Morven North Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 3, Annex 8.1: Benthic Subtidal Ecology Shared Technical Report

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1 Introduction

1.1.1.1 The Morven North Offshore Wind Array Project (hereafter "Morven North") and the Morven South Offshore Wind Array Project (hereafter "Morven South") are both located within the Morven Option Lease Agreement Site (hereafter "Morven Site"') in Scottish offshore waters (Figure 1.1). Morven North is located approximately 61.2km from the Aberdeenshire coast (at its closest point) and Morven South is located approximately 86.1km from the Aberdeenshire coast (at its closest point). Each project will comprise wind turbines, Offshore Substation Platforms (OSPs), associated foundations, inter-array and interconnector cables and cable protection. Consent for the offshore export cables of Morven North and Morven South will be sought separately.

1.1.1.2 As shown in Figure 1.1, Morven North is situated northwest of Morven South. The external boundaries of the projects correspond with the boundaries of the Morven Site.

1.1.1.3 This Morven North and Morven South Benthic Subtidal Ecology Shared Technical Report (hereafter referred to as the Benthic Subtidal Ecology Shared Technical Report) presents the baseline characterisation of benthic subtidal ecology for both Morven North and Morven South.

1.1.1.4 Consent for Morven North and Morven South will be sought separately, aided by the development of a separate Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA) for each project. However, the survey campaign and desk based studies that support the impact assessments for Morven North and Morven South are based on the Morven Site, which accommodates both Morven North and Morven South. Given the comparability and consistency of information collected to inform the assessments for both projects, the baseline characterisation of benthic subtidal ecology for both Morven North and Morven South is reported in this Benthic Subtidal Ecology Shared Technical Report.

1.1.1.5 The information from this Benthic Subtidal Ecology Shared Technical Report provides the technical baseline to inform the assessment of the likely significant effects of Morven North and Morven South on benthic subtidal ecology receptors. This report accompanies the EIA provided in Volume 2, Chapter 8: Benthic Subtidal Ecology of the respective EIA Reports for Morven North or Morven South to support the respective consent applications.

1.1.1.6 The aim of this Benthic Subtidal Ecology Shared Technical Report is to:

- characterise the benthic subtidal environment within and surrounding the Morven North and Morven South boundaries;
- identify the occurrence and distribution of any habitats or species of conservation interest;
- assign habitat types to biotope level according to the JNCC habitat classification system (Connor *et al.,* 2004).

1.1.1.7 The information will be used as evidence for the EIA and to identify Important Ecological Features (IEFs) that may be affected by Morven North or Morven South, in accordance with the EIA guidelines (Chartered Institute of Ecology and Environmental Management, 2022).

1.1.1.8 Data were collated through a detailed desktop study of the existing resources available for benthic subtidal ecology within the region, incorporating data from third party organisations, to gain a historical perspective of benthic subtidal ecology population dynamics at, and surrounding, Morven North and Morven South. Site specific surveys were also undertaken in 2022 (Section 3.2).

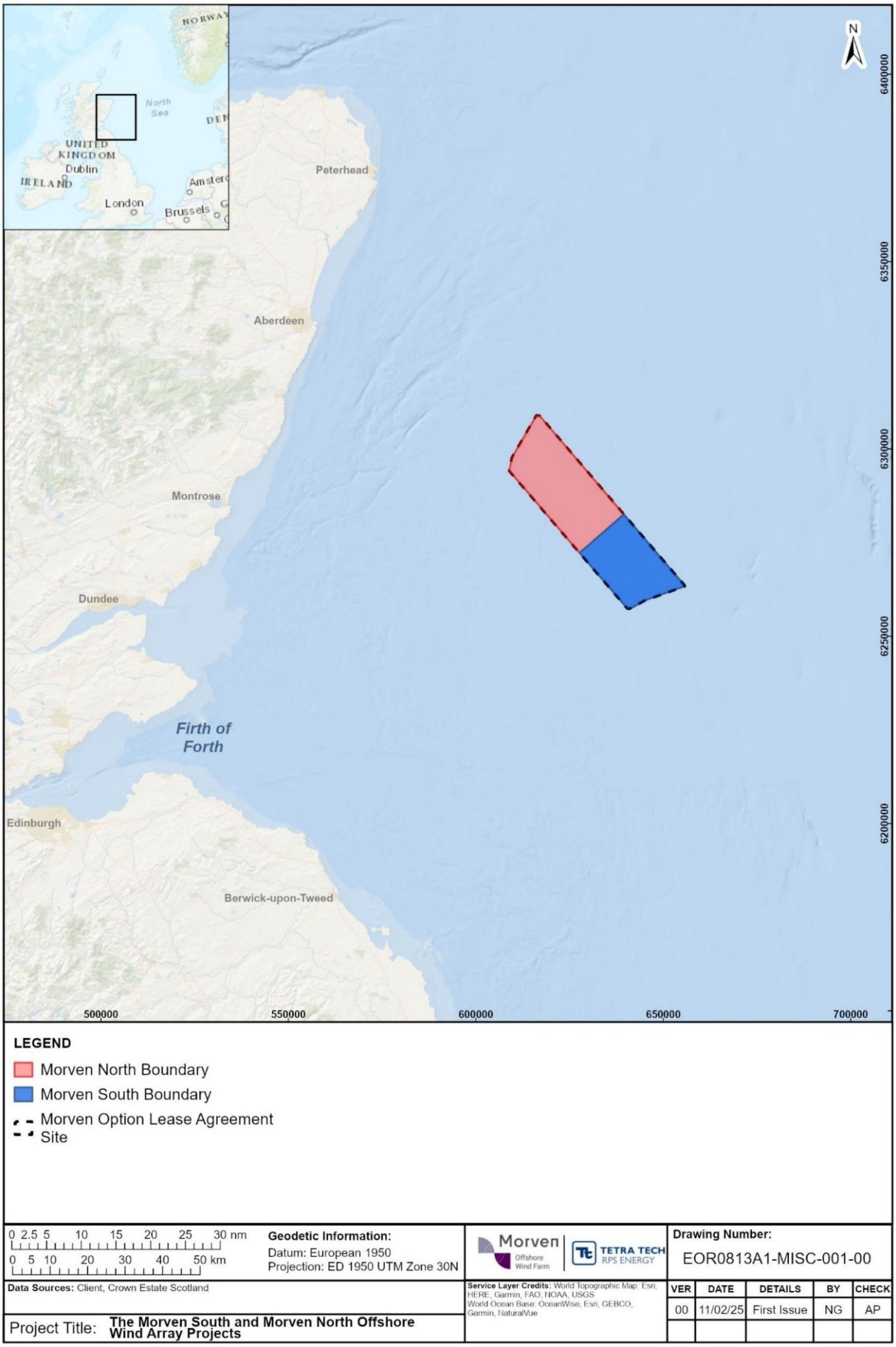

Figure 1.1: The boundaries of the Morven North and the Morven South within the Morven Option Lease Agreement Site

2 Study Areas

2.1.1.1 Four study areas are defined for benthic subtidal ecology:

- the Morven North Benthic Subtidal Ecology Study Area;
- the Morven South Benthic Subtidal Ecology Study Area;
- the Survey Area;
- the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area.

2.1.1.2 The study areas are shown in Figure 2.1 and defined as follows:

- The Morven North Benthic Subtidal Ecology Study Area (Figure 2.1) informs the baseline for Morven North. The study area includes the Morven North Boundary, plus a buffer extending approximately 5km to 14km from the Morven North Boundary. This buffer is designed to incorporate the Zone of Influence (ZoI) from indirect impacts (e.g. increases in suspended sediment concentrations (SSC) and potential changes in physical processes) and equates to one maximum tidal ellipse over a large spring tide around the Morven North Boundary[1] . Beyond this distance, any impacts from Morven North on benthic subtidal ecology receptors would be minimal.
- The Morven South Benthic Subtidal Ecology Study Area (Figure 2.1) informs the baseline for Morven South. The study area includes the Morven South Boundary, plus a buffer extending approximately 5km to 14km from the Morven South Boundary. This buffer is designed to incorporate the ZoI from indirect impacts (e.g. increases in SSC and potential changes in physical processes) and equates to one maximum tidal ellipse over a large spring tide around the Morven South Boundary1. Beyond this distance, any impacts from the Morven South on benthic subtidal ecology receptors would be minimal.
- The Survey Area is the area within which the benthic site specific survey was undertaken in 2022 (Section 3.2), covering both Morven North and Morven South and the predicted ZoI. Sampling locations are shown in Figure 3.1. Information reported for the Survey Area is equally relevant to both the Morven North Benthic Subtidal Ecology Study Area and the Morven South Benthic Subtidal Ecology Study Area. There is an area of spatial overlap between the Morven North Benthic Subtidal Ecology Study Area and the Morven South Benthic Subtidal Ecology Study Area (Figure 2.1). Where sampling points are located in this area of spatial overlap (i.e. within both the Morven North Benthic Subtidal Ecology Study Area and the Morven South Benthic Subtidal Ecology Study Area), these shared data points are described as “Shared Sampling Locations”. Shared Sampling Locations inform the baseline for both Morven North and Morven South.
- The Morven North and Morven South Regional Benthic Subtidal Ecology Study Area (Figure 2.1) encompasses wider northern North Sea habitats and neighbouring designated sites, and consented, developing and planned offshore wind farms (OWFs). Morven North and Morven South are both located within this wider regional area, which, accordingly, provides the regional context for both projects. The Morven North and Morven South Regional Benthic Subtidal Ecology Study Area has been characterised by desktop data to provide wider context to site specific data. The Morven North and Morven South Regional Benthic Subtidal Ecology Study Area also considers feedback received from the Marine Directorate – Licensing Operations Team (MD-LOT) and the Statutory Nature Conservation Bodies (SNCBs) on other OWF projects in the Firth of

[1] One spring tidal excursion has been identified through numerical modelling techniques and is defined as the distance that suspended sediment is transported before being carried back on the returning tide. The model was informed from bathymetric datasets available as part of the Marine Environmental Data Information Network. The area is asymmetrical due to the orientation of Morven North and Morven South compared to the tidal currents.

Forth region, namely Berwick Bank. The feedback within the Berwick Bank Scoping Opinion advised that Regional Benthic Subtidal Ecology Study Areas should include neighbouring consented OWF projects with their associated export cable corridors, and all relevant designated sites.

2.1.1.3 The Survey Area was presented and agreed during the scoping process for the Morven Site as the OWF Project Benthic Subtidal Ecology Study Area. The separate Morven North Benthic Subtidal Ecology Study Area and Morven South Benthic Subtidal Ecology Study Area have been defined using Physical Processes modelling, as described above. These separate study areas for Morven North and Morven South for benthic subtidal ecology were presented to MD-LOT via a “Targeted Consultation Exercise” undertaken in Quarter 1, 2025.

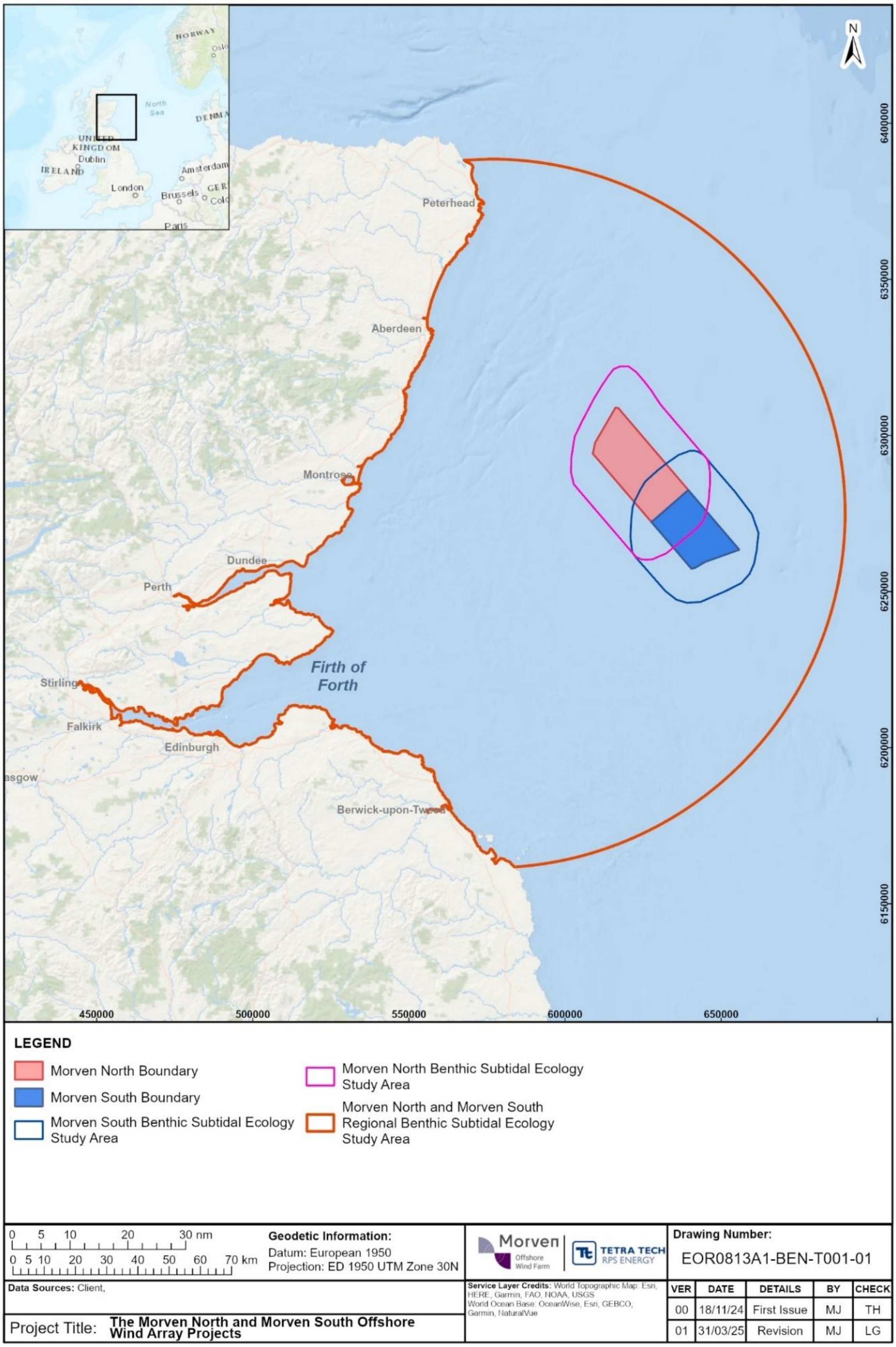

Figure 2.1: Morven North Benthic Subtidal Ecology Study Area, Morven South Benthic Subtidal Ecology Study Area and Morven North and Morven South Regional Benthic Subtidal Ecology Study Area

3 Methodology

3.1 Desktop Study

3.1.1.1 Information on benthic subtidal ecology within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area was collected through a detailed desktop review of existing studies and datasets. Desktop study sources used to inform the baseline characterisation are summarised in Table 3.1.

Table 3.1: Summary of key desktop datasets and reports for benthic subtidal ecology

Title	Source	Year	Author
Ossian Offshore Wind Farm – Appendix 8.1: Benthic Subtidal Ecology Technical Report, Array EIA Report.	SSE Renewables	2024	SSE Renewables
Muir Mhòr Offshore Wind Farm - Environmental Impact Assessment Report - Volume 2, Chapter 9: Benthic, Subtidal and Intertidal Ecology	Muir Mhòr Offshore Wind Farm Ltd	2024	Muir Mhòr Offshore Wind Farm Ltd
Cambois Connection – Marine Scheme. Environmental Statement – Volume 2, ES Chapter 8: Benthic Subtidal and Intertidal Ecology	SSE Renewables	2023	SSE Renewables
Berwick Bank Wind Farm Offshore Environmental Impact Assessment Appendix 8.1: Benthic Subtidal and Intertidal Ecology Technical Report	SSE Renewables	2022	SSE Renewables
Eastern Green Link 2 – Marine Scheme Environmental Appraisal Report Volume 2 Chapter 8 – Benthic Ecology	National Grid Electricity Transmission and Scottish Hydro Electric Transmission	2022	National Grid Electricity Transmission and Scottish Hydro Electric Transmission plc
Benthic subtidal ecology validation survey undertaken for the Seagreen (Alpha) export cable corridor	Seagreen Ltd	2021	Seagreen Ltd

Title	Source	Year	Author
marine licence application			
National Biodiversity Network (NBN) Atlas	NBN Atlas	2019	NBN Atlas
European Marine Observation and Data Network (EMODnet) broad scale seabed habitat map for Europe (EUSeaMap)	EMODnet – Seabed Habitats	2019	EMODnet – Seabed Habitats
The Marine Scotland National Marine Interactive (NMPi) maps	Marine Scotland	2019	Marine Scotland for the Scottish Government
A big data approach to macrofaunal baseline assessment, monitoring and sustainable exploitation of the seabed	Centre for Environment, Fisheries and Aquaculture Science (Cefas)	2017	Cooper, K.M. and Barry, J.
Descriptions of Scottish Priority Marine Features (PMFs)	Scottish Natural Heritage	2016	Tyler-Walters *et al.*
Kincardine Offshore Wind Farm: Environmental Statement	Kincardine Offshore Wind Farm	2016	Atkins
Hywind Scotland Pilot Park Environmental Statement	Hywind Offshore Wind Farm	2015	Statoil
Firth of Forth Banks Complex Marine Protected Area (MPA) – Relevant Documentation – Site Summary Document	Joint Nature Conservation Committee (JNCC)	2014	JNCC
Biotope Assignment of Grab Samples from Four Surveys Undertaken in 2011 Across Scotland's Seas (2012)	JNCC	2014	Pearce, B., Grubb, L., Earnshaw, S., Pitts, J. and Goodchild, R.
Analysis of seabed imagery from the 2011 survey of the Firth of Forth Banks Complex, the 2011 International Bottom Trawl Survey Quarter 4 (Q4) survey	JNCC	2014	Axelsson, M., Dewey, S. and Allen, C.

Title	Source	Year	Author
and additional deep water sites from Marine Scotland Science surveys			
Mapping habitats and biotopes from acoustic datasets to strengthen the information base of MPAs in Scottish waters – Phase 2	JNCC	2014	Sotheran, I. and Crawford-Avis, O.
Environmental Impact Statement. Volume 1, Chapter 11 Benthic Ecology and Intertidal Ecology	Seagreen Ltd	2012	Seagreen Ltd
Offshore Environmental Statement, Volume 1B: Biological Environment, Chapter 12 Benthic Ecology	Inch Cape Offshore Ltd	2011	Inch Cape Offshore Ltd
European Offshore Wind Deployment Centre: Request for an Environmental Impact Assessment (EIA), Scoping Opinion	Aberdeen Offshore Wind Farm Ltd	2010	Aberdeen Offshore Wind Farm Ltd
Appendix 7.1 Benthic Characterisation Survey Report	Neart na Gaoithe Offshore Wind Ltd	2010	Neart na Gaoithe Offshore Wind Ltd
The Marine Nature Conservation Review (MNCR) Area Summary for southeast Scotland and northeast England	JNCC	1998	Brazier *et al.*
The Ecology of Scottish Inshore Fishing Grounds	Aberdeen Offshore Wind Farm Ltd	1958	McIntyre, A. D.

3.2 Site Specific Surveys

3.2.1.1 A benthic subtidal survey was undertaken from April to August 2022 by Gardline Ltd, on the vessel Ocean Geograph, to characterise the Survey Area.

3.2.1.2 The sampling strategy was designed to characterise the benthic communities associated with all the broadscale habitats and identify any potentially sensitive features. This involved 69 stations pre-selected to satisfy the survey objectives, with a further 33 stations selected after geophysical data acquisition, which directed focus onto points of interest within the data. The survey design was discussed and agreed with the Marine Directorate (formerly Marine Scotland), and the SNCBs.

