																							
Amphictene auricoma	-	-	-	3	-	10	17	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Aonides oxycephala	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Caulleriella alata	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Chaetozone christiei	-	-	3	7	-	-	37	-	-	30	43	13	-	27	7	-	-	-	33	3	3	20	20
Chaetozone gibber	7	10	-	-	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaetozone vivipara	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cirriformia tentaculata	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-
Eteone longa	30	20	3	10	13	3	3	10	-	3	7	3	-	-	3	-	-	-	-	3	3	-	7
Euchone limnicola	140	243	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galathowenia oculata	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glycera lapidum	-	-	-	-	-	-	-	-	7	-	-	3	7	-	-	-	-	-	-	-	-	-	-
Glycinde nordmanni	-	-	-	3	-	-	7	-	-	3	23	-	-	20	7	-	-	-	3	-	13	-	7
Goniada maculata	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Lagis koreni	-	-	-	-	-	10	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Magelona filiformis	3	-	10	-	-	10	20	3	-	57	67	23	-	23	20	7	-	3	10	7	7	-	17
Magelona johnstoni	10	13	287	523	30	250	437	180	47	877	623	950	20	610	583	657	37	93	573	797	660	453	867
Malacoceros jirkovi	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
Melinna palmata	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Nephtys sp. (juvenile)	60	153	3	70	60	17	30	20	3	43	50	23	-	13	20	17	-	7	10	13	13	13	20
Nephtys assimilis	-	-	7	3	-	13	7	-	-	-	10	3	-	7	-	-	-	-	-	7	7	3	3
Nephtys cirrosa	-	-	17	20	-	-	-	23	7	27	3	13	-	-	13	3	7	30	37	-	-	13	13
Nephtys hombergii	60	63	7	23	27	27	10	3	-	7	7	10	-	13	13	23	-	3	7	23	33	-	7
Nephtys incisa	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nephtys kersivalensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	10
Nicomache	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophelia borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Ophelina acuminata	3	17	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophryotrocha	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Owenia	-	-	10	27	-	23	40	7	-	30	50	37	-	40	17	7	-	-	3	7	20	3	20
Oxydromus flexuosus	3	7	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phyllodoce groenlandica	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Phyllodoce mucosa	-	3	-	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Phyllodoce rosea	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	3	-	-	3	-	-	-	-
Pisione remota	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Podarkeopsis capensis	3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Poecilochaetus serpens	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Prionospio fallax	13	37	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scolelepis (Scolelepis) squamata	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-
Scolelepis bonnieri	-	-	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	-	-	-	-
Scoloplos armiger	-	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Serpulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sigalion sp. (juvenile)	-	-	3	3	-	-	3	3	-	10	10	3	-	10	3	7	-	-	10	3	7	7	10
Sigalion mathildae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	3	3	-	-
Spio decorata	-	-	-	-	-	-	-	7	-	-	-	3	-	-	7	-	-	-	3	-	-	-	3
Spio martinensis	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Spio symphyta	-	-	-	-	-	-	-	-	-	7	-	3	-	-	-	-	-	-	-	7	-	-	-
Spiophanes bombyx	-	-	3	7	-	20	67	3	-	37	63	60	-	43	7	3	-	3	23	37	13	27	3
Sthenelais limicola	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebellides	7	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tubificoides galiciensis	-	7	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-
Tubificoides swirencoides	-	10	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arthropoda																							
Ampelisca brevicornis	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-	-
Bathyporeia elegans	-	-	10	-	-	3	10	13	3	7	10	13	217	97	10	13	10	13	-	10	7	-	13
Bathyporeia guilliamsoniana	-	-	60	23	-	-	3	57	-	87	60	207	-	80	183	53	-	20	13	250	73	7	30
Centraloecetes kroyeranus	-	-	-	-	-	-	10	-	-	3	37	20	-	-	-	-	-	-	10	-	10	-	-
Crangon allmanni	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Diastylis bradyi	-	-	57	-	-	3	-	-	7	-	3	-	-	3	-	7	-	-	-	3	-	-	3
Eudorella truncatula	-	3	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hippomedon denticulatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Leucothoe lilljeborgi	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Liocarcinus marmoreus	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nototropis falcatus	-	-	-	7	-	3	3	-	-	3	7	3	-	-	3	10	-	7	-	-	-	-	3