3.2.1.3 A summary of the surveys undertaken to inform benthic subtidal ecology is outlined in Table 3.2 below.

Table 3.2: Summary of surveys undertaken for benthic subtidal ecology

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Pre-construction site investigation surveys	Morven North Boundary and Morven South Boundary	Multi-beam echo sounder, side scan sonar, magnetometer, innomar sub-bottom profiler and 2D ultra-high resolution seismic.	Gardline Ltd	April to August 2022	Gardline, 2022a
Benthic subtidal survey	The Survey Area	Grab and DDV sampling.	Gardline Ltd	April to August 2022	Gardline, 2022b

3.2.2 Sample Collection

3.2.2.1 A total of 102 stations were sampled across the Survey Area during the benthic subtidal survey. The benthic subtidal survey within the Morven North Benthic Subtidal Ecology Study Area comprised combined drop down video (DDV) and grab sampling at 79 stations, with DDV only data collected at a further two stations, providing data from 81 stations overall. The benthic subtidal survey within the Morven South Benthic Subtidal Ecology Study Area comprised combined DDV and grab sampling at 60 stations. Of the 102 sampling stations, 39 are Shared Sampling Locations which are located in both the Morven North Benthic Subtidal Ecology Study Area and Morven South Benthic Subtidal Ecology Study Area. These sampling methods were used to ensure adequate data coverage for both epifaunal and infaunal communities at each location.

3.2.2.2 All 100 grab sampling stations included samples analysed for macrofauna and particle size analysis (PSA) (with an additional macrofaunal sample replicate which was collected and stored), and had samples collected for sediment bacterial and infaunal environmental Deoxyribonucleic Acid (eDNA) analysis.

3.2.2.3 Samples were also collected from a subset of 39 stations within the Morven North Benthic Subtidal Ecology Study Area and 31 stations within the Morven South Benthic Subtidal Ecology Study Area for physico-chemical analyses. Physico-chemical analysis was undertaken at 18 Shared Sampling Locations.

3.2.2.4 Of the 100 eDNA samples collected, a subset of 50 were analysed (38 in the Morven North Benthic Subtidal Ecology Study Area stations and 29 in the Morven South Benthic Subtidal Ecology Study Area stations of which 17 were at Shared Sampling Locations). There were 24 stations with samples analysed for both physico-chemical (see Appendix A) and eDNA (see Appendix E) (17 stations in the Morven North Benthic Subtidal Ecology Study Area stations and 15 in the Morven South Benthic Subtidal Ecology Study Area of which 8 were at Shared Sampling Locations).

3.2.2.5 Of the 98 stations that were investigated within the Morven North Benthic Subtidal Ecology Study Area, 67 were located within the Morven North Boundary and 31 were within the ZoI (Figure 3.1). Four of the stations in the Morven North ZoI were positioned within the Firth of Forth Banks Complex MPA. Of the 77 stations that were investigated within the Morven South Benthic Subtidal Ecology Study Area, 51 were located within the Morven South Boundary and 26 were within the ZoI (Figure 3.1).

Grab sampling

3.2.2.6 A total of 300 single grab samples were retained from 367 deployments of a 0.1m^2 Day grab within the Survey Area. On average, retained samples were acquired 2.6m (±4.9m standard deviation (SD)) from their target location. The 67 failed sampling attempts were from 25 stations across the Survey Area (50 failures across 18 stations within the Morven North Benthic Subtidal Ecology Study Area only, 1 failure at 1 station in the Morven South Benthic Subtidal Ecology Study Area only, and 16 failures across 6 Shared Sampling Locations) , with most of these attributed to stones or shells holding open the grab jaw, or low retention.

3.2.2.7 Initial processing of samples was undertaken aboard the survey vessel by assessment of sample size and validity against strict quality assurance criteria, while recording descriptions and metadata (position, collection time, depth) of collected sediments, with photographs taken of samples still in the Day grab.

3.2.2.8 Where required, surficial (<2cm depth) sediments were taken directly from the Day grab for physico-chemical and eDNA analyses. One sediment grab was divided into six sub-samples: three for chemical analysis of hydrocarbons, metals and polychlorinated biphenyls (PCBs), one for PSA, with a spare for chemical analysis and a spare for PSA. The sub-samples for hydrocarbon and PCB analysis were taken using a stainless steel spoon and stored in appropriate pentane-washed containers, and the rest were taken using a plastic scoop and placed into zip lock bags. eDNA sub-samples were taken from two grabs at each sampling location, one for analysis and one as a spare. For these, sub-samples of >40g were taken as small scoops to 5cm depth, with each sample stored in a double-lined zip lock bag at -18^{o}C prior to analysis.

3.2.2.9 For each faunal sample, the entire contents (except for eDNA sub-samples where relevant) of one grab was washed into a plastic tray using sea water and transferred to a 0.5mm mesh sieve, with finer sediment fractions washed from the sample using an auto-sieve. The sieve residue was transferred to a uniquely labelled sample container using a scoop or funnel and fixed with formaldehyde solution (4% formalin).

Drop down video

3.2.2.10 All 102 stations in the Survey Area were surveyed with DDV. Environmental seabed photos were taken by means of a digital stills shallow water camera system with a dedicated strobe and lamps, mounted within a stainless steel frame. Continuous video footage was also acquired at all stations using a high-definition video camera.

3.2.2.11 At each station, a minimum of 24 photographs and 25 minutes of footage were collected at appropriate intervals to determine the presence of potential Annex 1 or other designated features prior to deployment of the grab. A total of 5,221 photos were taken using the stills camera system across the 102 stations. All the photographs were taken less than or equal to 40m from the target location, with 91% of photographs taken within 10m of the target location. An additional 353 photos were collected and analysed from video footage.

3.2.2.12 The images were captured remotely using the surface control unit and stored on the camera's internal memory card. Video footage was overlaid with time, position and depth, and recorded directly onto the computer hard drive.

Survey limitations

3.2.2.13 Two stations in the Morven North Benthic Subtidal Ecology Study Area were sampled using DDV only as grab sampling failed to produce valid samples, due to coarse sediment holding open the grab jaws. The two stations were ENV001, in the northeast corner of the Morven North Boundary and ENV068, in the northwest of the Morven North ZoI, overlapping with the Firth of Forth Banks Complex MPA (Figure 3.1). Therefore, these two stations could only be included in the epifaunal analysis.

Similarly, a number of grabs at other stations had to be repeated several times due to low retention due to stones in the grab jaws, although full samples for analysis were collected from these stations after several attempts.

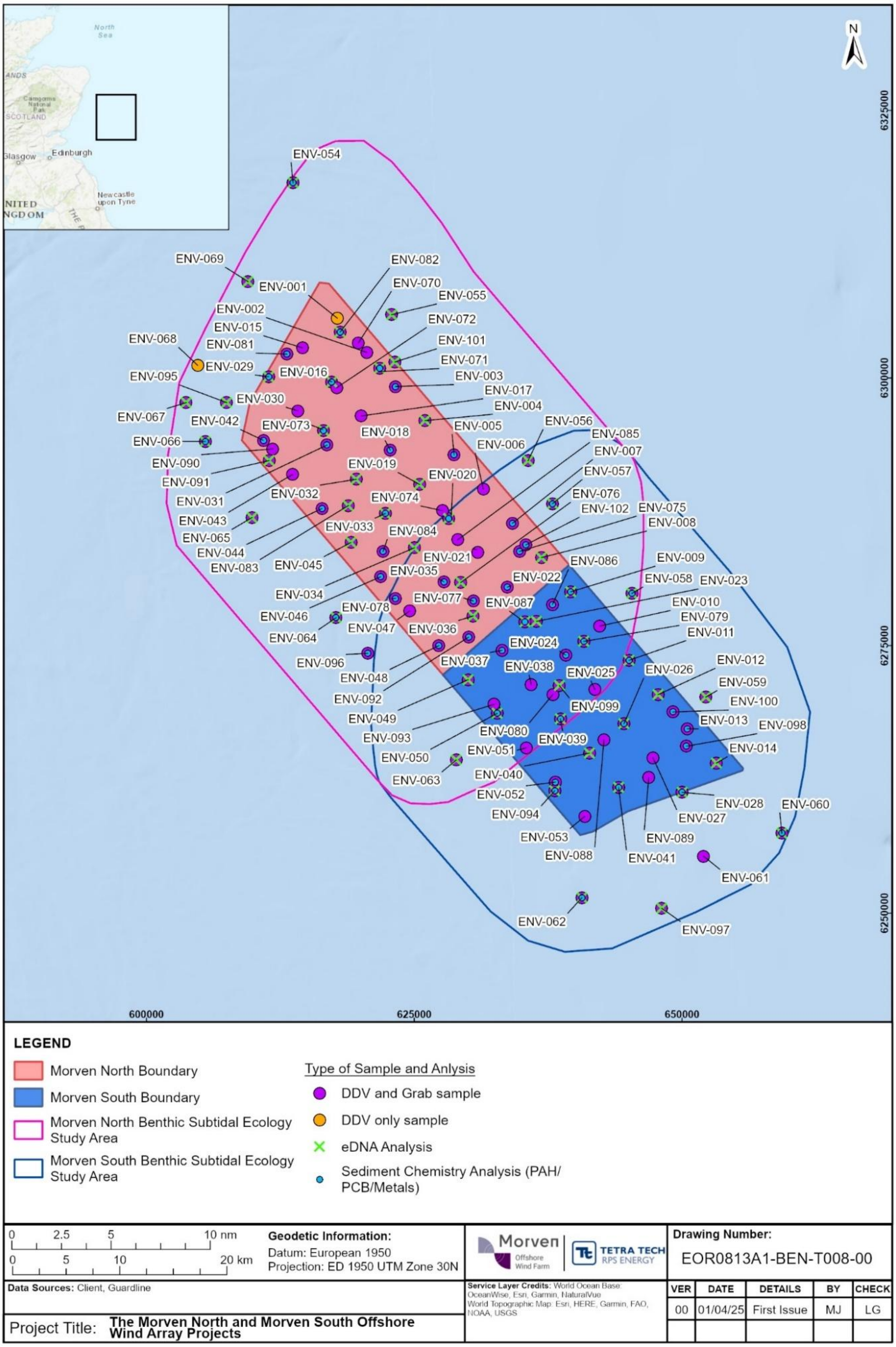

Figure 3.1: Sample locations within the Morven North Benthic Subtidal Ecology Study Area and the Morven South Benthic Subtidal Ecology Study Area

3.2.3 Sample Analysis

Benthic infaunal analysis

3.2.3.1 The benthic macrofaunal analysis was undertaken by Thomson Environmental Consultants Ltd following the North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme's best practice guidelines (Worsfold and Hall, 2010).

3.2.3.2 Firstly, the formalin was drained from each sample over a 63µm sieve. Any animals collected on this sieve were extracted immediately, avoiding damage from further washing. The samples were then washed over a clean stack of sieves (4mm, 2mm, 1mm and 0.5mm), dividing the sediment into uniform fractions, to allow for accurate faunal extraction.

3.2.3.3 For all size fractions, lighter animals were removed by repeatedly agitating the sediment with water and decanting off the liquid onto the corresponding sieve. Where large amounts of 2mm and 4mm sediment were present, these fractions were examined by eye in clean, gridded trays. Any individuals that were not removed by floating were extracted using forceps. Tubes, shells with boring holes, or any other structures that may have contained cryptic fauna were scraped from rocks, crushed, or examined under the microscope. All sediment sorted in trays was checked by a second member of staff.

3.2.3.4 All sediment fractions and extracted fauna were then preserved in 70% industrial denatured alcohol. The >1mm sediment and <1mm sediment were assigned sequential reference numbers to allow these fractions to be reported separately.

3.2.3.5 The sieved sediment fractions were then sorted under a stereomicroscope. All countable animals, fragments of animals and examples of colonial taxa were extracted for identification. All fauna extracted from the >1mm sediment was sorted together by taxa, as was the fauna from the <1mm sediment. Following extraction, all sample sediment residues were examined by a senior member of staff to check that >95% of fauna was found (exceeding the NMBAQC standard of 90%). Once confirmed that this standard of extraction has been achieved, the sediment residues were discarded.

3.2.3.6 Fauna removed from the samples were identified to the most accurate taxonomic level practicable, usually species. Higher taxonomic levels were used if specimens were too damaged or small to identify further, or where the taxonomy was unresolved (in line with the NMBAQC Taxonomic Discrimination Protocol). High power compound microscopes were used to confirm the identity of some species. All identification analysts used approved literature and keys, as well as reliably identified reference material from the in-house reference collection.

3.2.3.7 Countable individuals were enumerated. Where only fragments of individuals were found, "P" for present was recorded. "Present" was also used for any non-countable, colonial taxa.

3.2.3.8 Taxonomic identifications and enumerations were quality assured by a Thomson Principal Taxonomist, with at least 10% of taxa from each sample checked. Specimens with difficult taxonomic characters were routinely checked.

3.2.3.9 For biomass, calibrated scales with 0.0001g accuracy were used. For each sample, all specimens from each taxon were placed onto a dry piece of tissue paper. Animals were blotted gently to remove excess surface alcohol. The blotted specimens were placed in a weighing boat, on a tared balance. When the reading was stable, the weight was recorded to 4 decimal places. Following weighing, all specimens were transferred from the weighing boat back to a labelled vial for storage.

3.2.3.10 Additionally, it should be noted that the analyses presented in this report, both infaunal and epifaunal, were undertaken using data collected from sample stations across the Survey Area, covering both the Morven North Benthic Subtidal Ecology Study Area and the Morven South Subtidal Ecology Study Area (as described in Section 2).

eDNA analysis

3.2.3.11 Analysis of eDNA samples was undertaken by Naturemetrics Ltd, with DNA extracted from 10g of each sample and amplified using triplicate polymerase chain reactions. Sequence data was processed for quality filtering and taxonomic assignment, with each taxonomic unit assigned by being compared to two reference databases. Minimum similarity thresholds of 98%, 95%, and 92% were required for species-, genus-, and higher level assignments. Assignments were made to the lowest possible taxonomic level where there was consistency in the matches. The full results are presented in Appendix E.

Sediment characteristic analysis

3.2.3.12 PSA was carried out by Thomson Environmental Consultants Ltd in accordance with NMBAQC best practice guidance (Mason, 2016). A subsample was taken from each homogenised sample and washed over a 1mm sieve to determine analysis methodology. Where no material from the subsample was retained on the 1mm sieve, the sample was classified as sands, muds, and muddy sands, meaning only laser diffraction was required. When material was retained on the 1mm sieve, the sample was classified as a diamicton and both sieve and laser diffraction methodologies were carried out.

3.2.3.13 The particle size distribution of the <1mm sediment was measured using a laser diffraction particle size analyser. The >1mm sediment was oven dried and sieved at 0.5φ intervals using a sieve shaker; the weights of the sediment retained on each sieve were recorded to two decimal places.

3.2.3.14 Following data quality control, the sieve and laser data were merged to produce a continuous particle size distribution for each sample. These were then entered into the GRADISTAT program (Blott and Pye, 2001) to obtain sample statistics.

Sediment chemistry analysis

3.2.3.15 Chemical analyses were performed by SOCOTEC Ltd for the following contaminants:

- total organic matter (TOM);
- total organic carbon (TOC);
- metals;
- PCBs;
- organotins;
- Polycyclic aromatic hydrocarbons (PAHs).

3.2.4 Data Analysis

Sediment characterisation analysis

3.2.4.1 Samples were all assigned to a Wentworth classification (Wentworth, 1922) based on the proportion of sediment in three size categories: mud (up to 0.0625mm), sand (>0.0625 and <2mm) and gravel (>2mm). As a quality control measure, these classifications were checked against the original sample descriptions.

3.2.4.2 The sediment samples were additionally classified using the modified Folk triangle classification and the European Union Nature Information System (EUNIS) classification. These classifications use the sand:mud ratio and the percentage of gravel (Folk, 1954; Parry, 2019). The EUNIS biotope classifications is a hierarchical system used to classify habitats in the marine environment depending on their sediment type and biota.

Sediment chemistry analysis

3.2.4.3 The results of the sediment chemistry analysis were compared to the Marine Scotland Action Levels (ALs) (Marine Scotland, 2017). Marine Scotland Action Level 1 (AL1) and Action Level 2 (AL2) are thresholds which give an indication of how suitable the sediments are for disposal at sea. Contaminant levels which are below AL1 are of no concern and are unlikely to influence the marine licensing decision while those above AL2 are considered unsuitable for disposal at sea. Those between AL1 and AL2 require further consideration before a marine licensing decision can be made.

3.2.4.4 Sediment chemistry data were also compared to the Canadian Sediment Quality Guidelines (CSQG) (Canadian Council of Ministers of the Environment, 2001). These thresholds give an indication of the degree of contamination and the likely impact on marine ecology. For each contaminant, the guidelines provide a Threshold Effect Level (TEL), which is the minimal effect range at which adverse effects rarely occur and a Probable Effect Level (PEL), which is the probable effect range within which adverse effects frequently occur. For PAHs, the best estimates of the potential toxicity of marine sediments are Effects Range Low (ERL) and Effects Range Median (ERM) concentrations for total low molecular weight, total high molecular weight and total PAHs (Neff, 2004).

3.2.4.5 OSPAR (2005) published Background Concentrations, Background Assessment Criteria and Background Reference Concentrations tools to assess concentrations of certain hazardous substances. Comparison to these data required normalisation of the US EPA 16 PAH concentrations to 2.5% TOC.

Macrofaunal analysis

<u>Data rationalisation</u>

3.2.4.6 The benthic infaunal and epifaunal datasets were analysed separately, with the infaunal dataset based on the grab samples, and the epifaunal dataset based on the DDV footage, still images, and colonial taxa from grab samples recorded as present. The infaunal dataset was then processed by combining the 0.5mm and 1mm fractions to provide a complete dataset. The analysis of the infaunal community was made using the enumerated taxa only dataset to avoid skewing the results with the taxa recorded as "present", such as colonial fauna, fragments of individuals and taxa which were not the target of the assessment (e.g. meiofauna and pelagic groups). Following this processing, these two datasets were then square root transformed to down-weight the species with the highest abundances for multivariate community analysis.

3.2.4.7 Juveniles of some taxa, identified to the lowest taxonomic level possible, were recorded in the raw infaunal data including species such as *Aphroditidae*, Paguridae, *Corystes cassivelaunus*, Acanthocardia, *Lucinoma borealis*, Mytilidae, *A. islandica*, Spatangoida and Ophiuroidea. A Spearman's Rank (rho) RELATE function analysis indicated that the datasets including and excluding the juveniles were highly similar (rho=0.99, significance=0.1%), but the inclusion of the juveniles created three additional statistically distinct faunal groups due to relatively highly abundances of Spatangoida juveniles. The juveniles were therefore excluded from the analysis for biotope classification but have been referred to where relevant.

3.2.4.8 All fish species were removed prior to analysis and are discussed separately within Volume 3, Annex 9.1: Morven North and Morven South Fish and Shellfish Ecology Shared Technical Report.

<u>Univariate analysis</u>

3.2.4.9 The untransformed benthic infaunal data, and combined DDV and grab epifaunal data were summarised to highlight the number of individuals and number of taxa recorded. Analysis was also undertaken to identify the percentage composition of the major taxonomic groups within each station, the percentage contribution of each taxonomic group to the total number of taxa and to the total number of individuals.

3.2.4.10 Several univariate indices were calculated for each sample to further describe the untransformed infaunal and epifaunal data, including: S = number of species; N = abundance; B = Biomass (wet mass); d = Margalef's index of Richness; J' = Pielou's Evenness index; H' = Shannon-Wiener Diversity index; λ = Simpson's index of Dominance.

Multivariate community analysis

3.2.4.11 The benthic infaunal data and combined DDV and grab epifaunal data were analysed using the PRIMER v6 software (Clarke and Gorley, 2006). As outlined in Section 1, the multivariate community analysis presented in this technical report, has been undertaken on the combined dataset collected across the Survey Area, covering both the Morven North Benthic Subtidal Ecology Study Area and the Morven South Subtidal Ecology Study Area. This is because the proximity of the Morven North Benthic Subtidal Ecology Study Area and the Morven South Subtidal Ecology Study Area allows for a single baseline characterisation.

3.2.4.12 To determine the relative similarities between stations, the benthic infaunal and epifaunal community structure were investigated using CLUSTER analysis (hierarchical agglomerative clustering). Separate multivariate analyses were undertaken on the infaunal and epifaunal datasets however the same methodology was used. The Bray Curtis similarity coefficient was used to assess the similarity of stations based on the faunal components. The procedure produces a dendrogram indicating the relationships between sites based on the similarity matrix and uses a Similarity Profile (SIMPROF) test (at a 5% significance level) to test whether the differences between the clusters are significant.

3.2.4.13 Similarity Percentages (SIMPER) analyses were subsequently undertaken on the separate infaunal and epifaunal datasets to identify which species best explained the similarity within groups and the dissimilarity between groups identified in the CLUSTER analysis. The similarity matrix was also used to produce a Multi-Dimensional Scaling (MDS) ordination plot to show, on a two or three-dimensional representation, the relatedness of the communities (at each site) to one another. Full methods for the application of both the hierarchical clustering and the MDS analysis are given in Clarke *et al.* (2014).

Biotope allocation

3.2.4.14 The results of the CLUSTER analyses and associated SIMPER outputs were reviewed alongside the raw, untransformed data to assign preliminary biotopes (Connor *et al.,* 2004). Using the identified clusters, several sites within a cluster and, where appropriate several clusters, were assigned to a single biotope, based on relatedness and presence of key indicator species for a particular biotope. The infaunal and epifaunal biotopes were plotted over the results of the geophysical surveys for the Survey Area. The geophysical data (i.e. sediment classification and seabed features) were used to map the distribution, extent and boundaries of each biotope resulting in the generation of infaunal and epifaunal biotope maps. The infaunal and epifaunal biotope allocations were combined to provide a final combined biotope map.

3.2.5 Habitat Analysis

Seapen and burrowing megafauna communities

3.2.5.1 The "seapen and burrowing megafauna communities" habitat is classified as a threatened and/or declining habitat (Oslo and Paris Conventions (OSPAR), 2008) and is a PMF in Scottish waters (NatureScot, 2020). At stations where burrows were sufficiently large enough to indicate the presence of burrowing megafauna, an assessment was undertaken to determine whether the OSPAR "seapen and burrowing megafauna communities" habitat was present. As detailed in the JNCC (2014b) clarification document for defining this habitat, video and still imagery was assessed to confirm burrows and/or mounds and, where present, seapens.

3.2.5.2 The density classifications as laid out by the MNCR SACFOR scale (JNCC, 2013) were used to quantify these defining features. The JNCC (2014b) report specifies that multiple sightings of burrows and/or mounds attributable to relevant species together with seapens, if present, should be classified as at least "frequent" for their size on the SACFOR scale for the area to be considered a "seapen and burrowing megafauna communities" habitat. However, it acknowledges the inherent difficulties of identifying species from burrow type alone. Therefore, the overall density of burrows was assessed, to consider whether their density was a "prominent" feature of the sediment surface and potentially indicative of a sub-surface complex gallery burrow system.

3.2.5.3 The average burrow and seapen densities were calculated for each station using the total area covered by the seabed imagery (average swathe width x camera transect length). Average image swath width was calculated on a per station basis using the laser scaling present within the image to provide an estimate of the swathe covered by that image.

Biogenic reefs – *Sabellaria spinulosa*

3.2.5.4 The "reefiness" scale was used to quantify *Sabellaria spinulosa* reefs, which is based largely on results of an inter-agency workshop run by JNCC to help define and manage *S. spinulosa* reefs and reported in Gubbay (2007). This gave a range of elevations, area coverage and patchiness metrics against which to compare potential *S. spinulosa* reefs, with definitions provided for "Not a reef", "Low", "Medium", and "High" resemblance reefs, as shown in Table 3.3.

Table 3.3: Range of measures to define S. spinulosa 'reefiness'

Measure of "reefiness"	Not a reef	Low	Medium	High
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m^2)	<25	25-10,000	10,000-1,000,000	>1,000,000
Patchiness (% cover)	<10	10-20	20-30	>30

3.2.5.5 The images and DDV footage acquired at all stations were analysed and metrics were assigned when *S. spinulosa* individuals or aggregations were found from which their "reefiness" could be estimated. Each 5m segment of video footage was also analysed in the same way to ensure a full assessment of the investigated area for potential *S. spinulosa* reef structures. *S. spinulosa* can also be found as "bommies", which are less well-defined aggregations that fall partially into some of the criteria for low reef resemblance but would not be classified as a designated feature.

Biogenic reefs – *Modiolus modiolus*

3.2.5.6 According to Morris (2015), *M. modiolus* is the foundation species in diverse biogenic reefs that are characterised by clumped mussels and shell covering more than 30% of the substrate, which may be infaunal or embedded reefs, semi-infaunal (with densities of greater than five live individuals per m^2) or form epifaunal mounds (standing clear of the substrate with more than 10 live individuals per clump), all of which support communities with high diversity compared to the surrounding area.

3.2.5.7 To assess for presence of mussel beds, assessment criteria established from an inter-agency workshop relating to *Modiolus modiolus* reef (Morris, 2015) are used. Firstly Morris (2015) identified three primary (Stage 1) factors, all of which must be met before assessing the confidence for Annex I designation:

- Presence of live adult *M. modiolus* individuals;
- The biota/communities are distinct from the surrounding habitat;
- The distinct region containing *M. modiolus* is greater than 25m^2 in extent.

3.2.5.8 If the three Stage 1 factors are met, the Stage 2 assessment involves defining percentage cover, the number of individuals of *M. modiolus*, and the elevation of reef structures relative to the surrounding substrate to confirm if the structure can be classified as an Annex I biogenic reef.

<u>Rocky reefs</u>

3.2.5.9 A multi-criterion scoring system is used to assess the characteristics of the potential high diversity stony/bedrock reef, including composition (percentage cover of boulders), elevation and extent as the primary characteristics (Irving, 2009) and biota as a secondary characteristic. These criteria are widely used, but further refinement of the criteria for defining areas with a low resemblance to stony reef have been published (Golding *et al.,* 2020) and these have been taken into consideration in the analysis.

<u>Fragile sponge and Anthozoan communities on subtidal rocky habitats</u>

3.2.5.10 Recent attempts to formally quantify a threshold for what density of sponges defines a deep-sea sponge habitat have been made by DNV (2013) and the JNCC (Henry and Roberts, 2014). The DNV approach suggests that images with >10% sponge cover could constitute an OSPAR deep-sea sponge aggregation (DNV, 2013). In contrast, the methods proposed by the JNCC (Henry and Roberts, 2014) uses a variety of quantitative approaches. These include assessment of images of areas with raw densities of 0.5 to 24 sponges per m^2, occurrences of sponges categorised as at least “frequent” under the MNCR SACFOR scale, and use of multivariate similarity of percentages (SIMPER) metric to determine if sponges are characteristic of the observed assemblages. A combination of these methods was therefore used in the assessment for this habitat.

4 Baseline Characterisation – Desktop Study

4.1 Morven North and South Regional Benthic Subtidal Ecology Study Area

4.1.1 Sediment Type

4.1.1.1 Based on EUSeaMap data (EMODnet, 2019) and NMPi data (NMPi, 2019), in the centre of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area the sediments are dominated by EUNIS classification of "deep circalittoral coarse sediment" (A5.15), forming a mosaic with areas of "deep circalittoral sand" (A5.27) (Figure 4.1). The sediment transitions to become more dominated by "deep circalittoral sand" (A5.27) in the east of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area.

4.1.1.2 Within the mosaic of "deep circalittoral coarse sediment" (A5.15) and "deep circalittoral sand" (A2.27) there are also smaller patches of "deep circalittoral mud" (A5.37), with the largest areas in the west of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area.

4.1.1.3 There are areas of "Atlantic and Mediterranean moderate energy circalittoral rock" (A4.2) further inshore to the southwest and further along the coast to the east and south of Morven North and Morven South. The largest area of circalittoral rock occurs around the entrance to the Firth of Forth and along the coast of Budle and Bamburgh at the southern-most extent of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The circalittoral rock around the entrance to the Firth of Forth is accompanied by "deep circalittoral mixed sediment" (A5.45) in most locations.

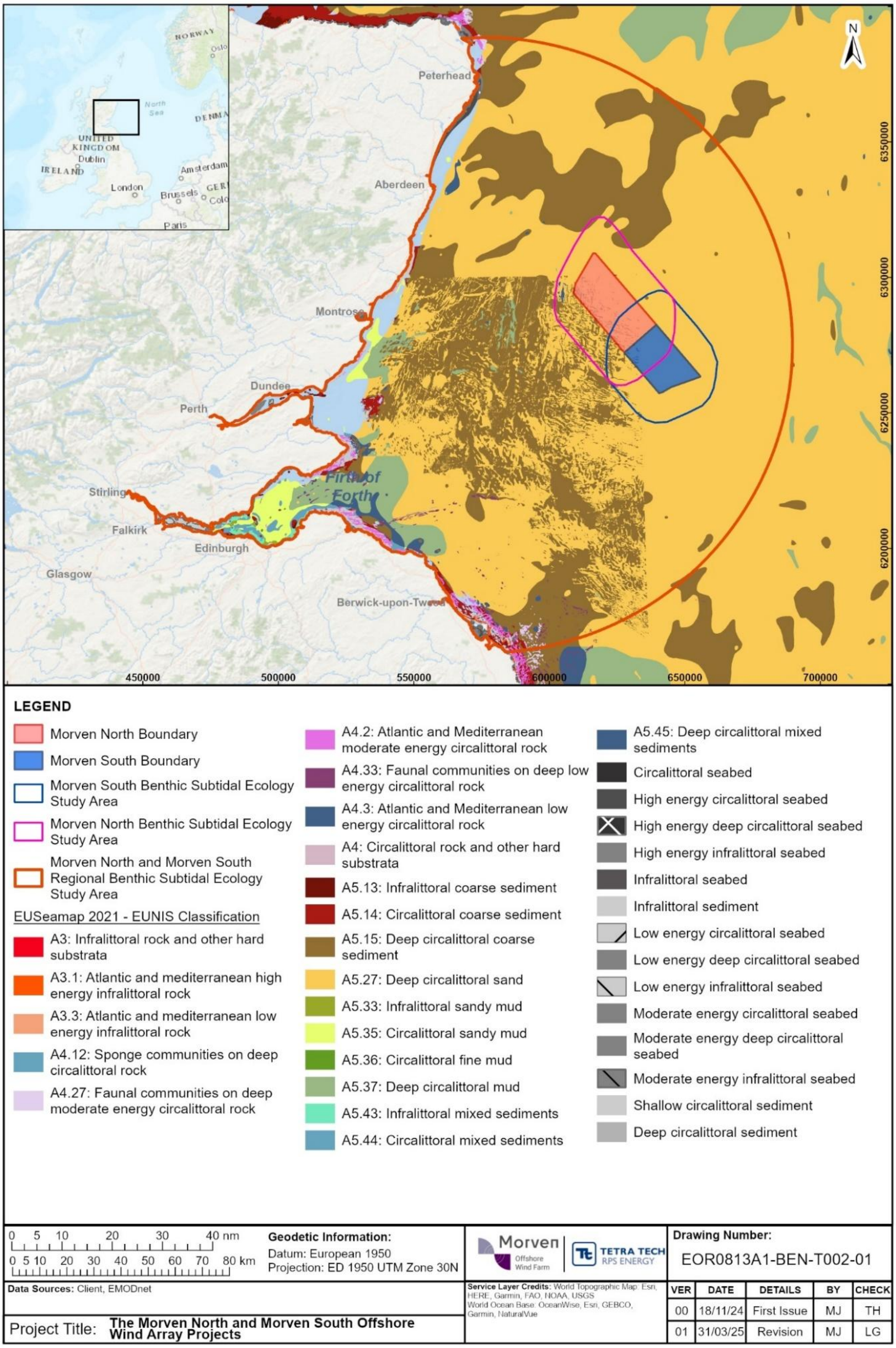

Figure 4.1: EUSeaMap data showing EUNIS seabed classifications for the Morven North and Morven South Regional Subtidal Ecology Study Area

Firth of Forth Banks Complex MPA

4.1.1.4 The key geological features of the Firth of Forth Banks Complex MPA within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area (Figure 4.3) are the Berwick, Scalp and Montrose Banks and the Wee Bankie shelf banks and mounds. The "Shelf Banks and Mounds" and "Moraines representative of the Wee Bankie Key Geodiversity Area" are both protected features of the Firth of Forth Banks Complex MPA. These features are composed of sands and gravels (JNCC, 2021). The Wee Bankie includes moraines, which are formed from glacial till deposited during the last Ice Age and they are scientifically important for their role in improving our understanding of the history of glaciation around Scotland (JNCC, 2021).

4.1.1.5 The Firth of Forth Banks Complex MPA is also designated for offshore subtidal sands and gravels. The offshore subtidal sands and gravels feature comprises a heterogeneous mosaic of coarse sandy and mixed sediments. The feature is interspersed with small patches of rock and mud (not considered part of the feature) in the Wee Bankie and Montrose Bank sections of this MPA. JNCC considers the heterogeneity of the habitat types present to be a consequence of localised hydrodynamic processes acting on the MPA (JNCC, 2014a).

4.1.1.6 The Axelsson *et al*. (2014) analysis of video and still photography from the 2011 surveys undertaken within the Firth of Forth Banks Complex MPA (undertaken as part of the Scottish MPA Project) directly to the west of Morven North and Morven South, reported three broad habitat types: soft sediments with ripples; mixed sediment; and coarse sediments with some rocky outcrops. In the north of the area surveyed for this study (south of the Morven South Benthic Subtidal Ecology Study Area) gravelly sand sediments were more frequently recorded and gravelly muddy sands and mixed sediments were more dominant in the south of the area surveyed for this study (Axelsson *et al.,* 2014).

Other offshore wind farms and interconnectors

4.1.1.7 The benthic surveys conducted for planned and operational offshore wind projects and interconnectors within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area also provide an overview of the sedimentary habitats present. These are shown in Figure 4.2 and listed below:

- Eastern Link 1;
- Eastern Link 2;
- Seagreen 1 Offshore Wind Farm;
- Seagreen 1A Project;
- Berwick Bank Offshore Wind Farm;
- Cambois Connection Marine Scheme;
- Inch Cape Offshore Wind Farm;
- Neart na Gaoithe Offshore Wind Farm;
- Kincardine Floating Demonstration Offshore Wind Farm;
- Aberdeen Offshore Wind Farm;
- Hywind Offshore Wind Farm;
- Ossian Offshore Wind Farm;
- Muir Mhor Offshore Wind Farm.

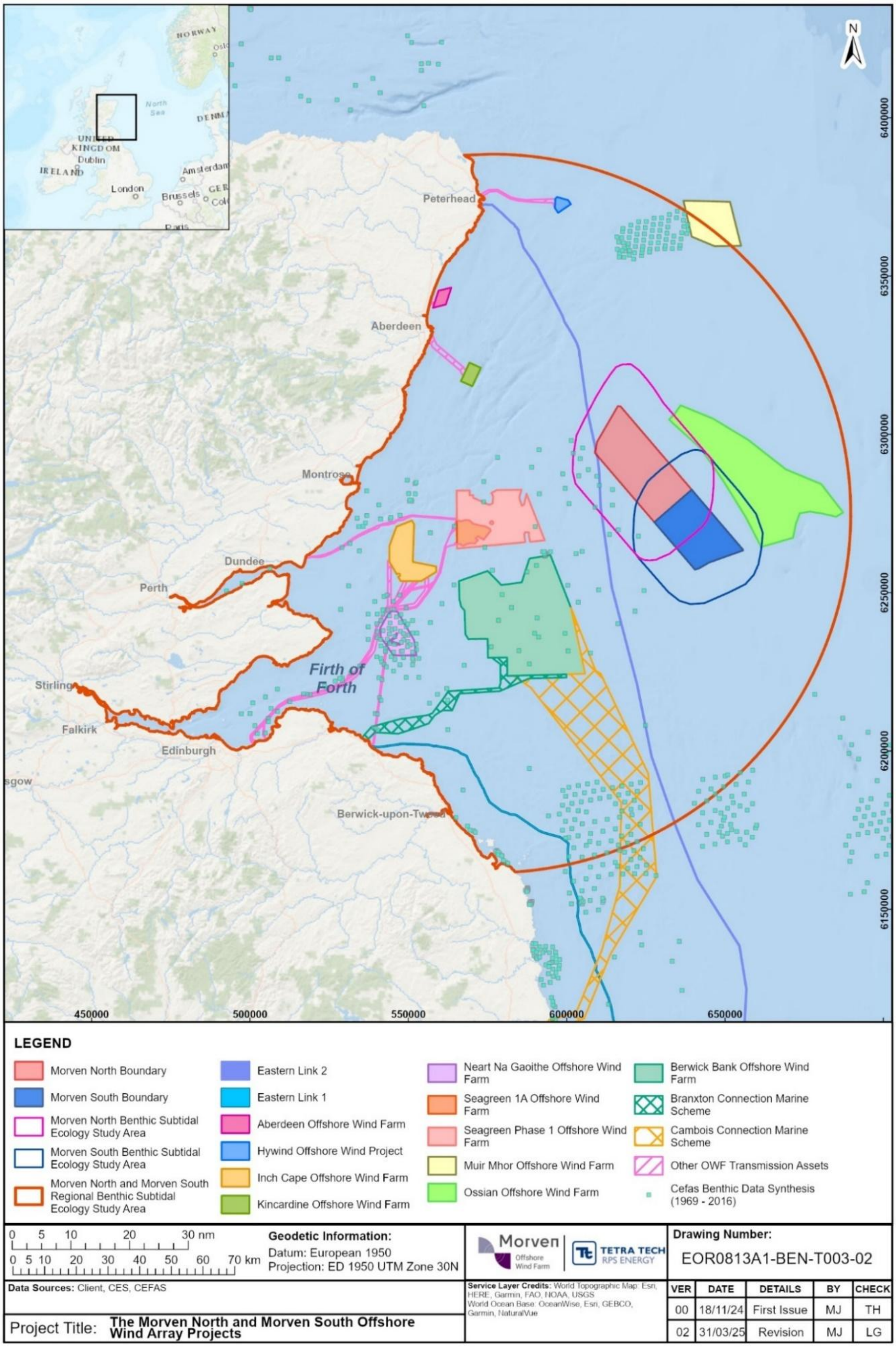

Figure 4.2: The locations of Offshore Wind Farms and Interconnectors overlaid with published research sample locations from nearby Cefas surveys (Cooper and Barry, 2017) within the Morven North and Morven South Regional Subtidal Ecology Study Area

4.1.1.8 Berwick Bank OWF, located approximately 32km southeast of Morven North and 34km southwest of Morven South, conducted geophysical surveys in 2020 (SSE Renewables, 2022). The data from these surveys identified heterogenous sediment across Berwick Bank's array area. Features such as megaripples, sandwaves, ribbons and bars were noted across the south and northwest extents.

4.1.1.9 Grab samples conducted across Berwick Bank OWF's array area and export cable corridor indicated that the sediments were predominantly slightly gravelly sands according to the Folk (1954) sediment classification. Sediments closer to the coast in the Berwick Bank OWF export cable corridor were, typically, finer than the offshore sediment in the array area.

4.1.1.10 The Cambois Connection Marine Scheme, which will connect the Berwick Bank OWF to a landfall in England, will comprise up to four buried high voltage direct current subsea cables which overlap with the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The subtidal sediments surveyed for this development in Scottish waters were characterised as slightly gravelly sand and gravelly sand in the east, near Morven North and Morven South, with coarser sandy gravel further to the west (SSE Renewables, 2023).

4.1.1.11 Baseline characterisation surveys for Neart na Gaoithe OWF, including seabed sampling, were conducted in 2009 (Neart na Gaoithe Offshore Wind Ltd, 2010). The survey area lies approximately 80km southwest of Morven North and approximately 85km southwest of Morven South. Most sampling stations were classified as slightly gravelly sand, with coarser sediment found offshore and finer sediment along the export cable corridors, with most sediment samples classified as slightly gravelly muddy sand and muddy sand.

4.1.1.12 The baseline characterisation surveys for Inch Cape OWF array area (Inch Cape Offshore Ltd, 2011), which lies to the southwest of Morven North and Morven South, reported the sediments to be primarily circalittoral sands and gravelly sands, with smaller areas of muddy mixed sediment.