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Paramysis arenosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Pariambus typicus	-	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Pinnotheres pisum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Pontocrates altamarinus	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	17	10	10	-	-	-	-	-
Pontocrates arenarius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Verruca stroemia	-	-	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Bryozoa																							
Electra pilosa	-	-	-	-	-	P	-	P	-	-	-	-	P	-	-	-	P	-	-	-	-	-	-
Cnidaria																							
Campanulariidae	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinodermata																							
Amphiuridae (juvenile)	3	3	-	-	-	7	3	-	-	7	3	-	-	10	-	-	-	-	3	-	3	7	3
Echinocardium cordatum	-	-	-	-	-	10	3	-	-	-	7	7	-	-	-	3	-	-	-	-	-	3	3
Leptopentacta elongata	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptosynapta inhaerens	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiura albida	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiura	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-	-
Ophiuridae (juvenile)	-	-	3	-	-	-	7	-	-	-	-	7	-	-	-	-	-	-	-	-	10	-	-
Spatangoida (juvenile)	-	-	3	3	-	10	10	-	3	3	13	13	-	7	3	3	-	-	-	3	3	7	7

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Entoprocta																							
Loxosomella sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mollusca																							
Abra sp. (juvenile)	-	37	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-
Abra alba	3	13	-	-	10	10	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3	-	-
Abra nitida	-	3	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Abra prismatica	-	-	3	-	-	7	23	-	-	13	-	-	-	7	-	-	-	-	-	3	10	3	7
Aclis minor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
Chamelea striatula	-	-	7	3	-	10	7	-	-	7	7	3	-	7	3	-	-	3	-	3	17	3	13
Donax vittatus	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	7	-	13	-	-	-	-	-
Dosinia sp. (juvenile)	-	-	-	-	-	-	3	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-
Ensis sp. (juvenile)	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-
Euspira nitida	-	-	7	7	-	-	7	-	-	-	3	3	-	3	-	-	-	-	7	-	3	-	7
Fabulina fabula	-	-	50	23	-	110	20	-	-	17	20	30	-	10	37	10	3	-	7	77	93	13	10
Gari sp. (juvenile)	-	-	3	-	-	-	7	-	-	-	10	-	-	3	-	-	-	-	-	3	-	-	-
Kurtiella bidentata	-	7	-	-	-	7	10	3	-	3	20	3	-	-	-	7	-	-	-	-	-	-	3
Macomangulus tenuis	-	-	-	-	3	-	-	13	7	3	-	-	-	-	-	3	-	33	3	-	-	-	-
Mactra sp. (juvenile)	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mactra stultorum	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	3
Mya sp. (juvenile)	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mytilidae (juvenile)	-	13	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nucula nitidosa	-	7	23	13	20	20	40	3	-	-	23	-	-	30	7	3	-	-	13	20	67	13	30

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Phaxas pellucidus	-	-	-	-	-	3	-	-	-	-	7	-	-	3	-	-	-	-	7	-	3	-	-
Retusa umbilicata	-	-	-	3	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-
Spisula sp. (juvenile)	-	-	30	90	7	3	33	-	3	37	37	63	-	47	37	20	-	3	7	27	13	7	30
Spisula subtruncata	-	-	-	3	-	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Tellimya ferruginosa	-	-	-	-	-	10	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
hracia sp. (juvenile)	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thyasira flexuosa	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yoldia hyperborea	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nematoda																							
Nematoda	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemertea																							
Nemertea	-	-	-	3	-	3	10	-	-	27	43	7	3	13	7	-	-	-	17	-	7	7	13
Phoronida																							
Phoronis sp.	-	-	-	3	3	-	-	-	-	3	7	7	-	23	-	-	-	3	-	-	3	-	3
Platyhelminthes																							
Platyhelminthes	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sipuncula																							
Thysanocardia procera	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-