4.1.1.13 Surveys conducted in 2011 to support the EIA benthic baseline characterisation for Seagreen 1 OWF, which lies southwest of Morven North and Morven South, identified a similarly small proportion of a gravelly sand environment to Neart na Gaoithe (Seagreen Ltd, 2012). Most samples in Seagreen 1 OWF were identified as gravelly sand and sandy gravels with samples in the export cable corridor and the west of the array area generally having a higher mud content. Video sampling of these areas found shelly and gravelly sand as well as ripples and megaripples. Cobbles were also recorded and were the predominant sediment component at six sites within Seagreen 1 OWF.

4.1.1.14 The Kincardine Floating Demonstration OWF site lies in the north of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, east of Aberdeen. Site specific sampling of the array area and export cable corridor for this project indicated that the sediment was difficult to sample as the seabed was quite compact (Kincardine Offshore Wind Farm – Atkins, 2016). Samples, which were obtained largely in the export cable corridor, characterised the sediment as sandy with medium grain sand identified closer to shore and fine sand identified further offshore and within the array area. The seabed also exhibited rippled bedforms.

4.1.1.15 Aberdeen OWF lies close to the coast north of Aberdeen. Surveys in this area identified the seabed to predominantly be composed of silty sand with patches of finer sediment (Aberdeen Offshore Wind Farm Ltd, 2010). In the southeast of the Aberdeen OWF a ribbon of finer sand within the silty sand was noted.

4.1.1.16 Hywind OWF occurs in the far north of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, east of Peterhead. The site specific surveys in this area found the sediments to be dominated by sand and gravel. Boulder fields were present at locations close to shore in the export cable corridor but as depth decreased to less than 20m, approximately 1km from shore, the seabed consisted almost entirely of outcropping bedrock

(Statoil, 2015). In the array area, sediments were like the export cable corridor and dominated by sand and gravel with megaripples. This description is representative of most of the array area except the northwest, which contained scattered patches of boulders.

4.1.1.17 Around the Scottish landfall site for the Eastern Link 1 corridor, the nearshore subtidal sediments were dominated by circalittoral mixed sediments and patches of deep circalittoral mixed sediments and deep circalittoral mud (National Grid, 2022). Specifically, in the area overlapping the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, the first 0.7-10km of the cable corridor near the Scottish landfall was dominated by sublittoral sand, with the next section up to 67.7km from the Scottish landfall associated with a biotope complex of deep circalittoral mixed sediments interspersed by deep circalittoral sand.

4.1.1.18 Along the route of the Eastern Link 2 corridor, which overlaps with the Morven North Benthic Subtidal Ecology Study Area, the benthic environment was characterised mainly by offshore circalittoral mixed sediment and circalittoral sand, with deep circalittoral coarse sediment noted to be overlapping the western edge of Morven North (National Grid Electricity Transmission and Scottish Hydro Electric Transmission plc, 2022).

4.1.1.19 The Ossian Offshore Wind Farm overlaps with the east of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. Site specific surveys within the Ossian Offshore Wind Farm indicated that most stations were dominated by muddy sand and gravelly muddy sand (SSE Renewables, 2024).

4.1.1.20 The Muir Mhor Offshore Wind Farm partially overlaps with the northeast of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. Site specific surveys within the Muir Mhor Offshore Wind Farm Array Area and Export Cable Corridor indicated that most stations were dominated by sediments ranging from sand to sandy gravel (Muir Mhor Offshore Wind Farm, 2024).

4.1.2 Sediment Contamination

4.1.2.1 Surveys from nearby offshore wind farms have provided a range of data about sediment contamination within the immediate vicinity of the Survey Area, and more broadly in the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The benthic survey for the nearby Berwick Bank OWF to the south and southwest found that all sampled stations were below Marine Scotland AL1 for all metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc (SSE Renewables, 2022). There were five stations above the CSQG TEL for arsenic (7.24mg/kg), ranging from 7.5 to 11.30mg.kg^{-1} throughout the entire Berwick Bank benthic subtidal study area, with one station overlapping with the Firth of Forth Banks Complex MPA, and most other stations located closer to the coastline in the export cable corridor. All sampled stations were found to have contamination levels of PCBs and PAHs below both Marine Scotland AL1 and the CSQG TEL where applicable.

4.1.2.2 The Cambois Connection Marine Scheme, which will connect to the Berwick Bank OWF to a landfall in England and is located to the south of this project, also performed benthic subtidal sediment contamination sampling within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area and found that no sampled metals exceeded Marine Scotland AL2 threshold (SSE Renewables, 2023, Natural Power, 2023). However, concentrations of chromium and nickel were slightly above the Marine Scotland AL1 threshold at two stations, arsenic concentrations slightly exceeded the Marine Scotland AL1 threshold at one station, and chromium and lead CSQG TEL thresholds were exceeded at one station. This indicates a relatively low level of metal contamination throughout this area south of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The levels of all 13 investigated PAHs exceeded CSQG TEL thresholds at three stations, although all other stations were below all relevant thresholds for these contaminants.

4.1.2.3 Chemical analysis of the Eastern Link 1 corridor route (National Grid, 2022) found that all heavy metals and hydrocarbons were present in low concentrations, except for a number of stations exceeding Cefas AL1 or the Canadian TEL. No heavy metal concentrations exceeded the Cefas AL2, but two stations were found to exceed Canadian PEL for arsenic. However, metal concentrations were within background levels reported from a Marine Scotland monitoring station in the Firth of Forth and a Clean Safe Seas Environmental Monitoring Programme station at Tyne/Tees (Fugro, 2021) indicating that these levels of contamination are typical for North Sea sediments. Similarly, for the Eastern Link 2 corridor route, the levels of contaminants within the sediment did not exceed this background contamination level (National Grid Electricity Transmission and Scottish Hydro Electric Transmission plc, 2022b).

4.1.2.4 Chemical analysis of sediment samples from the Ossian Offshore Wind Farm (SSE Renewables, 2024) indicated that heavy metal contamination was relatively low overall, with one station recording an elevated concentration of arsenic, but not exceeding the Cefas AL1 threshold. Concentrations of PAHs recorded a maximum of 81.2µg/kg, with increased levels of contamination noted in the south and east of the Ossian Offshore Wind Farm, but no stations exceeded Cefas AL1. Concentrations of both organotins and PCBs at all sampled stations across the survey area were below the limit of detection (SSE Renewables, 2024).

4.1.2.5 Chemical analysis of sediment samples from the Muir Mhor Offshore Wind Farm (Muir Mhor Offshore Wind Farm, 2024) determined that concentrations of all sediment bound contaminants were below AL1 including metals, PCBs and PAHs. The CSQG TEL for arsenic was exceeded at five stations in the array area and three stations in the export cable corridor, however all stations were well below the PEL.

4.1.3 Subtidal Ecology

4.1.3.1 The north part of the North Sea is mainly characterised by polychaete dominated communities (Spionidae, Glyceridae, Terebellidae, Capitellidae, and Phyllodocidae), sparse faunal communities (Nephtyidae, Spionidae, Opheliidae) and diverse faunal communities (including the polychaetes: Spionidae, Nephtyidae, Lumbrineridae, Oweniidae, Cirratulidae, Capitellidae, Ampharetidae, the echinoderm Amphiuridae, the bivalve Semelidae, and Nemertea) (Cooper and Barry, 2017).

4.1.3.2 The MNCR study of the nearshore subtidal zone from North Berwick in Lothian to Flamborough Head in Yorkshire identified nearshore seabed habitats in the south of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. Five seabed habitats were recorded (Brazier *et al*., 1998), including sublittoral mixed sediment/sandy mud biotopes, kelp forests, sublittoral fine sand biotopes and circalittoral rock biotopes.

- *Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment/*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMx.CMx.KurThyMx/SS.SMu.CSaMu.AfilMysAnit);
- *Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock (IR.MIR.KR.Lhyp.Ft);
- amphipods and *Scolelepis* spp. in littoral medium-fine sand (LS.LSa.MoSa.AmSco);
- *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat);
- brittlestars on faunal and algal encrusted exposed to moderately wave-exposed circalittoral rock (CR.MCR.EcCr.FaAlCr.Bri).

4.1.3.3 Analysis by Sotheran and Crawford-Avis was undertaken on the data from seabed acoustic surveys in 2013 to contribute to the evidence base for the presence and extent of MPA features in Scottish waters (Sotheran and Crawford-Avis, 2014). Phase 1 of the surveys included the approaches to the Firth of Forth in the southeast of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area.

4.1.3.4 Habitats varied from sand sediments to coarse and mixed sediments in the inshore regions and sand sediments in the offshore region. The biotope circalittoral muddy sand

(SS.SSa.CMuSa) was recorded in the nearshore subtidal area close to St. Andrews, with circalittoral rock habitats with mixed faunal turf communities (CR.HCR.XFa) and echinoderms and crustose communities (CR.MCR.EcCr) recorded in the nearshore subtidal area off Craighead.

4.1.3.5 Offshore subtidal sand (SS.SSa.OSa) and offshore circalittoral coarse sediment (SS.SCS.OSC) were recorded across the approaches to the Firth of Forth and the Wee Bankie to Gourdon. However, SS.SSa.OSa was more frequently recorded in the regions further offshore. Circalittoral mixed sediments (SS.SMx.CMx) and offshore mixed sediments (SS.SMx.OMx) were recorded in areas further inshore. Occasional patches of circalittoral rock were also recorded across the approaches to the Firth of Forth and Wee Bankie to Gourdon areas (Sotheran and Crawford-Avis, 2014).

4.1.3.6 The following biotopes were reported within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area (Sotheran and Crawford-Avis, 2014):

- kelp with cushion fauna and/or foliose red seaweeds (Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris polypodioides* on exposed lower infralittoral rock (IR.HIR.KFaR.FoR.Dic) and *Laminaria hyperborea* and red seaweeds on exposed vertical rock (IR.HIR.KFaR.LhypRVt));
- mixed faunal turf communities on circalittoral rock (*Flustra foliacea* and colonial ascidians on tide-swept exposed circalittoral mixed substrata (CR.HCR.XFa.FluCoAs.X), *Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders (CR.HCR.XFa.FluCoAs.SmAs) and *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock (CR.HCR.XFa.FluCoAs));
- circalittoral coarse sediment (*Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles (SS.SCS.CCS.SpiB));
- deep circalittoral coarse sediment (offshore circalittoral coarse sediment (SS.SCS.OCS), and SS.SCS.OCS.(Sbom));
- circalittoral muddy sand (*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc) and SS.SSa.CMuSa);
- deep circalittoral sand (SS.SSa.OSa/SS.SSa.OSa.(Sbom));
- circalittoral mixed sediments (*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx), *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (SS.SMx.CMx.(FluHyd)), *Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx) and *Sabellaria spinulosa* on stable circalittoral mixed sediment (SS.SBR.PoR.SspiMx));
- deep circalittoral mixed sediments (Polychaete-rich Galathea community with encrusting bryozoans and other epifauna on offshore circalittoral mixed sediment (SS.SMx.OMx.PoGintBy));
- *Modiolus* beds on open coast circalittoral mixed sediment (SS.SBR.SMus.ModMx);
- *Alcyonium digitatum*, *Spirobranchus triqueter,* algal and bryozoan crusts on wave-exposed circalittoral rock (CR.MCR.EcCr.FaAlCr.Adig) and *Flustra foliacea* on slightly scoured silty circalittoral rock (CR.MCR.EcCr.FaAlCr.Flu);
- seapens and burrowing megafauna in circalittoral fine mud (SS.SMu.CFiMu.SpnMeg).

4.1.3.7 Phase 2 survey analysis by Sotheran and Crawford-Avis focused on the data from seabed acoustic surveys on the east approaches to the Firth of Forth, the west tip of which overlaps with the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area (Sotheran and Crawford-Avis, 2014). The following biotopes were reported within the east approaches to the Firth of Forth area:

- Circalittoral coarse sediment SS.SCS.CCS;
- Circalittoral muddy sand SS.SSa.CMuSa;
- Offshore circalittoral sand SS.SSa.OSa.

4.1.3.8 Protected species and habitats, such as those protected as Scottish PMFs (Tyler-Walters *et al.,* 2016), Annex I species under the Habitats Directive and UK Biodiversity Action Plan (BAP) species, the National Biodiversity Network (NBN) Atlas and the SeaSearch database (2024) include protected reef form records of *Sabellaria* spp. and ocean quahog (*Arctica islandica)* in the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area (NBN, 2019). Tyler-Walters *et al*. (2016) reported blue mussel (*Mytilus edulis*) and horse mussel (*M. modiolus*) beds, burrowed mud, kelp beds, ocean quahog aggregations, maerl or coarse shell gravel with burrowing sea cucumbers, seagrass beds and offshore subtidal sands and gravels within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area.

4.1.3.9 *Sabellaria spinulosa* individuals have been recorded within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, but records of *S. spinulosa* reefs within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area are limited to the North Sea off Rattray Head based on the sources evaluated in a desk-based review conducted by Pearce and Kimber (2020). There are very few records of *S. spinulosa* from Scotland and even fewer extant records of reefs; one of the only other locations known to have recorded *S. spinulosa* outside of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area is Luce Bay in the south west of Scotland. This is thought to be due to low sampling effort to date and, therefore, it is expected that more records of individuals and reefs may be made as the offshore industry progresses in the region (Pearce and Kimber, 2020). Site specific studies for the Seagreen 1 and Berwick Bank Offshore Wind Farms have also recorded *S. spinulosa* but as individuals and not in a reef formation.

4.1.3.10 A baseline seagrass survey by the Scottish Environmental Protection Agency (SEPA, 2018) found that in Montrose Basin (in the west of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area) the total area of seagrass coverage in 2013 was 1,747,000m^2 with an average density of 41.8%. Most of the seagrass was found in the northeast and the west of the Montrose Basin but there were smaller beds in the south. These surveys identified two species of seagrass, *Zostera noltii* and *Zostera angustifolia*. Seagrass beds are a PMF in Scotland as well as being a UK BAP habitat.

4.1.3.11 A wider dataset from Cooper and Barry (2017), which collated data from Cefas surveys from 1969-2016 around the UK, has also been considered, and the distribution of investigated stations is illustrated in Figure 4.2. These stations gave high level faunal group classifications which broadly aligned with the more in-depth site specific surveys from nearby offshore wind farms and other projects.

Firth of Forth Bank Complex MPA

4.1.3.12 The Firth of Forth Bank Complex MPA is designated for ocean quahog, offshore subtidal sands and gravels, shelf banks and mounds, and moraines. More detail on this designated site is included in Section 1. Analysis by Axelsson *et al.* (2014) of grab samples and still photography from sample locations within the Firth of Forth Banks Complex MPA identified multiple other habitats of conservation interest. *M. modiolus* beds were identified on muddy gravels and coarse sands in the south of the Morven North Benthic Ecology Study Area and Morven South Benthic Ecology Study Area. "Seapen and burrowing megafauna communities" habitats were also observed on finer sediments classified as sandy mud. This habitat is characterised by the seapen (*Pennatula phosphorea*), which can be identified in video and still imagery. Other associated species included *A. digitatum, F. foliacea* and the sunstar *Crossaster papposus*. Stony reefs were also identified at four sample locations across the Firth of Forth Banks Complex MPA. The seabed at these locations was characterised by moderately large pebbles and cobbles on muddy sand and gravel colonised by large aggregations of ascidians or A. digitatum. A further three sites showed signs of stony reef, but this could not be confirmed by the author as the topography was indistinct, the soft sediment component was too large, or the extent was unknown (minimum requirement from Irving (2009) is 25m^2) at these locations (Axelsson *et al.,* 2014). All stony reef sites are located to the southwest of Morven North and Morven South, beyond the Survey Area.

Eastern Link 1

4.1.3.13 The proposed Eastern Link 1 subsea cable route (Figure 4.2) passes through the southwest of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, within the nearshore area, extending south from the Scottish landfall at Thorntonloch beach, East Lothian, to the English landfall near Seaham. Site specific surveys of this cable route were undertaken in 2020 (National Grid, 2022).

4.1.3.14 The offshore survey indicated the presence of relatively diverse polychaete annelid dominated communities, including species such as *Paramphinome jeffreysii, S. spinulosa*, and *Peresiella clymenoides*, while the second most common group was composed of crustacean amphipods such as *Bathyporeia elegans* and *Centraloecetes kroyeranus*. The most frequently occurring crustaceans were *Ampelisca tenuicornis*, and the isopod *Astacilla dilatata*. Mollusca along the offshore cable route were mainly represented by the bivalve *Ennucula tenuis* and the gastropod *Retusa umbilicata*. Most stations along the installation corridor were classified as *Thyasira* spp. and *Ennucula tenuis* in circalittoral sandy mud (SS.SMu.CSaMu.ThyEten). The biotopes *Amphiura filiformis* and *Ennucula tenuis* in circalittoral and offshore muddy sand (SS.SMu.CSaMu.AfilEten) and *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit), were also common.

4.1.3.15 The surveys also identified the presence of five stations with a medium resemblance to Annex I stony reefs within 1km of the Scottish landfall, within the southwest of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. All other stations overlapping with the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area had no designated benthic features.

Eastern Link 2

4.1.3.16 The proposed Eastern Link 2 subsea cable route (Figure 4.2) passes through the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, extending from Peterhead north of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area to Bridlington in England. Site specific surveys of the Eastern Link 2 subsea cable route were undertaken in 2021 including a combination of DDV and grab sampling methods (National Grid Electricity Transmission and Scottish Hydro Electric Transmission plc, 2022b). The survey identified a variety of taxonomic groups, mostly polychaetes, followed by molluscs and arthropods (mainly crustaceans).

4.1.3.17 Habitats with coarse or mixed sediments were identified as having higher taxonomic abundance and richness compared to sand habitats, in part due to high levels of epifauna including *S. spinulosa*, especially towards the nearshore stations. Characteristic species of coarse or mixed sediment habitats included the polychaetes *Mediomastus fragilis*, Lumbrineris spp., *Glycera lapidum*, the sea urchin *Echinocyamus pusillus* and a range of encrusting fauna. Habitats dominated by sand were characterised by species such as the brittlestar *Amphiura filiformis*, the polychaetes *Goniada maculata*, *Diplocirrus glaucus* and *Spiophanes kroyeri* and the bivalve *Timoclea ovata*.

4.1.3.18 The site specific surveys also identified protected habitats and species of conservation importance; those identified with the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area included subtidal sands and gravels (a UK BAP Priority Habitat) and ocean quahog.

Seagreen 1 Offshore Wind Farm

4.1.3.19 Seagreen 1 OWF (Figure 4.2) baseline characterisation surveys were conducted in 2011, approximately 25km southeast of Morven North and approximately 35km southeast of Morven South, and comprised grab sampling, beam trawl sampling and DDV sampling.

4.1.3.20 *Sabellaria spinulosa* on stable circalittoral mixed sediment (SS.SBR.PoR.SspiMx), *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (SS.SCS.ICS.MoeVen) and *Flustra* *foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (SS.SMX.CMx.FluHyd) were identified as key habitats in the west of the Seagreen 1 OWF. More centrally, the seabed was dominated by the Sabellidae polychaete family, "dense Chone" (SS.SMx.OMx.(Chone)) and also a sparser version of this biotope.

4.1.3.21 In the east, polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) was identified as a key habitat across the whole area, with the centre also associated with *S. spinulosa* and the east with *Chone* spp. polychaetes.

4.1.3.22 The number of species and individuals within the east of the Seagreen 1 OWF survey area was generally lower than within the west, likely due to a predominance of finer sediments in the east. Epifauna and encrusting fauna were more common where the sediments were coarser, containing gravel, shell or cobble (Seagreen Ltd, 2012).

4.1.3.23 Pre-construction benthic monitoring and Annex I reef surveys in 2020 for the Seagreen 1 OWF were undertaken in the array area and export cable corridor. Benthic habitats were recorded as circalittoral mixed sediments, *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (SS.SMx.CMx.FluHyd) and *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx), with patches of moderate energy circalittoral rock and circalittoral coarse sediment (Seagreen Ltd, 2021). The *S. spinulosa* aggregations identified in these surveys were not found to meet criteria to be defined as reefs, however, they were in association with high biodiversity areas (Seagreen Ltd, 2012). Patches of medium and low resemblance stony reef were recorded among larger areas of cobble and sand in the offshore section of the export cable corridor and within the centre and northeast of the Seagreen 1 OWF array area (Seagreen Ltd, 2021).