Table E-2: Average macrofauna biomass (grams/m²) per station

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Animalia	-	-	-	0.08	0.01	0.04	0.01	0.07	0.49	0.06	0.09	0.06	0.73	0.31	0.01	-	0.09	0.81	1.28	-	0.08	0.01	0.03
Annelida	7.29	5.93	1.33	1.45	5.55	2.94	1.50	0.59	0.38	2.02	1.62	2.27	0.53	3.07	1.24	0.86	0.29	1.86	1.42	1.76	1.72	1.12	1.40
Crustacea	-	0.00	0.65	33.43	0.00	0.07	0.01	0.10	0.06	0.11	0.10	1.31	0.18	0.31	0.27	0.26	0.03	0.10	0.03	1.85	0.10	0.01	0.07
Echinodermata	0.01	0.01	0.06	0.11	0.57	9.58	0.43	-	0.08	0.04	1.06	0.50	-	0.36	0.01	0.17	-	0.00	0.05	0.44	0.16	0.16	0.26
Mollusca	0.02	0.84	0.82	3.62	0.90	2.27	1.36	0.04	1.56	1.02	1.04	1.11	-	1.95	1.81	0.76	0.01	2.70	5.67	3.49	2.36	0.51	1.41

Appendix F : OWF Data Analysis and Discussion

Introduction

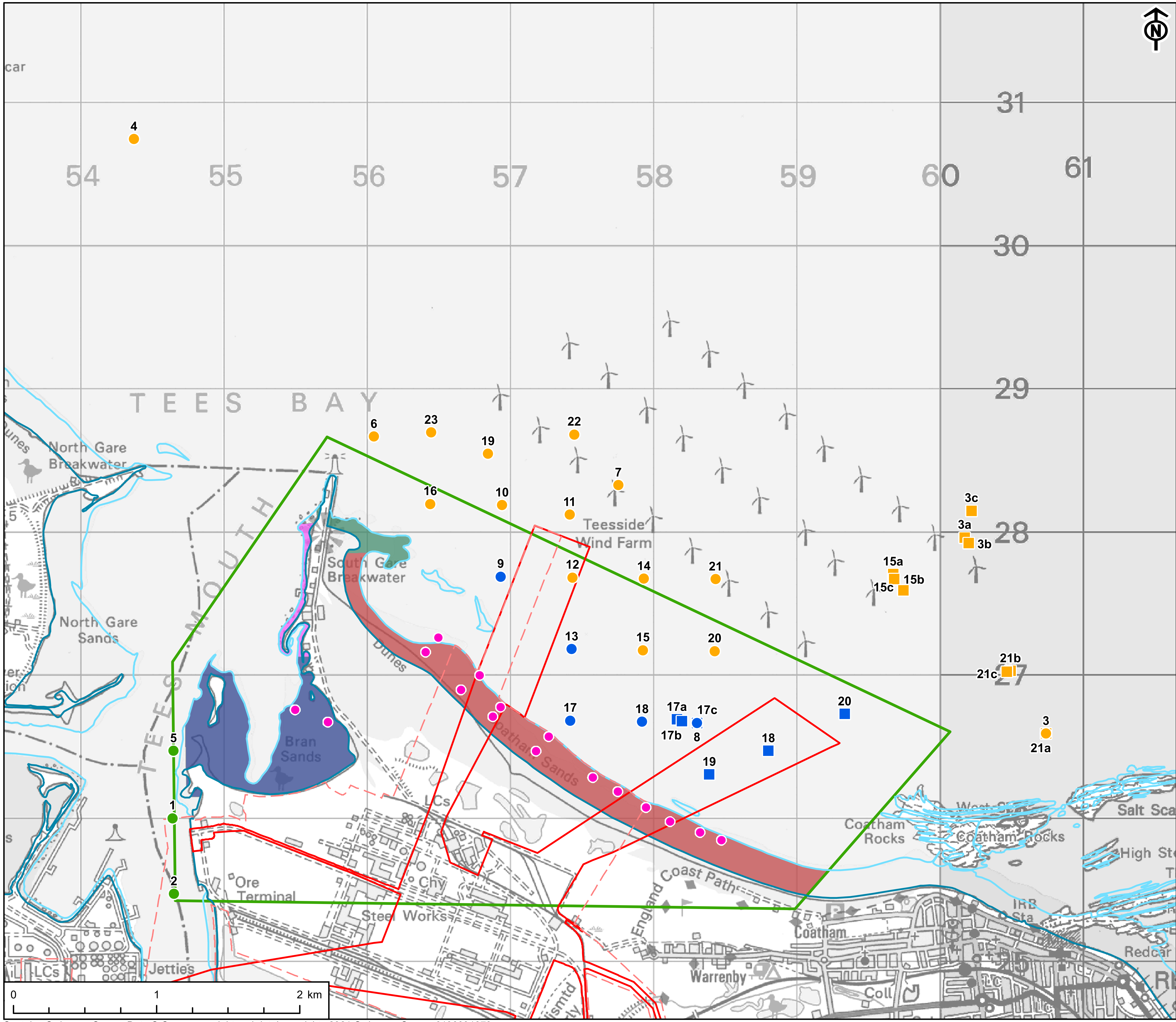
Following the submission (to the Planning Inspectorate) of a Preliminary Environmental Information (PEI) Report in July 2020, for the Net Zero Teesside (NZT) project, a potential design change related to the Water Connection Corridor was identified. Specifically, this includes the potential relocation of the Water Discharge Corridor to a location to the south east of the current proposal, by constructing a new outfall in close proximity to the proposed CO2 Export Pipeline.

Should the new discharge infrastructure be required the Zone of Influence (ZoI) will move further east and therefore consideration of this new area has been addressed. In particular, a review of data in relation to the subtidal benthic baseline survey undertaken in 2019 was carried out because the 2019 subtidal survey was defined on the basis of the existing Water Discharge Corridor. The extension to the existing red line boundary, that would result from a new discharge corridor, is shown in Figure 14D-14.

The 2019 survey sampling stations did not extend into the newly proposed and amended red line boundary encompassing the newly proposed outfall. There are, however, several stations from the 2010 Teesside OWF benthic grab survey that do encompass this area (see Figure 14D-14, below) and provide subtidal community data within and in close proximity to the new outfall area.

Figure 14D-14: Teesside OWF and Teesside Net Zero subtidal benthic sampling stations and EUNIS biotope classifications

Project Management Initials: RL Designer: LC Checked: AR Approved: RG



Scale @ A3 1:25,000

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AECOM

PROJECT

NET ZERO TEESSIDE PROJECT

Net Zero Teesside

APPLICANTS

NZT POWER LTD. AND NZNS STORAGE LTD.

KEY

- Site Boundary
- PEIR Site Boundary
- Mean Low Water
- Mean High Water
- Phase II Intertidal Sample Location

Subtidal Sampling Location - Survey

- AECOM
- Teesside OWF *

EUNIS Biotope - Symbol Colour

- A5.233 (SS.SSa.IFiSa.NcirBat) – *'Nephtys cirrosa and Bathyporeia spp. in infralittoral sand'*
- A5.242 (SS.SSa.IMuSa.FfabMag) – *'Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'*
- A5.331 (SS.SMu.ISaMu.NhomMac) – *'Nephtys hombergii and Macoma balthica in infralittoral sandy mud'*
- Phase I Intertidal Study Area

Intertidal Phase I Broad Scale EUNIS Biotope

- A1.113, [Semibalanus balanoides] on exposed to moderately exposed or vertical sheltered eulittoral rock
- A1.323, [Fucus vesiculosus] on variable salinity mid eulittoral boulders and stable mixed substrata
- A2.2, Littoral sand and muddy sand
- A2.242, [Cerastoderma edule] and polychaetes in littoral muddy sand

* Entec UK Limited (2011). Teesside Windfarm Ltd, Teesside Offshore Wind Farm FEPA Monitoring, Benthic Survey Report 2010

TITLE

FIGURE 14D-14
TEESSIDE OFFSHORE WIND FARM AND NET ZERO TEESSIDE SUBTIDAL BENTHIC EUNIS BIOTOPE AND SEDIMENT CLASSIFICATION MAP

REFERENCE

NZT_210511_SBS_14D-141_v2

SHEET NUMBER	DATE
1 of 1	11/05/21

Sediment Composition

The major sediment fractions at each OWF benthic grab station are presented in Figure 14D-15. The particle size analysis (PSA) data has been summarised and classified as per the Folk (1954) classification system (as described in Table F-1). There was little variation between the OWF stations, all being dominated by a high content of sandy sediments (63 µm - 2 mm), with a generally low mud content (sediment <63 µm). Only station 21C had a sediment composition containing gravel (sediment ≥2 mm), representing 11.2% of the total sediment fraction. Overall, sand represented the highest sediment fraction across all stations (>90%), excluding station 21C (sand = 75.8%). The classification of most stations was 'sand', whilst station 21C was classified as 'gravelly muddy sand'. This conforms with the PSA results from other areas in the Tees Bay sampled as part of NZT subtidal benthic survey in 2019.