<u>Seagreen 1A Project</u>

4.1.3.24 The Seagreen 1A Project provides the infrastructure required to connect the remaining 36 consented offshore wind turbines at Seagreen 1 OWF to the grid at the same landfall point as the Inch Cape OWF (Figure 4.2). A benthic validation survey was undertaken in 2020 and 2021 to support the marine licence application for Seagreen Project 1A. The benthic subtidal survey (comprised of grab and DDV sampling) was located to the southeast of Morven North and Morven South.

4.1.3.25 The sediments recorded ranged from sand to mixed sediments, with stations closer to the coast containing a higher percentage of mud and those further offshore containing a higher percentage of sand. The Seagreen Project 1A benthic validation survey recorded sandy mud biotopes (circalittoral sandy mud (SS.SMu.CSaMu) and *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilMysAnit)) across the mid-section of the export cable corridor survey area. Mixed sediment biotopes (polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) and SS.SMx.CMx.OphMx) were recorded in the furthest offshore samples within the export cable corridor survey area. The inshore sections of the export cable corridor survey area were dominated by muddy sediment biotopes (seapens and burrowing megafauna in circalittoral fine mud (SS.SMu.CFiMu.SpnMeg) and *Melinna palmata* with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud (SS.SMu.ISaMu.MelMagThy)). No Annex I reefs were recorded during the Seagreen Project 1A benthic validation surveys, which included some areas of the Seagreen 1 OWF array area.

<u>Berwick Bank Offshore Wind Farm</u>

4.1.3.26 The Berwick Bank OWF is located 32km to the southwest of Morven North and 34km to the southwest of Morven South, as well as being within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The baseline characterisation surveys for Berwick Bank OWF were undertaken in 2020 and comprised grab and DDV sampling (SSE Renewables, 2022).

4.1.3.27 The results of these surveys identified that the array area was predominantly populated by sand based communities including *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.Smu.CsaMu.AfilKurAnit) and *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri), which were found to be particularly dominant in the east of the Berwick Bank OWF array area, accompanied by smaller areas of offshore circalittoral sand (SS.SSa.OSa), and *Echinocyamus pusillus* and *Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx). In the west of the Berwick Bank OWF array area mixed sediment and mud-based communities were more prevalent, including SS.SMx.OMx.PoVen and SS.SMu.CSaMu.AfilMysAnit biotopes, with two patches of non-reef forming *Sabellaria spinulosa* on stable circalittoral mixed sediment (SS.SBR.PoR.SspiMx) in the south.

4.1.3.28 The Berwick Bank OWF export cable corridor was also characterised by mixed and soft sediment communities such as SS.SSa.OSa and *Amphiura filiformis* and *Ennucula tenuis* in circalittoral and offshore sandy mud (SS.SMu.CSaMu.AfilEten) in the offshore end of the export cable corridor, transitioning to SS.SMu.CFiMu.SpnMeg in the central section. The echinoderms and crustose communities (CR.MCR.EcCr) biotope was recorded in the inshore areas adjacent to the landfall.

4.1.3.29 During the Berwick Bank OWF survey some grab samples also recorded species of conservation importance. *A. islandica* was recorded in the array area and export cable corridor and *M. modiolus* was recorded in the Berwick Bank OWF array area in small numbers (<4 individuals) except for one trawl, which recorded 31 individuals. No *M. modiolus* beds were recorded during the DDV survey and no M. modiolus were recorded in the infaunal grab survey.

<u>Cambois Connection Marine Scheme</u>

4.1.3.30 The Cambois Connection Marine Scheme is located to the south and southwest of Morven North and Morven South within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The benthic characterisation survey for the Cambois Connection Marine Scheme was undertaken alongside the Berwick Bank OWF survey in 2022, and comprised grab and DDV sampling (Natural Power, 2023).

4.1.3.31 The results of the survey identified that, within Scottish waters overlapping with the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area and the area surveyed for the Berwick Bank OWF, the biotopes were in alignment with the findings of the Berwick Bank OWF surveys (SSE Renewables, 2022). To the south, along the rest of the Cambois Connection Marine Scheme within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, the subtidal biotopes were dominated by *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo), interspersed with less frequent *Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud (SS.Smu.OMu.PjefThyAfil) and the higher level biotope of offshore circalittoral mixed sediment (SS.SMx.OMx) (Natural Power, 2023).

4.1.3.32 The survey for this project identified the presence of the same species of conservation importance as the Berwick Bank OWF assessment when resurveying parts of the Berwick Bank OWF array area. The survey also identified the presence of habitats of conservation importance, specifically subtidal sands and gravels, and mud habitats in deep water (SSE Renewables, 2023). There were several stations which qualified as low resemblance Annex I stony and bedrock reef, although these stations were located outside of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area.

<u>Inch Cape Offshore Wind Farm</u>

4.1.3.33 The Inch Cape OWF is located 61km to the west of Morven North and 70km to the west of Morven South, as well as being within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area (Figure 4.2). The baseline characterisation surveys for the Inch Cape OWF showed that the array area was dominated by circalittoral sands and gravelly sands with areas of mixed sediment. The epifaunal surveys recorded epibenthic species that were typical for these sediments and included dead man's fingers (*A. digitatum*), horned wrack (*F. foliacea*), brittlestars (*O. fragilis*), hydroids (e.g. *H. falcata*) and several mobile benthic invertebrates. The key species recorded by the DDV survey were *A. digitatum, S. triqueter, Munida rugosa, F. foliacea*, and common starfish (Asterias rubens). The brittlestar *O. fragilis* occurred in high densities, but only at two stations (Inch Cape Offshore Ltd, 2011).

4.1.3.34 The dominant biotopes within the array area were *Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx) covering 65% of the array area, SS.SCS.OCS covering 31% of the area and *Mediomastus fragilis,* Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen) covering 4% of the area (Inch Cape Offshore Ltd, 2011). Reef forming polychaetes (i.e. *Sabellaria* spp.) were recorded, however, no evidence of annex I reef features was found.

<u>Neart na Gaoithe Offshore Wind Farm</u>

4.1.3.35 The Neart na Gaoithe OWF (Figure 4.2) array area is approximately 80km southwest of Morven North and approximately 85km southwest of Morven South, as well as being within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area. The baseline characterisation surveys for the Neart na Gaoithe OWF array area reported slightly gravelly sands with areas of gravel sediments. Analysis of the grab samples mainly characterised the Neart na Gaoithe OWF array area as *Amphiura filiformis* and *Ennucula tenuis* in circalittoral and offshore sandy mud (SS.SMu.CSaMu.AfilEten) and a mosaic of SS.SCS.CCS/SS.SSa.OSa. Small patches of *Thyasira* spp. and *Ennucula tenuis* in circalittoral sandy mud (SS.SMu.CSaMu.ThyEten) were reported in the east, *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) in the south and *Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand (SS.SSa.OSa.OfusAfil) in the north and west of the Neart na Gaoithe OWF array area (Neart na Gaoithe Offshore Wind Ltd, 2010). No protected or rare species were recorded (Neart na Gaoithe Offshore Wind Ltd, 2010).

4.1.3.36 Analysis of the DDV data mainly characterised the array area as SS.SMu.CFiMu.SpnMeg with regular patches of SS.SMx.CMx throughout the Neart na Gaoithe OWF array area. Sublittoral mixed sediments (SS.SMx), SS.SMx.CMx.OphMx and CR.MCR.EcCr (on boulders) were also recorded in small patches in the array area (Neart na Gaoithe Offshore Wind Ltd, 2010).

<u>Kincardine Floating Demonstration Offshore Wind Farm</u>

4.1.3.37 The site specific surveys at the Kincardine OWF (Figure 4.2) involved a combination of DDV and grab sampling of the Kincardine OWF array area and export cable corridor (Kincardine Offshore Wind Farm, 2016). The Kincardine OWF array area was predominantly characterised by SS.SSa.OSa, which was found at all 18 stations across the array area. DDV identified *A. digitatum* and *A. rubens* at all 18 stations within the array area; these species were also the most common within the Kincardine OWF export cable corridor. In the Kincardine OWF export cable corridor, east of the Kincardine OWF array area, there was a greater variety of habitats identified, the majority of which were circalittoral fine sand (SS.SSa.CFiSa) followed by SS.SSa.OSa, with only a couple of stations defined as SS.SCS.CCS.

<u>Aberdeen Offshore Wind Farm</u>

4.1.3.38 Within the Aberdeen OWF (Figure 4.2) in the north of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area two main biotopes were identified: SS.SCS.CCS and SS.SSa.CMuSa (Aberdeen Offshore Wind Farm Ltd, 2010). Data from surveys completed around this area by McIntyre (1958) described the benthic environment to be dominated by bivalves and polychaetes as well as echinoderms such as *Ophiocten affinis* and *E. pusillus*.

<u>Hywind Offshore Wind Farm</u>

4.1.3.39 Hywind OWF, located in the north of the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, identified a variety of habitats within its array area and export cable corridor. DDV surveys of the Buchan Deep recorded the biotope circalittoral fine sand, characterised by a poorly developed epifauna with sparse hermit crabs and brittle stars, as well as hydroids and anemones on the scattered cobbles (Statoil, 2015). The main infaunal species were the polychaetes *Scoloplos armiger*, *Spiophanes bombyx* and *O. fusiformis*, the brittle stars *A. filiformis* and *O. affinis* and the burrowing sea urchins (*Spatangus* sp. and *E. pusillus*) (Statoil, 2015). The occasional patches of boulders and mixed sediment supported a higher diversity of epifaunal species including shrimps, sponges, sessile cnidarians and occasional aggregations of sandy tubes of the polychaete *S. spinulosa*. Coverage of *S. spinulosa* on the seabed in these locations was low, patchy and small in extent (Statoil, 2015).

Ossian Offshore Wind Farm

4.1.3.40 The Ossian OWF was characterised through subtidal grab sample and DDV surveys, with four biotopes identified (SSE Renewables, 2024). Specifically, these were the biotopes SS.SMx.OMx, SS.SSa.OSa, SS.SSa.CFiSa.EpusOborApri, and SS.SSa.CFiSa.ApriBatPo. The north and south of the survey area were dominated by the SS.SSa.CFiSa.EpusOborApri biotope, with the centre and east dominated by the SS.SSa.CFiSa.ApriBatPo biotope. The SS.SSa.OSa biotope was recorded at two stations in the east of the survey area, and the SS.SMx.OMx biotope was recorded at three stations to the west and north of the survey area. All identified biotopes, with the exception of SS.SMx.OMx, were identified as contributing to the designation of the offshore subtidal sands and gravels PMF and also contributing to the subtidal sands and gravels feature on the Scottish Biodiversity List.

Muir Mhor Offshore Wind Farm

4.1.3.41 The Muir Mhor Offshore Wind Farm was characterised through subtidal grab sampling and DDV surveys, with four biotopes identified within the array area and seven biotopes identified within the export cable corridor (Muir Mhor Offshore Wind Farm, 2024). In the south of the array rea where it overlaps with the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area, the *Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand (SS.SCS.OCS.GlapThy Amy) and SS.SMx.OMx.PoVen biotopes were identified. In the export cable corridor moving from the furthest offshore to closer inshore, the SS.SSa.IfiSa.NcirBat, SS.SSa.OSa.OfusAfil, SS.SCS.CCS.MedLumVen, SS.SCS.CCS.SpiB, SS.SMx.CMx.FluHyd and SS.SMx.OMx.PoVen biotopes were recorded.

4.1.4 Designated Sites

4.1.4.1 Within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area there are several European (i.e. Special Areas of Conservation (SACs) and nationally (i.e. MPAs) designated sites with relevant subtidal benthic ecology features (Table 4.1).

Table 4.1: Summary of designated sites with relevant benthic ecology features within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area

Designated site	Distance to Morven North (km)*	Distance to Morven South (km)*	Distance to Morven North Benthic Subtidal Ecology Study Area (km)*	Distance to Morven South Benthic Subtidal Ecology Study Area (km)*	Relevant subtidal features
Firth of Forth Banks Complex MPA	0.04	17.3	0	10.5	Ocean quahog Offshore subtidal sands and gravels Shelf banks and mounds Quaternary of Scotland: Moraines
Southern Trench MPA	56.79	90.9	45.4	79.7	Burrowed mud Shelf deeps Quaternary of Scotland: Moraines Quaternary of Scotland: Sub-glacial tunnel valleys Submarine Mass Movement: Slide scars
Firth of Tay and Eden Estuary SAC	95.9	109.3	87.1	102.7	Estuaries Sandbanks which are slightly covered by sea water all the time
Berwickshire and North Northumberland Coast SAC	101.9	97.3	90.6	86.3	Large shallow inlets and bays Reefs Submerged or partially submerged sea caves
Isle of May SAC	104.7	108.7	93.8	99.3	Reefs

** Represents the shortest distance between the external boundaries of the respective project and protected site*

4.1.4.2 The identification of designated sites for inclusion in the Morven North and Morven South benthic subtidal ecology chapters of the respective EIA Reports was carried out as follows. Sites with relevant qualifying features were screened in if they:

- Overlap with either the Morven North Boundary or Morven South Boundary;
- Are located within the likely ZoI associated with either Morven North or Morven South. The ZoI has been identified as one maximum tidal ellipse over a large spring tide either the Morven North or Morven South (i.e. the Morven North Benthic Subtidal Ecology Study Area or the Morven South Benthic Subtidal Ecology Study Area).

4.1.4.3 The above approach ensures that all sites potentially affected by changes in water quality (e.g. increased SSC) and potential changes to the hydrodynamic regime are included in the assessment.

4.1.4.4 Within the Morven North Benthic Subtidal Ecology Study Area there is a single MPA with benthic ecology features: the Firth of Forth Banks Complex MPA (Table 4.1). This designated site only overlaps with Morven North ZoI and does not overlap with the Morven North Boundary. All other designated sites are located beyond the ZoI for benthic receptors (i.e. are located outside the Morven North Benthic Subtidal Ecology Study Area). The Morven South Benthic Subtidal Ecology Study Area does not overlap with any designated sites.

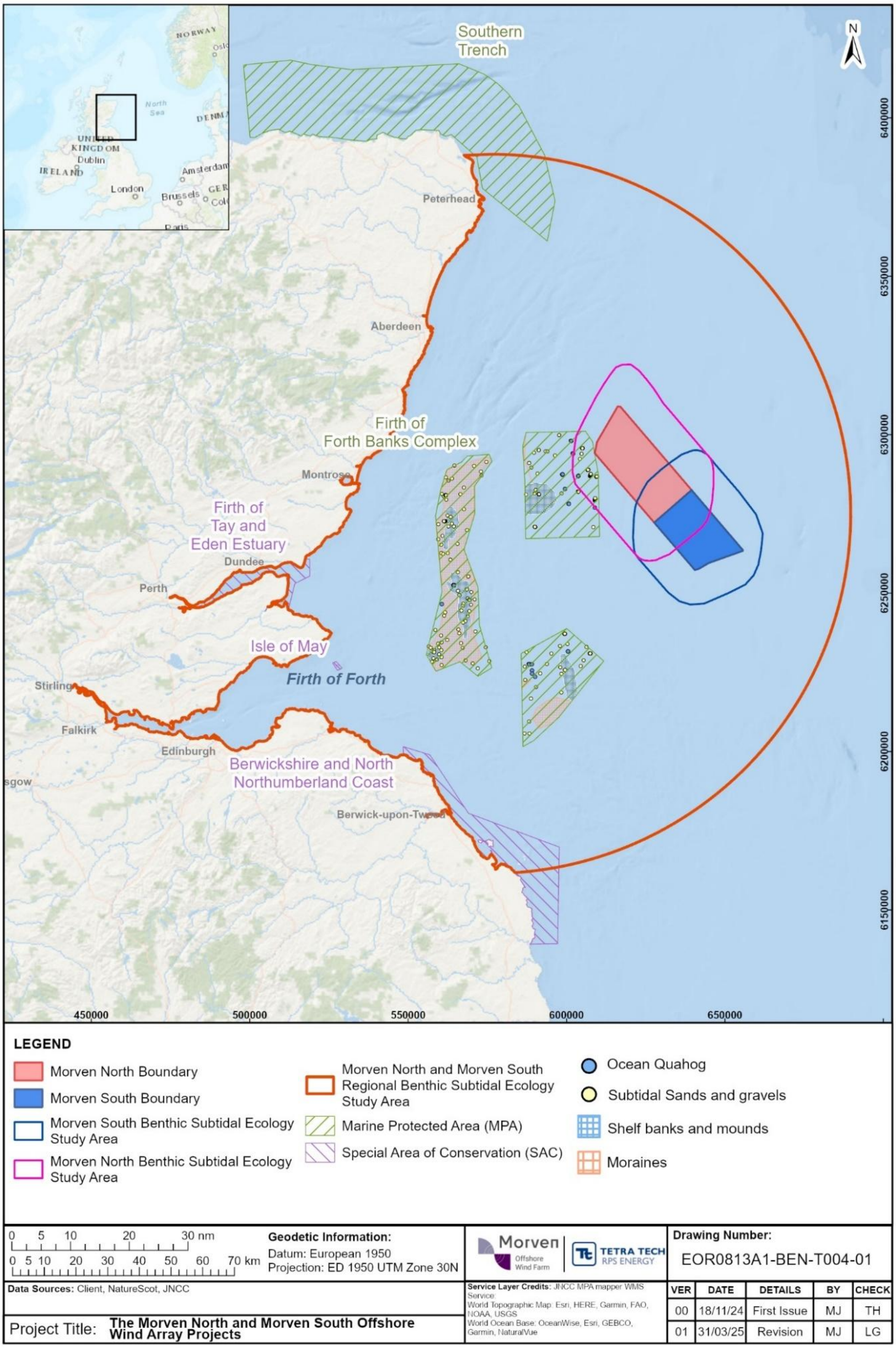

Figure 4.3: Designated sites within the Morven North and Morven South Regional Benthic Subtidal Ecology Study Area

4.1.4.5 The Firth of Forth Banks Complex MPA covers 2,130km^2 and is spilt into the three sections of Berwick Bank, Scalp and Montrose Bank, and Wee Bankie. The MPA is located to the southwest of Morven North and Morven South. Montrose Bank overlaps with the Morven North Benthic Subtidal Ecology Study Area.

4.1.4.6 The Firth of Forth Banks Complex MPA is designated for ocean quahog aggregations, offshore subtidal sands and gravels, shelf banks and mounds, and moraines (JNCC, 2018). The conservation objectives are that the protected features:

- so far as already in favourable condition, remain in such condition;
- so far as not already in favourable condition, be brought into such condition, and remain in such condition.

4.1.4.7 Further information detailing the sediment type and subtidal benthic ecology of the Firth of Forth Banks Complex MPA is provided in Sections 4.1.1 and 4.1.3 respectively.

4.1.4.8 The offshore subtidal sands and gravels and ocean quahog features of the Firth of Forth Banks Complex MPA occur inside the Morven North Benthic Subtidal Ecology Study Area. However, the shelf banks and mounds, and the moraines, which are features of this MPA, occur outside the Morven North Benthic Subtidal Ecology Study Area (13km and 14km respectively from the Morven North Benthic Subtidal Ecology Study Area).

4.2 Morven North Benthic Subtidal Ecology Study Area and Morven South Benthic Subtidal Ecology Study Area

4.2.1 Sediment Type

Morven North Benthic Subtidal Ecology Study Area

4.2.1.1 Based on EMODnet (2019) data (Figure 4.1), the Morven North Benthic Subtidal Ecology Study Area is characterised primarily by “deep circalittoral sand” (A5.27), with a patchy distribution of “deep circalittoral coarse sediment” (A5.15) along the western edge of the Morven North Benthic Subtidal Ecology Study Area. Additionally, within the western most corner of the Morven North Benthic Subtidal Ecology Study Area, there is a small area of “deep circalittoral mixed sediment” (A5.45), which overlaps broadly with the location of the nearby Firth of Forth Banks Complex MPA.

Morven South Benthic Subtidal Ecology Study Area

4.2.1.2 Based on EMODnet (2019) data (Figure 4.1), the Morven South Benthic Subtidal Ecology Study Area is characterised primarily by “deep circalittoral sand” (A5.27), with a patchy distribution of “deep circalittoral coarse sediment” (A5.15) in the west of the Morven South Benthic Subtidal Ecology Study Area.