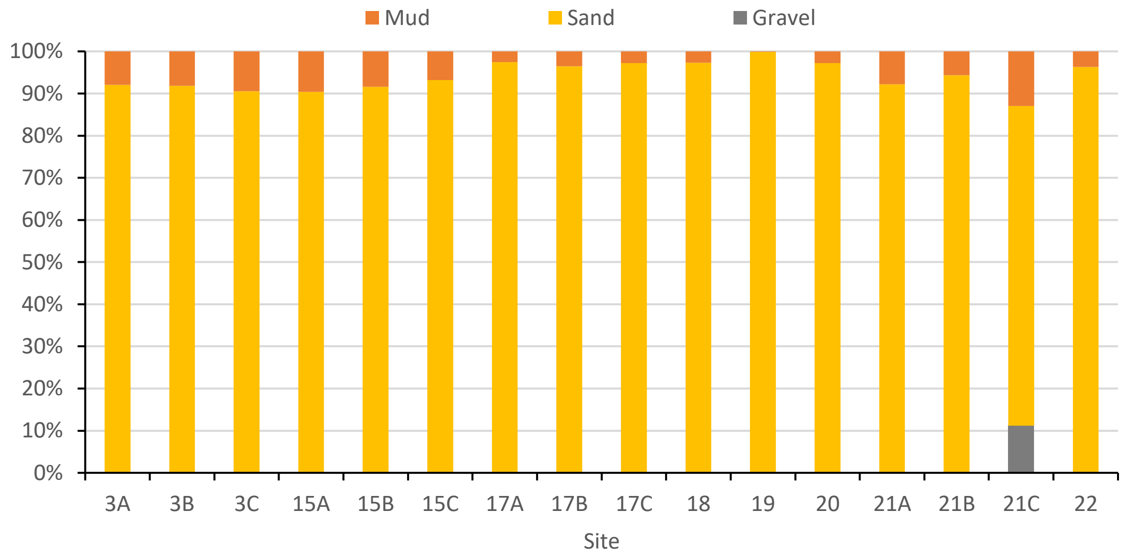

Figure 14D-15: Major sediment fractions (%) at each OWF grab sampling station considered

Table F-3: Summarised OWF PSA data as classified by Folk (1954)

Station no.	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Sediment Classification	Modified Folk
3A	Very Fine Sand	Poorly Sorted	105.2	3.765	Sand	S
3B	Very Fine Sand	Poorly Sorted	106.2	3.767	Sand	S
3C	Very Fine Sand	Poorly Sorted	114.7	3.785	Sand	S
15A	Fine Sand	Poorly Sorted	149.8	3.435	Sand	S
15B	Very Fine Sand	Poorly Sorted	139.4	3.429	Sand	S
15C	Very Fine Sand	Poorly Sorted	127.7	3.475	Sand	S

Station no.	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Sediment Classification	Modified Folk
17A	Fine Sand	Well Sorted	186.4	2.682	Sand	S
17B	Fine Sand	Well Sorted	183.1	2.753	Sand	S
17C	Fine Sand	Moderately Well Sorted	171.1	2.832	Sand	S
18	Fine Sand	Well Sorted	178.0	2.769	Sand	S
19	Fine Sand	Well Sorted	189.6	2.534	Sand	S
20	Fine Sand	Well Sorted	189.2	2.685	Sand	S
21A	Very Fine Sand	Poorly Sorted	134.9	3.471	Sand	S
21B	Very Fine Sand	Moderately Sorted	132.7	3.366	Sand	S
21C	Fine Sand	Very Poorly Sorted	327.6	3.120	Gravelly Muddy Sand	gmS
22	Fine Sand	Well Sorted	177.8	2.809	Sand	S

Macrobenthic Communities

Across all OWF benthic grab stations (not just those considered in this appendix), a total of 114 species were recorded, with Chaetozone cf. christiei and Magelona johnsti being the most commonly encountered species recorded. For the OWF benthic grab stations considered within this appendix, the average abundance recorded was 517.5 individuals/m2. The key species characterising each of these stations and contributing to similarity in infaunal multivariate cluster groups is outlined below.