4.2.2 Sediment Contamination

Morven North Benthic Subtidal Ecology Study Area

4.2.2.1 The North Sea has been historically and currently heavily industrialised (Logemann *et al.*, 2022), with a high level of metal, PAH, and PCB contamination noted throughout. Specifically, near to the Morven North Benthic Subtidal Ecology Study Area, high concentrations of these contaminants have been recorded around heavily industrialised coastal areas and from drill cuttings (Sheahan *et al.*, 2001), however levels of metals, PAHs and PCBs generally fall below detection thresholds in offshore regions such as the Morven North Benthic Subtidal Ecology Study Area.

Morven South Benthic Subtidal Ecology Study Area

4.2.2.2 Near to the Morven South Benthic Subtidal Ecology Study Area, high concentrations of metals, PAHs and PCBs have been recorded around heavily industrialised coastal areas and from drill cuttings (Sheahan *et al.,* 2001), however levels of metals, PAHs and PCBs generally fall below detection thresholds in the offshore regions such as the Morven South Benthic Subtidal Ecology Study Area.

4.2.3 Subtidal Benthic Ecology

Morven North Benthic Subtidal Ecology Study Area

4.2.3.1 At a broad scale, the benthos within the Morven North Benthic Subtidal Ecology Study Area has been defined from infaunal surveys and modelling as being comprised of a range of widely distributed species including *S. bombyx, E. cordatum, P. jeffreyseii*, and *O. fusiformis* (Reiss *et al.,* 2011). These characterisations are very broadscale throughout the Morven North Benthic Subtidal Ecology Study Area and presence or absence of these species or habitats depends on the underlying sediment types.

Morven South Benthic Subtidal Ecology Study Area

4.2.3.2 At a broad scale, the benthos within Morven South Benthic Subtidal Ecology Study Area has been defined from infaunal surveys and modelling as being comprised of a range of widely distributed species including *S. bombyx, E. cordatum, P. jeffreyseii,* and *O. fusiformis* (Reiss *et al.,* 2011). These characterisations are very broadscale throughout the Morven South Benthic Subtidal Ecology Study Area and presence or absence of these species or habitats depends on the underlying sediment types.

5 Baseline Characterisation – Site Specific Survey

5.1 Results – Sediment Analysis

5.1.1 Geophysical survey and physical sediment characteristics

Morven North Benthic Subtidal Ecology Study Area

5.1.1.1 Across the Morven North Benthic Subtidal Ecology Study Area, seabed sediments were interpreted from Side Scan Sonar (SSS) and backscatter data to be relatively homogenous, comprising fine to medium sand with varying amounts of gravel and shell fragments.

5.1.1.2 Additionally, boulders and numerous cobbles were identified across the Morven North Benthic Subtidal Ecology Study Area, with these being most common in the northwest and southeast. These boulders and cobbles with thin veneers of gravel and sand were noted to be located on underlying seabed shoals.

5.1.1.3 The seabed was dominated by current induced bedforms (e.g. megaripples), orientated from west-northwest to east-southeast, with the most defined bedforms being found in the Morven North Benthic Subtidal Ecology Study Area (compared to further south in the Survey Area), with wavelengths reaching up to 50m. Analysis of the SSS data indicated that the seabed across the Morven North Benthic Subtidal Ecology Study Area, undulated relatively gently, generally with gradients of less than 1°, except for steeper gradients on underlying geological features and surficial sediment accumulations. Full results are available in Gardline (2023).

5.1.1.4 The percentage sediment composition (i.e. proportion of mud ≤0.63mm; sand <2mm; gravel ≥2mm) at each station is presented in Figure 5.1. The sediment composition across stations in the Morven North Benthic Subtidal Ecology Study Area was composed on average of 1.06% gravel, 91.70% sand and 7.24% mud. The sediment of all but one station was classified as sand, with varying mud and gravel content. The remaining station (ENV054), located in the northernmost corner of the Morven North Benthic Subtidal Ecology Study Area, was classified as sandy gravel.

5.1.1.5 In general, coarser sediments were found in the northwest of the Morven North Benthic Subtidal Ecology Study Area, whereas stations with higher mud content were found toward the southeast (Figure 5.2). Most stations within the Morven North Benthic Subtidal Ecology Study Area were characterised as sand, with only a couple of stations classified as muddy sand, slightly gravelly muddy sand and slightly gravelly sand (Figure 5.1).

5.1.1.6 Most samples across the Morven North Benthic Subtidal Ecology Study Area were identified as being moderately sorted (58%) and poorly sorted (33%). Only one sandy gravel station (ENV054) was classified as being very poorly sorted. This was due to the proportion of gravel at this site being much higher than average and sand being lower than average (mud 5.2%; sand 62.8%; gravel 32%).

Morven South Benthic Subtidal Ecology Study Area

5.1.1.7 Across the Morven South Benthic Subtidal Ecology Study Area, seabed sediments were interpreted from SSS and backscatter data to be relatively homogenous, comprising fine to medium sand with varying amounts of gravel and shell fragments.

5.1.1.8 Additionally, boulders and numerous cobbles were identified across the Morven South Benthic Subtidal Ecology Study Area. These boulders and cobbles with thin veneers of gravel and sand were noted to be located on underlying seabed shoals.

5.1.1.9 The seabed in the Morven South Benthic Subtidal Ecology Study Area was dominated by current induced bedforms (e.g. megaripples), orientated from west-northwest to east-southeast. Analysis of the SSS data indicated that the seabed across the Morven South Benthic Subtidal Ecology Study Area undulated relatively gently, generally with gradients of less than 1o, except for steeper gradients on underlying geological features and surficial sediment accumulations. Full results are available in Gardline (2023).

5.1.1.10 The percentage sediment composition at each station is presented in Figure 5.1. The sediment composition across stations in the Morven South Benthic Subtidal Ecology Study Area was composed on average of 0.39% gravel, 91.18% sand and 8.42% mud. The sediment of all stations was classified as sand, with varying mud and gravel content.

5.1.1.11 In general, stations with higher mud content were found towards the southeast of the Morven South Benthic Subtidal Ecology Study Area (Figure 5.2). The majority of stations were classified as sand, with a minority of stations characterised as muddy sand, slightly gravelly muddy sand and slightly gravelly sand (Figure 5.1).

5.1.1.12 Most samples across the Morven South Benthic Subtidal Ecology Study Area were identified as being moderately sorted (55%) and poorly sorted (42%).

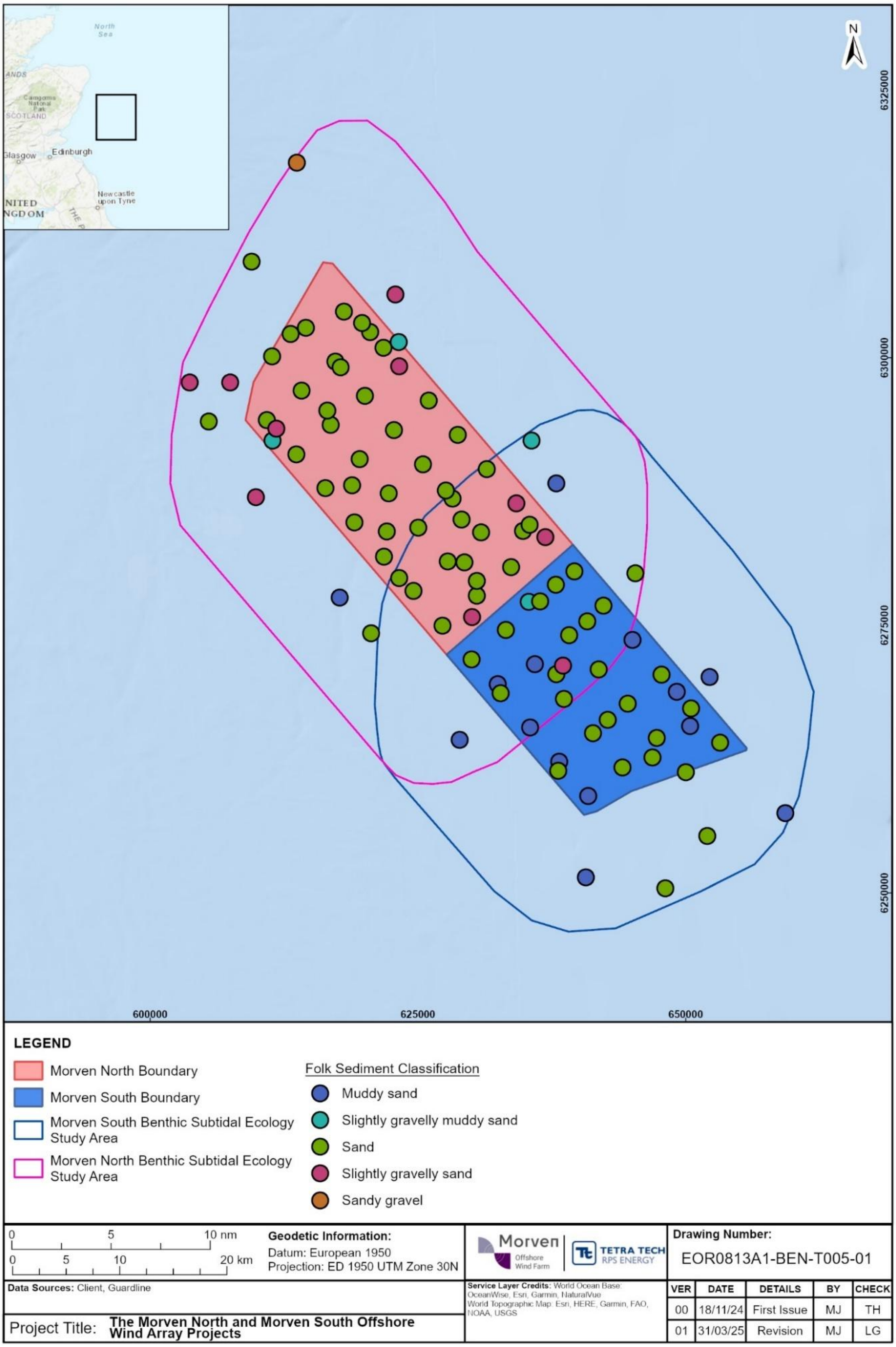

Figure 5.1: Folk sediment classifications and stations sampled for each benthic infaunal grab sample in the Survey Area

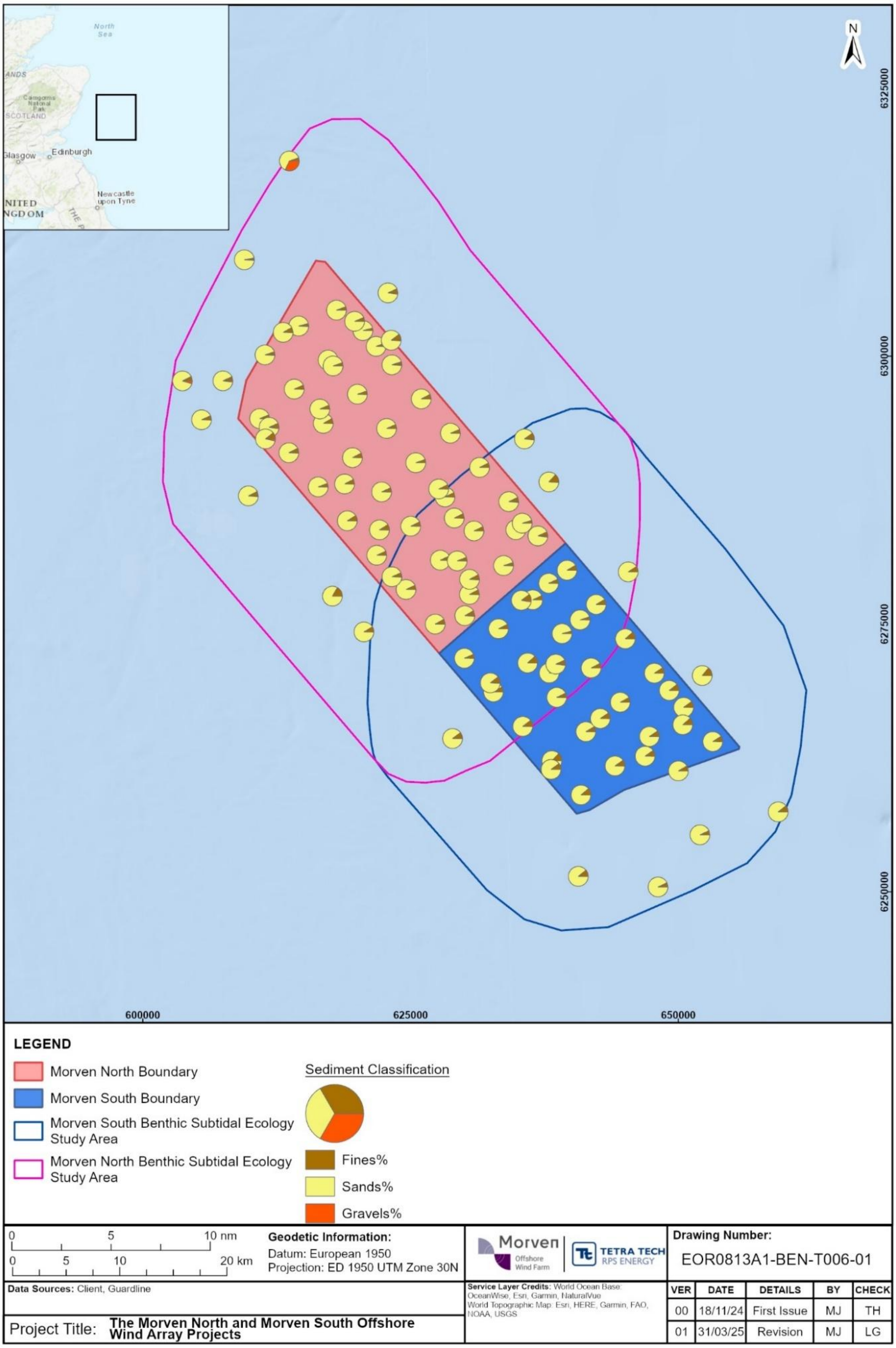

Figure 5.2: Sediment composition (from Particle Size Analysis) at each benthic grab sample location in the Survey Area

5.1.2 Sediment contamination

Morven North Benthic Subtidal Ecology Study Area

Organic matter and organic carbon

5.1.2.1 Analysis of TOM by the loss on ignition process indicated that in the Morven North Benthic Subtidal Ecology Study Area organic matter generally ranged from 1.5% at ENV071 to 3.9% at ENV102, with an outlier of 9.7% TOM at ENV054. The mean TOM for the Survey Area was 2.5% (±1.2% SD).

5.1.2.2 Analysis of TOC indicated that organic carbon generally ranged from 0.13% at stations ENV081 and ENV082 in the Morven North Benthic Subtidal Ecology Study Area as well as the Shared Sampling Location ENV024, to 0.29% at ENV057, a Shared Sampling Location. Elevated levels of TOC were noted at station ENV064 (0.35%) and the gravellier ENV054 (0.38%), both located in the Morven North Benthic Subtidal Ecology Study Area. The mean TOC for the Survey Area was 0.19% (±0.05% SD).

Metals

5.1.2.3 Metals tend to be readily adsorbed by sediments which can lead to them accumulating to concentrations far higher than the surrounding environment. These sediments can become re-suspended through bioturbation, physical processes or other disturbances, which can release the accumulated metals. The ingestion of sediments contaminated with heavy metals by marine organisms can lead to bioaccumulation through trophic levels, leading to apex organisms accumulating metals to adverse and toxic levels, resulting in significant adverse effects including mortality, impaired reproduction, reduced growth, alterations in metabolism as a result of oxidative stress and disruption of the food chain.

5.1.2.4 The levels of metals that were recorded in the sediment samples collected from the 39 stations within the Morven North Benthic Subtidal Ecology Study Area are presented in Appendix B. The results showed that most stations had metal contamination levels below the relevant Marine Scotland ALs and Canadian thresholds.

5.1.2.5 Specifically, results indicated that for all stations across the Morven North Benthic Subtidal Ecology Study Area, levels of the following metals were below the Marine Scotland AL1 thresholds: mercury (Marine Scotland AL1 threshold: 0.3mg/kg), cadmium (0.4mg/kg), chromium (40mg/kg), copper (40mg/kg), nickel (20mg/kg), lead (50mg/kg) and zinc (130mg/kg). All stations were also below the CSQG TEL threshold for mercury (0.13mg/kg), cadmium (0.7mg/kg), chromium (52.3mg/kg), copper (18.7mg/kg), lead (30.2mg/kg) and zinc (124mg/kg) (nickel is not measured for this threshold).

5.1.2.6 Similarly, most stations across the Morven North Benthic Subtidal Ecology Study Area were under the thresholds for arsenic for both Marine Scotland AL1 (20mg/kg) and CSQG TEL (7.24mg/kg), except for ENV054 in the far north of the Morven North Benthic Subtidal Ecology Study Area, which had 27mg/kg[1] dry weight sediment of arsenic. This concentration of arsenic exceeded the Marine Scotland AL1 but was below the Marine Scotland AL2 (70mg/kg), as well as exceeding the CSQG TEL but was below the CSQG PEL (41.6mg/kg).

Polychlorinated biphenyls

5.1.2.7 PCBs are toxic to fish and other aquatic organisms. Reproductive and developmental problems have been observed in fish at low PCB concentrations, with the early life stages being most susceptible. There is growing evidence linking PCBs and similar compounds with reproductive and immuno-toxic effects in wildlife, including effects on seals and other marine mammals. Due to their persistence and lipophilic nature, PCBs have the potential to bioaccumulate, particularly in lipid rich tissue such as fish liver. Bioaccumulation of PCBs is recorded in fish, birds and marine mammals with known sublethal toxicological effects.

Accumulation of PCBs in sediments poses a potential hazard to sediment-dwelling organisms.

5.1.2.8 Table 5.1 presents the total of the International Council for the Exploration of the Sea (ICES) -7 PCBs at stations across the Survey Area that were recorded as being above the detection threshold of $0.08ng/g^{-1}$ compared to Marine Scotland AL1 (0.02mg/kg) and AL2 (0.18mg/kg). The full results for the individual PCBs are presented in Appendix B.2.

5.1.2.9 At the four stations with detectable levels of PCBs (ENV064 in the east of the Morven North Benthic Subtidal Ecology Study Area and Shared Sampling Locations ENV075, ENV077 and ENV092), levels of total PCBs ranged from 0.00038mg/kg to 0.00287mg/kg, but all of these were below Marine Scotland AL1 and below the CSQG TEL (0.0215mg/kg).

Table 5.1: Concentrations of total ICES-7 Polychlorinated biphenyls in sediments within the Survey Area

Relevant study area	Station	Total Polychlorinated biphenyls (mg/kg)
	Threshold: Marine Scotland AL1 (mg/kg)	0.02
	Threshold: Marine Scotland AL2 (mg/kg)	0.18
Morven North Benthic Subtidal Ecology Study Area	ENV064	0.00087
Survey Area (Shared Sampling Location)	ENV075	0.00051
Survey Area (Shared Sampling Location)	ENV077	0.00287
Survey Area (Shared Sampling Location)	ENV092	0.00038

<u>Organotins</u>

5.1.2.10 Organotins are a large class of organometallic compounds which contain tin-carbon bonds. They are important environmental contaminants associated with agricultural, industrial and biomedical activities which were banned by the International Maritime Organisation due to toxicity effects (Okoro *et al.,* 2015). Organotins are toxic to marine organisms even at very low concentrations. High concentrations can cause shell deformities in oysters and impair reproduction, with significant negative impacts on cellular respiration leading to cell and organism death (Alzieu *et al.,* 1986).

5.1.2.11 Levels of the organotins dibutyltin and tributyltin were both below the detection limit of 0.001mg/kg at all stations in the Morven North Benthic Subtidal Ecology Study Area and were therefore below the Marine Scotland Als.

<u>Polycyclic aromatic hydrocarbons</u>

5.1.2.12 PAHs enter the environment through a variety of sources, including road run-off, sewage, atmospheric circulation and from historical industrial discharge. Once in the environment, PAHs have a strong affinity for organic carbon and as such sediment can act as a substantial sink. Due to the high affinity for organic carbon, once ingested by fauna the PAHs cause oxidative stress and lead to adverse effects in the organism. Most species have a limited ability to metabolise PAHs and as a result they can bioaccumulate to toxic levels.

5.1.2.13 Full analysis of all PAHs at all stations within the Morven North Benthic Subtidal Ecology Study Area is presented in Appendix B.

5.1.2.14 At three stations within the Morven North Benthic Subtidal Ecology Study Area, normalised concentrations greater than the limit of detection (LOD) of one or more US Environmental Protection Agency 16 PAH compounds were above the OSPAR (2005) Background Concentration values. Most notably this included the low molecular weight compounds naphthalene or phenanthrene at stations ENV029 and ENV054 in the Morven North Benthic Subtidal Ecology Study Area.

5.1.2.15 For the Survey Area, average normalised concentrations exceeded the OSPAR (2005) Background Concentration value for anthracene, and where only concentrations >LOD were considered, survey average normalised concentrations also exceeded the OSPAR (2005) Background Concentration value for naphthalene, pyrene, benzo(a) anthracene and chrysene, suggesting that for the Survey Area these five PAH compounds were slightly above background.

5.1.2.16 Total PAH concentrations ranged from 1.03 $\mu g/kg^{-1}$ to 22.59$\mu g/kg^{-1}$ across the Morven North Benthic Subtidal Ecology Study Area. Concentrations of all PAHs at all stations across the Morven North Benthic Subtidal Ecology Study Area were below their relevant CSQG TEL and CSQG PEL thresholds, ERL and ERM thresholds, and the Marine Scotland AL1 threshold.

Morven South Benthic Subtidal Ecology Study Area

Organic matter and organic carbon

5.1.2.17 Analysis of TOM by the loss on ignition process indicated that in the Morven South Benthic Subtidal Ecology Study Area, organic matter ranged from 1.5% at ENV041 to 3.9% at ENV102. The mean TOM for the Survey Area was 2.5% (±1.2% SD).

5.1.2.18 Analysis of TOC indicated that organic carbon generally ranged from 0.13% at ENV024, to 0.29% at ENV057, both which are Shared Sampling Locations. No elevated levels of TOC were noted within the Morven South Benthic Subtidal Ecology Study Area. The mean TOC for the Survey Area was 0.19% (±0.05% SD).

Metals

5.1.2.19 The levels of metals that were recorded in the sediment samples collected from the 30 stations within the Morven South Benthic Subtidal Ecology Study Area are presented in Appendix B.1. The results showed that most stations had metal contamination levels below the relevant Marine Scotland ALs and Canadian thresholds.

5.1.2.20 Specifically, results indicated that for all stations across the Morven South Benthic Subtidal Ecology Study Area, levels of the following metals were below the Marine Scotland AL1 thresholds: mercury (Marine Scotland AL1 threshold: 0.3mg/kg), arsenic (20mg/kg), cadmium (0.4mg/kg), chromium (40mg/kg), copper (40mg/kg), nickel (20mg/kg), lead (50mg/kg) and zinc (130mg/kg). All stations were also below the CSQG TEL threshold for mercury (0.13mg/kg), arsenic (7.24mg/kg), cadmium (0.7mg/kg), chromium (52.3mg/kg), copper (18.7mg/kg), lead (30.2mg/kg) and zinc (124mg/kg) (nickel is not measured for this threshold).

Polychlorinated biphenyls

5.1.2.21 Table 5.1 presents the total of the ICES-7 PCBs at stations across the Survey Area that were recorded as being above the detection threshold of 0.08ng/g^{-1} compared to Marine Scotland AL1 (0.02mg/kg) and AL2 (0.18mg/kg). The full results for the individual PCBs are presented in Appendix B.2.

5.1.2.22 At the three stations with detectable levels of PCBs within the Morven South Benthic Subtidal Ecology Study Area (Shared Sampling Locations ENV075, ENV077 and ENV092), levels of total PCBs ranged from 0.00038mg/kg to 0.00287mg/kg, but all of these were below Marine Scotland AL1 and below the CSQG TEL (0.0215mg/kg).

Organotins

5.1.2.23 Levels of the organotins dibutyltin and tributyltin were both below the detection limit of 0.001mg/kg at all stations in the Morven South Benthic Subtidal Ecology Study Area and were therefore below the Marine Scotland Als.

Polycyclic aromatic hydrocarbons

5.1.2.24 Full analysis of all PAHs at all stations is presented in Appendix B.

5.1.2.25 At eight stations within the Morven South Benthic Subtidal Ecology Study Area, normalised concentrations greater than LOD of one or more US Environmental Protection Agency 16 PAH compounds were above the OSPAR (2005) Background Concentration values. Most notably this included the low molecular weight compounds naphthalene or phenanthrene at stations ENV028 and ENV062 in the Morven South Benthic Subtidal Ecology Study Area.

5.1.2.26 For the Survey Area, survey average normalised concentrations exceeded the OSPAR (2005) BAC value for anthracene, and where only concentrations >LOD were considered, survey average normalised concentrations also exceeded the OSPAR (2005) BAC value for naphthalene, pyrene, benzo(a) anthracene and chrysene, suggesting that for the Morven South Benthic Subtidal Ecology Study Area these five PAH compounds were slightly above background.

5.1.2.27 Total PAH concentrations ranged from 1.03 to 36.55 in the Morven South Benthic Subtidal Ecology Study Area. Concentrations of all PAHs at all stations across the Morven South Benthic Subtidal Ecology Study Area were below their relevant CSQG TEL and CSQG PEL thresholds, ERL and ERM thresholds, and the Marine Scotland AL1 threshold.

5.2 Results – Infaunal Analysis

5.2.1 Summary Statistics

Morven North Benthic Subtidal Ecology Study Area

5.2.1.1 A total of 245 taxa were recorded across samples within the Morven North Benthic Subtidal Ecology Study Area. Those taxa only recorded as present (colonial taxa and taxa whose abundance was not enumerated due to processing protocols or because only fragments of individuals were found) were removed from the numerical and statistical analyses (Section 3.2.4). The processing of samples included 0.5mm and 1mm sieves for each sample, to provide more detail on the distribution of organism sizes. This analysis showed an approximately equal distribution of number of taxa between the 0.5mm and 1mm fractions.

5.2.1.2 A total of 20,706 individuals were recorded across the Morven North Benthic Subtidal Ecology Study Area. Of these, juveniles accounted for 614 individuals from taxa, representing 2.96% of the total number of individuals and 3.67% of the total number of taxa recorded. Juveniles were recorded at stations across the Morven North Benthic Subtidal Ecology Study Area from the phyla Mollusca, Echinodermata, Arthropoda and Annelida. The five most abundant juvenile taxa were the echinoderms Spatangoida and Ophiuroidea and the molluscs *Lucinoma borealis*, *A. islandica* and Mytilidae. Juveniles of these five taxa comprised 93.97% of the total number of juvenile individuals.

5.2.1.3 Thirteen juveniles and one adult of the ocean quahog were identified across the Morven North Benthic Subtidal Ecology Study Area, with two additional individuals identified and returned to the sea at stations ENV073 and ENV082, both of which are within the Morven North Boundary. The biomass of the adult found in the grab sample at station ENV004, located within the Morven North Boundary, was 0.66g, and the juveniles recorded an average biomass of <0.001g. The two adults that were returned to sea at stations ENV073 and ENV082 measured 5.8x5cm and 9x8cm, respectively.

5.2.1.4 Of the 245 taxa enumerated from the site specific survey data, one (*Spiophanes bombyx*) was observed at all stations. A total of 39 taxa (15.92%) were recorded as single individuals; these rarely recorded taxa were distributed across the Morven North Benthic Subtidal Ecology Study Area. A total of 135 taxa (55.10%) were represented by fewer than 10 individuals. It is generally accepted that ecological communities which are frequently subjected to local disturbance or contamination events will be dominated by a limited number of tolerant taxa, which will be represented in high individual abundances (Clarke *et al.,* 2014). The relatively high numbers of single and low abundance taxa suggest a reasonably diverse community that has been subjected to relatively limited disturbance or contamination.

5.2.1.5 Station ENV006 in the Morven North Boundary recorded the highest number of juvenile individuals (38, mainly Spatangoida), while one station (ENV009) contained four juvenile taxa. The juveniles were excluded in the statistical analysis due to the very high similarity between the datasets including and excluding them (Rho=0.99, significance=0.1%).

5.2.1.6 Stations ENV043, ENV086, and ENV096 (located across the Morven North Benthic Subtidal Ecology Study Area) recorded the highest number of colonial or encrusting taxa, with five taxa at each, with only Anthoathecata being present at all three of these stations. Otherwise, a range of colonial or encrusting taxa including *Electra monostachys, Alcyonidium diaphanum,* and *Leptothecata* were present across these and other stations.

5.2.1.7 Station ENV054 (located in the far north of the Morven North Benthic Subtidal Ecology Study Area) recorded lower abundances of all common species including S. bombyx, with a complete lack of S. armiger, which was present in all but one other station. The taxa *Pholoe inornata, Terebellidae, Urothoe marina, Leptocheirus, Leptochiton asellus*, and Limatula were found only at this station.

5.2.1.8 Initially, the enumerated dataset was divided into the five major taxonomic groups: Annelida (Polychaeta), Arthropoda, Mollusca, Echinodermata and “Other”. The “Other” group was comprised of Cnidaria, Hemichordata, Nemertea, Phoronis and Platyhelminthes.

5.2.1.9 The absolute and proportional contributions of these five taxonomic groups to the overall community structure is summarised in Table 5.2. The faunal communities were generally dominated by Annelida (Polychaeta) (n=11,540), which contributed 55.73% of the total numbers of individuals followed by Mollusca (n=4,489) and Arthropoda (n=2,198), which contributed 21.68% and 10.62% of the total number of individuals, respectively. Annelida were the most diverse group as well as the most abundant, accounting for 55.73% of the total number of taxa.

Table 5.2: Contribution of gross taxonomic groups recorded in the infaunal grab samples within the Morven North Benthic Subtidal Ecology Study Area

Group	Individual abundance	Proportional contribution (%)	No. taxa	Proportional contribution (%)
Annelida (Polychaeta)	11,540	55.73	101	41.22
Arthropoda	2,198	10.62	65	26.53
Mollusca	4,489	21.68	57	23.27
Echinodermata	1,941	9.37	11	4.49
Other	577	2.79	11	4.49

5.2.1.10 At individual stations, gross taxonomic group proportions reflected these results, with Annelida comprising the highest proportion and highest number individuals of the taxa, at all but five stations (ENV002, ENV004, ENV030, ENV079 and ENV080), with proportions ranging from 26.97% to 77.54% of the total individuals. At station ENV002 within the Morven North Boundary, Echinodermata accounted for the largest proportion of individuals, with 31.67% within this taxon. At ENV030 within the Morven North Boundary, Arthropoda accounted for the largest proportion of individuals, with 31.45% within this taxon. At stations ENV004, ENV079 and ENV080, Mollusca comprised the highest proportion of individuals, accounting for 38.20% to 47.02% of individuals at these stations. The station ENV102 had an equal proportion (40.61%) of both Mollusca and Annelida.

5.2.1.11 In terms of biomass, Echinodermata accounted for most of the mass recorded (48.77%) across all stations, with Mollusca accounting for the second highest biomass (36.09%) across all stations. At the station with the highest biomass (ENV025), Echinodermata accounted for 95.33% of the biomass, due to the presence of relatively high numbers of the common heart urchin *Echinocardium cordatum*. The stations with the next two highest biomass totals (ENV017 and ENV043) were also dominated by this species.

5.2.1.12 The most abundant taxon by far was the polychaete *Spiophanes bombyx,* with a total of 5,958 individuals recorded. These individuals were distributed at every station throughout the Morven North Benthic Subtidal Ecology Study Area, with the stations ENV054 and ENV079 having the lowest numbers of individuals (3 and 5, respectively). The highest number of individuals of this species occurred at ENV022 in the centre of the Survey Area, with 279 individuals recorded.

5.2.1.13 The species with the second highest abundance was the polychaete *Scoloplos armiger* with 1,408 individuals. These individuals were widely distributed across the Morven North Benthic Subtidal Ecology Study Area, with no single station skewing the abundance. The highest abundance of S. armiger occurred at station ENV055 in the northeast corner of the Morven North Benthic Subtidal Ecology Study Area, with 61 individuals recorded.

5.2.1.14 The highest number of individuals at a single station was 466 individuals across 54 taxa at ENV086. The highest number of taxa (67) was found at both ENV099 and ENV022. The lowest number of taxa was 33 at ENV080, and the lowest number of individuals was 85 also at ENV080.

Morven South Benthic Subtidal Ecology Study Area

5.2.1.15 A total of 215 taxa were recorded across samples within the Morven South Benthic Subtidal Ecology Study Area. Those taxa only recorded as present (colonial taxa and taxa whose abundance was not enumerated due to processing protocols or because only fragments of individuals were found) were removed from the numerical and statistical analyses (Section

5.2). The processing of samples included 0.5mm and 1mm sieves for each sample, to provide more detail on the distribution of organism sizes. This analysis showed an approximately equal distribution of number of taxa between the 0.5mm and 1mm fractions.

5.2.1.16 A total of 17,357 individuals were recorded across the Morven South Benthic Subtidal Ecology Study Area. Of these, juveniles accounted for 378 individuals from taxa, representing 2.18% of the total number of individuals and 4.19% of the total number of taxa recorded. Juveniles were recorded at stations across the Morven South Benthic Subtidal Ecology Study Area from the phyla Mollusca, Echinodermata, Arthropoda and Annelida. The five most abundant juvenile taxa were the echinoderms Spatangoida, annelid Aphroditidae and the molluscs *L. borealis*, *A. islandica* and Acanthocardia. Juveniles of these five taxa comprised 97.62% of the total number of juvenile individuals. Seventeen juvenile ocean quahog were identified across the Morven South Benthic Subtidal Ecology Study Area.

5.2.1.17 Of the 215 taxa enumerated from the site specific survey data, three (*S. bombyx, S. armiger* and Thracioidea) were observed at all stations. A total of 46 taxa (21.40%) were recorded as single individuals; these rarely recorded taxa were distributed across the Morven South Benthic Subtidal Ecology Study Area. A total of 148 taxa (68.84%) were represented by fewer than 10 individuals. It is generally accepted that ecological communities which are frequently subjected to local disturbance or contamination events will be dominated by a limited number of tolerant taxa, which will be represented in high individual abundances (Clarke *et al.,* 2014). The relatively high numbers of single and low abundance taxa suggest a reasonably diverse community that has been subjected to relatively limited disturbance or contamination.

5.2.1.18 Station ENV006 in the Morven South Benthic Subtidal Ecology Study Area recorded the highest number of juvenile individuals (38, mainly Spatangoida), while four stations (ENV09, ENV014, ENV028, ENV062 and ENV089) had four juvenile taxa each. The juveniles were excluded in the statistical analysis due to the very high similarity between the datasets including and excluding them (Rho=0.99, significance=0.1%).

5.2.1.19 Station ENV086 (located within the Morven South Boundary) recorded the highest number of colonial or encrusting taxa, with five taxa. A range of colonial or encrusting taxa including *E. monostachys*, *A. diaphanum*, and Leptothecata were present at this station.

5.2.1.20 Initially, the enumerated dataset was divided into the five major taxonomic groups: Annelida (Polychaeta), Arthropoda, Mollusca, Echinodermata and “Other”. The “Other” group was comprised of Cnidaria, Hemichordata, Nemertea, Phoronis and Platyhelminthes.

5.2.1.21 The absolute and proportional contributions of these five taxonomic groups to the overall community structure is summarised in Table 5.3. The faunal communities were generally dominated by Annelida (Polychaeta) (n=10,070), which contributed 58.02% of the total numbers of individuals followed by Mollusca (n=3,830) and Arthropoda (n=1,560), which contributed 22.07% and 8.99% of the total number of individuals, respectively. Annelida were the most diverse group as well as the most abundant, accounting for 41.40% of the total number of taxa.

Table 5.3: Contribution of gross taxonomic groups recorded in the infaunal grab samples within the Morven South Benthic Subtidal Ecology Study Area

Group	Individual abundance	Proportional contribution (%)	No. taxa	Proportional contribution (%)
Annelida (Polychaeta)	10,070	58.02	89	41.40
Arthropoda	1,560	8.99	53	24.65
Mollusca	3,830	22.07	54	25.12
Echinodermata	1,367	7.88	11	5.12
Other	530	3.05	10	4.65

5.2.1.22 At individual stations, gross taxonomic group proportions reflected these results, with Annelida comprising the highest proportion and highest number individuals of the taxa at all but four stations (ENV028, ENV061, ENV079 and ENV080), with proportions ranging from 17.54% to 76.79% of the total individuals. At stations ENV028, ENV061, ENV079 and ENV080, Mollusca comprised the highest proportion of individuals, accounting for 37.90% to 47.02% of individuals at these stations. The station ENV102 had an equal proportion (40.61%) of both Mollusca and Annelida.

5.2.1.23 In terms of biomass, Echinodermata accounted for most of the mass recorded (49.57%) across all stations, with Mollusca accounting for the second highest biomass (36.68%) across all stations. At the station with the highest biomass (ENV025), Echinodermata accounted for 95.39% of the biomass, due to the presence of relatively high numbers of the common heart urchin *Echinocardium cordatum*. The stations with the next two highest biomass totals (ENV027 and ENV077) were also dominated by this species.

5.2.1.24 The most abundant taxon by far was the polychaete *S. bombyx*, with a total of 5,610 individuals recorded. These individuals were distributed at every station throughout the Morven South Benthic Subtidal Ecology Study Area, with the stations ENV061 and ENV079 having the lowest numbers of individuals (8 and 5, respectively). The highest number of individuals of this species occurred at ENV022, with 279 individuals recorded.

5.2.1.25 The species with the second highest abundance was the polychaete *S. armiger* with 1,138 individuals. These individuals were widely distributed across the Morven South Benthic Subtidal Ecology Study Area, with no single station skewing the abundance. The highest abundance of S. armiger occurred at station ENV077 in the northwest of the Morven South Benthic Subtidal Ecology Study Area, with 59 individuals recorded.

5.2.1.26 The highest number of individuals at a single station was 547 individuals across 60 taxa at ENV014. The highest number of taxa (78) was found at ENV077 and the second highest number of taxa (76) was recorded at ENV099. The lowest number of taxa was 34 at ENV080, and the lowest number of individuals was 85 also at ENV080.

5.2.2 Multivariate Community Analysis

Survey Area

5.2.2.1 The following multivariate statistics were calculated for the Survey Area and are equally relevant to both the Morven North Benthic Subtidal Ecology Study Area the Morven South Benthic Subtidal Ecology Study Area.

5.2.2.2 The results of the CULSTER analysis, SIMPROF tests and SIMPER analyses were used, together with the raw untransformed infaunal data, to assign infaunal biotopes to each station. In several instances, clusters that were identified as significantly different from each other in SIMPROF tests were assigned the same biotope code. This was based on a review of the SIMPER results, which indicated that the differences between the groups could be explained by differences in abundances of characterising species rather than the presence or absence of key species.

5.2.2.3 The results of the hierarchical clusters analysis of the square root transformed infaunal dataset together with the SIMPROF test identified 16 faunal groups that were statistically dissimilar (Figure 5.3). Of these faunal groups, station ENV054 was a clear outlier (located in the north of the Morven North Benthic Subtidal Ecology Study Area), as shown in the two dimensional MDS plot (Figure 5.4). The stress value for the MDS plot (0.24) indicates that this is a relatively good representation of the data but should be treated with caution. The three-dimensional MDS plot has not been presented as the two dimensional MDS plot presents a clearer representation of the data.