The species richness (total number of species, S) and diversity (Shannon diversity index, H’) at each OWF benthic grab station is presented in Figure 14D-16. Species richness ranged from 4 to 34 species, whilst species diversity ranged from H’ = 1.034 to H’ = 2.945. This was comparable to the range of species richness and diversity recorded during the Teesside Net Zero subtidal benthic surveys (S = 8 to S = 37; H’ = 1.275 to H’ = 2.854).

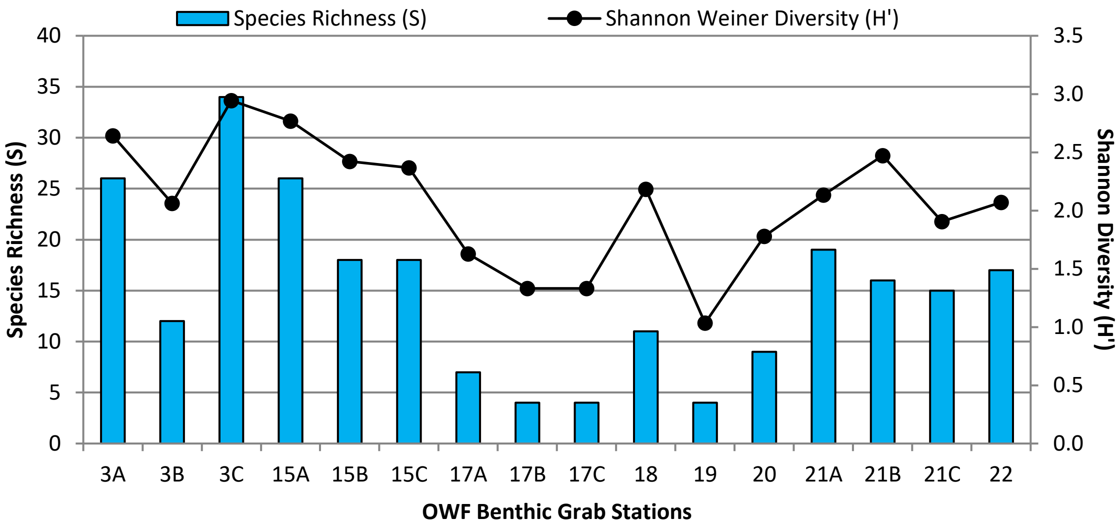

Figure 14D-16: Species richness (S) and Shannon diversity index (H') recorded at each OWF benthic grab station considered within this appendix

Priority Species and INNS

The OWF benthic grab surveys recorded the presence of a number of individuals and colonies of Sabellaria spinulosa. This species forms biogenic reefs which is an Annex 1 habitat under the Habitats Directive, as well as being a habitat of principal importance listed under Section 41 of the NERC Act 2006. Of the OWF benthic grab stations considered within this appendix, Sabellaria spinulosa was recorded at station 21C only, with a total of 25 individuals. Overall, the results of the OWF benthic surveys concluded that the abundance of Sabellaria spinulosa was not great enough to represent biogenic reef. No other species of conservation importance were found during the OWF benthic survey; all species were considered common to the Teesside area and in UK waters.

Biotope Classifications

Multivariate analysis of the OWF benthic grab stations was undertaken by Entec UK Ltd to determine the clustering of stations with a similar community composition, and to assign different biotope classifications.

Five discrete groups (A – E) were identified using cluster analysis and a SIMPROF test. Of these, groups A and B were considered as two distinct clusters, representing the majority of the grab samples. Groups C, D, and E correspond to three grab samples and do not include the stations considered within this appendix. SIMPER analysis was used to identify the species which contribute to within group similarity, and how these characterise each group. The results of this analysis11, including which stations (considered in this appendix) comprise each group, is presented in Table F-2. Nephtys cirrosa contributed the highest to the within group similarity of Group A, representing 47.04%. In Group B, both Chaetozone cf. christiei and Magelona johnsti accounted for the highest within group similarity, representing 13.00% and 11.80%, respectively.

[11] The SIMPER analysis was undertaken for all OWF grab sampling stations, not just those considered within this appendix.

Table F-2. OWF infaunal multivariate cluster groups and the results of the SIMPER analysis*

Group	Stations	Species	Contribution to Similarity (%)
A	17 (A, B, C), 18, 19, 20	*Nephtys cirrosa*	47.04
		Bathyporeia elegans	16.56
		Echinocardium cordatum	6.29
		Nemertea indet.	5.18
B	3 (A, B, C), 15 (A, B, C), 21 (A, B, C), 22	*Chaetozone* cf. *christiei*	13.00
		Magelona johnsti	11.80
		Bathyporeia elegans	7.11
		Echinocardium cordatum	6.32

*top four species contributing to similarity presented

Each OWF infaunal multivariate cluster group was assigned a biotope outlined within the EUNIS habitat classification system (EEA, 2012), based on the composition of the species assemblage at each station and the composition of the substrate. Each biotope is based on codes outlined within the EUNIS habitat classification system (EEA, 2012). A habitat classification map of each station is presented in Figure 14D-14.

Group A was classified as ‘Nephtys cirrosa and Bathyporeia spp. in infralittoral sand’ (A5.233; SS.SSa.IFiSa.NcirBat), which is synonymous with sediment that has a high content of sand, with little to no fractions of mud (‘infralittoral fine sand’). The stations comprising group A (such as 18 and 19) were found in the shallow inshore area which is characterised by moderate to high exposure and sediments possessing a low clay/silt content, characteristic of this biotope. The amphipod Bathyporeia sp. and polychaete Nephtys cirrosa are typical of this biotope and dominated the abundance of these stations.

In contrast, group B was classified as ‘Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’ (A5.242; SS.SSa.IMuSa.FfabMag). This biotope is typically found in less exposed areas compared to the biotope A5.233, ‘extending from the extreme lower shore down to more stable circalittoral zone at about 15-20 m’ (EEA, 2019). The stations of group B were located in most cases, in slightly deeper waters and were less exposed, exhibiting a higher percentage of silt/clay. Due to the higher content of mud for this biotope, a greater dominance of venerid bivalves is expected.

The two biotopes identified (A5.233 and A5.242) qualify as habitats of principal importance listed under Section 41 of the NERC Act 2006 and belong to the habitat type, ‘subtidal sands and gravels’. These are also representative of the Annex I habitat ‘sandbanks slightly covered by sea water all the time’. However, these habitats are not a qualifying feature of any nearby designated site.

Discussion

The sediment content of the 2019 Teesside Net Zero subtidal benthic stations in Tees Bay, consisted of predominantly sand, with a generally low mud and gravel content.

The classification of these stations was ‘slightly gravelly sand’, ‘slightly gravelly muddy sand’, and ‘sand’. This conforms with the high content of sand recorded in the additional 16 OWF benthic grab samples considered within this appendix.

The Teesside Net Zero stations in Tees Bay were classified as either the biotope ‘Nephtys cirrosa and Bathyporeia spp. in infralittoral sand’ (A5.233; SS.SSa.IFiSa.NcirBat) or ‘Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’ (A5.242; SS.SSa.IMuSa.FfabMag). In general, the stations in the shallow inshore area, where the level of exposure is considered to be greater (apparent from the lower sediment content of mud), were determined to be the biotope A5.223. The stations located in slightly deeper waters, where the sediment content of mud was higher and as such the number of venerid bivalves were also, were classified as A5.242. These two biotopes were also recorded at the OWF benthic grab stations considered within this appendix, demonstrating the same association between water depth gradients and mud gradients from the shore and the biotope assigned (see Figure 14D-14). It was noted in the OWF benthic survey report that, although small scale spatial variations between grabs were recorded, ‘in terms of the specific macro-faunal assemblage’, these variations were not sufficient to change the biotope classifications (Entec UK Ltd, 2011).