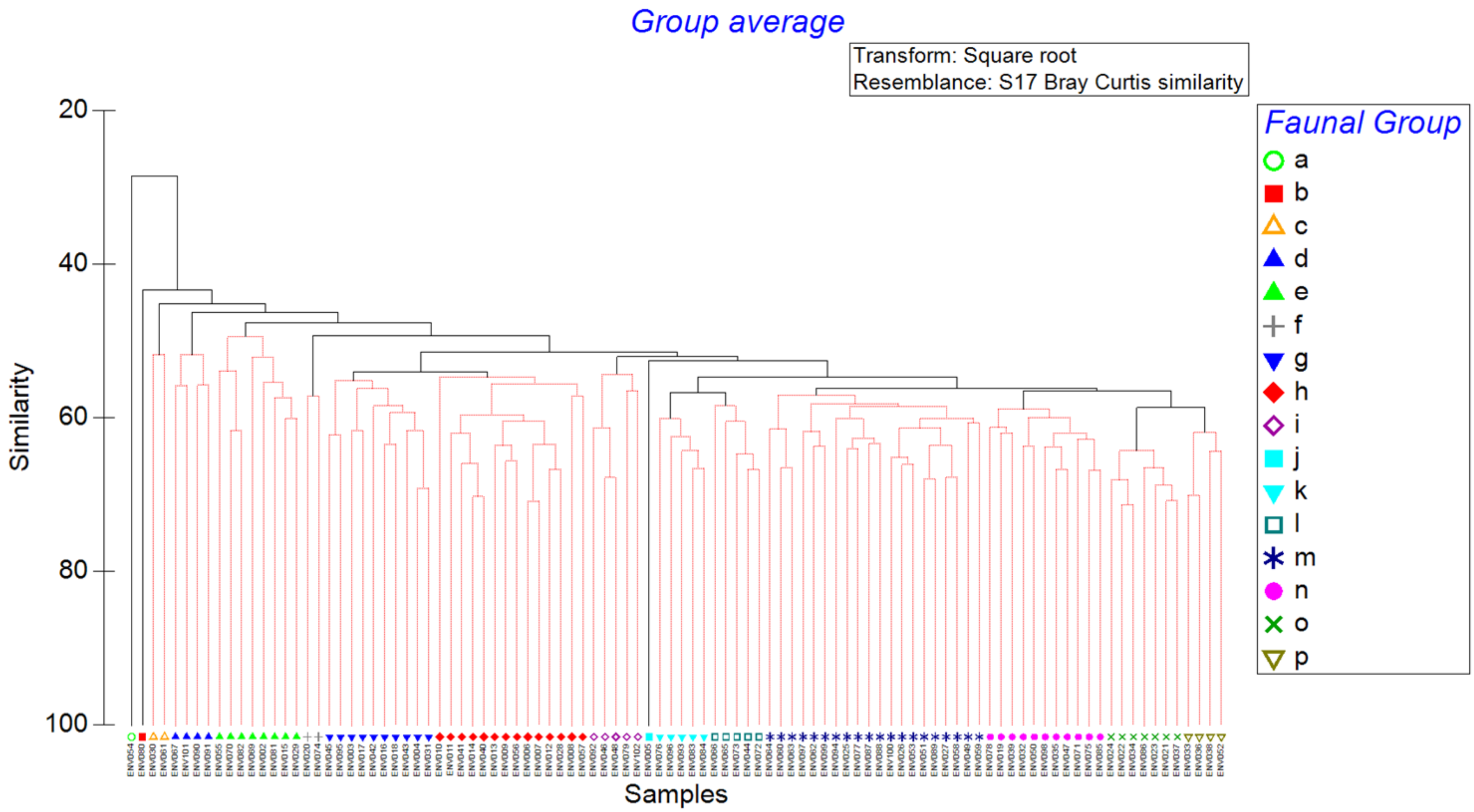

Figure 5.3: Dendrogram of Faunal Groups from benthic subtidal grab sample for the survey area

Morven North Benthic Subtidal Ecology Study Area

5.2.2.4 Samples located throughout the Morven North Benthic Subtidal Ecology Study Area in faunal groups C, D, E, F, G, J, L, N, O and P (Figure 5.4), were characterised by fine to medium sand and slightly gravelly sand sediment. These faunal groups were also characterised by relatively abundant bivalve and amphipod species, alongside a wide range of polychaete species, in most cases dominated by *S. bombyx* and *S. armiger*. These faunal groups were clustered together and classified as the *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) biotope (Figure 5.3, Table 5.4) The majority of stations in the Morven North Benthic Subtidal Ecology Study Area were classified as this biotope (Table 5.4).

5.2.2.5 Samples broadly along the southeastern edge of the Morven North Benthic Subtidal Ecology Study Area, as well as some stations in the southwestern edge of the Morven North Boundary, were clustered together in faunal groups B, H and I, and these were generally associated with mostly sandy sediments with a small number of stations with some slightly gravelly sand sediments and the presence of *E. pusillus* in almost all stations alongside a range of Abra species and diverse polychaete communities. The relative abundances of the echinoderms *E. pusillus* and *O. borealis* compared to the polychaete species allowed these faunal groups to be classified as the *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri) biotope (Figure 5.3, Table 5.4). There were 11 Shared Sampling Locations and only 1 station solely in the Morven North Benthic Subtidal Ecology Study Area classified as this biotope (Table 5.4).

5.2.2.6 Samples predominantly within the south of the Morven North Benthic Subtidal Ecology Study Area were clustered together in faunal groups K and M and were associated with muddy sand and sand in most cases. These stations were typically dominated by a diverse range of polychaete species including *S. bombyx, S. armiger, S. kroyeri* and *Lanice conchilega*. However, the relative abundances of these species compared to abundances of amphipod and bivalve species present did not match any specific biotope. Therefore, these faunal groups were classified as the higher level circalittoral fine sand (SS.SSa.CFiSa), which more broadly matched the species and sediment present at these stations (Figure 5.3, Table 5.4). There were 10 Shared Sampling Locations and 4 stations solely in the Morven North Benthic Subtidal Ecology Study Area classified as this biotope (Table 5.4).

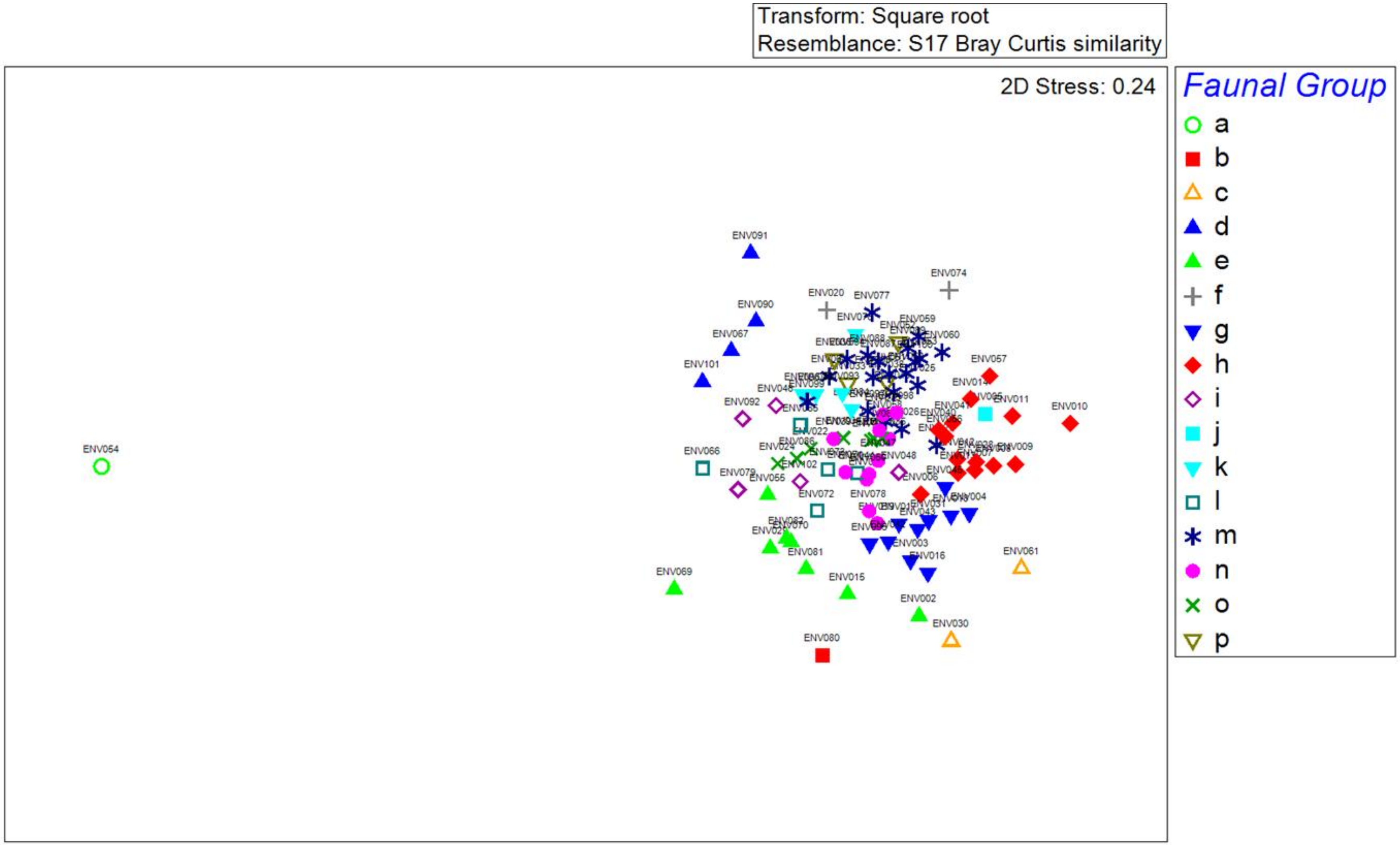

Figure 5.4: Two dimensional Multi-Dimensional Scaling plot of faunal groups from benthic subtidal grab samples for the Survey Area, including outlier ENV054

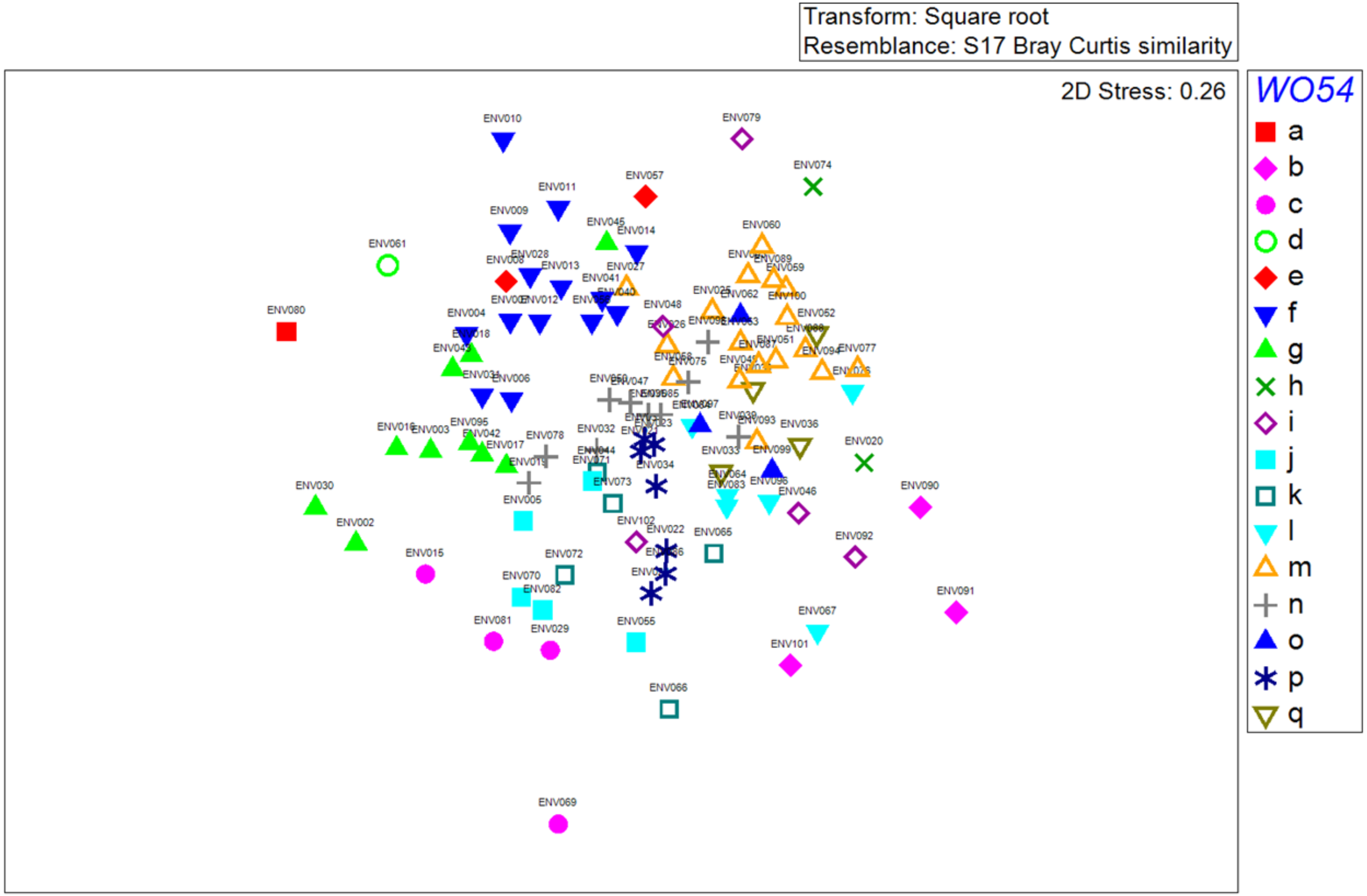

Figure 5.5: Two dimensional Multi-Dimensional Scaling plot of faunal groups from benthic subtidal grab samples for the Survey Area, excluding ENV054

5.2.2.7 One station of note was ENV054 (Figure 5.4), which differed significantly from all other groups in terms of species presence and abundance. This station was located in the northern corner of the Morven North Benthic Subtidal Ecology Study Area, at the edge of the ZoI, and was significantly different due to the very low abundance (up to two orders of magnitude lower) of *S. bombyx* compared to nearby stations, and also the lack of *S. armiger*. The species composition at this station broadly matched with the polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) biotope.

5.2.2.8 To examine the size of the impact of this one outlier station, the analyses were run including this station (Figure 5.4) and excluding this station (Figure 5.5). This showed that the size of the impact was minor overall, with no other groups changing. As discussed in the metal contamination analysis in paragraph 5.1.2.6, this station (ENV054) was found to be the only station which exceeded the arsenic Marine Scotland AL1 and CSQG TEL thresholds, indicating a potential cause for the low diversity found at this station.

Morven South Benthic Subtidal Ecology Study Area

5.2.2.9 Samples located throughout the Morven South Benthic Subtidal Ecology Study Area in faunal groups C, F, N, O and P (Figure 5.4) were characterised by fine to medium sand and slightly gravelly sand sediment. These faunal groups were also characterised by relatively abundant bivalve and amphipod species, alongside a wide range of polychaete species, in most cases dominated by S. bombyx and S. armiger. These faunal groups were clustered together and classified as the *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) biotope (Figure 5.3, Table 5.4). There were 17 Shared Sampling Locations and 3 stations solely in the Morven South Benthic Subtidal Ecology Study Area classified as this biotope (Table 5.4).

5.2.2.10 Samples broadly along the eastern and southern edges of the Morven South Boundary were clustered together in faunal groups B, H and I, and these were generally associated with mostly sandy sediments with a small number of stations with some slightly gravelly sand sediments. I pea urchin E. pusillus was present at almost all stations, alongside a range of Abra species and diverse polychaete communities. The relative abundances of the echinoderms E. pusillus and O. borealis compared to the polychaete species allowed these faunal groups to be classified as the *Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri) biotope (Figure 5.3, Table 5.4). There were 11 Shared Sampling Locations and 7 stations solely in the Morven South Benthic Subtidal Ecology Study Area classified as this biotope (Table 5.4).

5.2.2.11 Samples located throughout the Morven South Benthic Subtidal Ecology Study Area in faunal groups K and M were associated with muddy sand and sand sediments in most cases. These stations were typically dominated by a diverse range of polychaete species including *S. bombyx, S. armiger, S. kroyeri* and *L. conchilega*. However, the relative abundances of these species compared to abundances of amphipod and bivalve species present did not match any specific biotope. Therefore, these faunal groups were classified as the higher level circalittoral fine sand (SS.SSa.CFiSa), which more broadly matched the species and sediment present at these stations (Figure 5.3, Table 5.4). There were 10 Shared Sampling Locations and 11 stations solely in the Morven South Benthic Subtidal Ecology Study Area classified as this biotope (Table 5.4).

Table 5.4: Summary of infaunal biotopes identified from grab samples for the survey area

Preliminary infaunal biotope	Stations in Morven North Benthic Subtidal Ecology Study Area	Stations in Morven South Benthic Subtidal Ecology Study Area	Shared sampling locations	Water depth range (m)	Sediment classification	Characterising species	Geographic location
SS.SSa.CFiSa.ApriBatPo	ENV002, ENV003, ENV004, ENV005, ENV015, ENV016, ENV017, ENV018, ENV019, ENV029, ENV030, ENV031, ENV032, ENV033, ENV042, ENV043, ENV044, ENV045, ENV055, ENV065, ENV066, ENV067, ENV069, ENV070, ENV071, ENV072, ENV073, ENV074, ENV081, ENV082, ENV090, ENV091, ENV095, ENV101	ENV052, ENV061, ENV098	ENV020, ENV021, ENV022, ENV023, ENV024, ENV034, ENV035, ENV036, ENV037, ENV038, ENV039, ENV047, ENV050, ENV075, ENV078, ENV085, ENV086	65-75	Sand and muddy sand	*S. bombyx, S. armiger, Thracioidea, S. kroyeri, L. conchilega, Bathyporeia, Abra, B. elegans, O. affinis, Sipuncula, S. inflatum, Abra prismatica.*	Throughout the Survey Area.
SS.SSa.CFiSa	ENV064, ENV083, ENV084, ENV096	ENV026, ENV027, ENV053, ENV059, ENV060, ENV062, ENV088, ENV089, ENV094,	ENV025, ENV049, ENV051, ENV058, ENV063, ENV076, ENV077, ENV087, ENV093, ENV099	64-78	Sand and muddy sand, coarse sediments	*S. bombyx, S. armiger, Thracioidea, Abra, S. kroyeri, L. conchilega, E. pusillus, S. inflatum, Sipuncula*	South of the Morven North Benthic Subtidal Ecology Study Area and throughout the Morven South Benthic Subtidal Ecology Study Area.

Preliminary infaunal biotope	Stations in Morven North Benthic Subtidal Ecology Study Area	Stations in Morven South Benthic Subtidal Ecology Study Area	Shared sampling locations	Water depth range (m)	Sediment classification	Characterising species	Geographic location
		ENV097, ENV100					
SS.SSa.CFiSa.EpusOborApri	ENV046	ENV011, ENV012, ENV013, ENV014, ENV028, ENV040, ENV041	ENV006, ENV007, ENV008, ENV009, ENV010, ENV056, ENV057, ENV079, ENV080, ENV092, ENV102	67-82	Sand and muddy sand	*Abra* sp., *Thracioidea*, *S. bombyx*, *L. conchilega*, *S. armiger*, *O. affinis*, *E. tenuis*.	Southeastern edge and western edge of the Morven North Benthic Subtidal Ecology Study Area and eastern and southern areas of the Morven South Benthic Subtidal Ecology Study Area.
SS.SMx.OMx.PoVen	ENV054			64-65	Sand and muddy sand	*Sipuncula*, *Thracioidea*, *S. kroyeri*, *S. bombyx*	Northeast corner of Morven North Benthic Subtidal Ecology Study Area.

5.2.3 Univariate Analysis

Survey Area

5.2.3.1 The following univariate statistics were calculated for the Survey Area and are equally relevant to both the Morven North Benthic Subtidal Ecology Study Area the Morven South Benthic Subtidal Ecology Study Area

5.2.3.2 The following univariate statistics were calculated for each station across the Survey Area: number of species (S), abundance (N), wet mass in grams (g), Margalef's index of Richness (d), Pielou's Evenness index (J'), Shannon-Wiener Diversity index (H') and Simpson's index of Dominance (λ). The mean of each of these indices was then calculated for each of the biotopes identified from the infaunal data, and these are summarised in Table 5.5 with univariate statistics for individual sites presented in Appendix C.

5.2.3.3 The univariate statistics indicate that the SS.SSa.CFiSa biotope had the highest mean number of taxa (51.08±5.8), with the lowest mean number of taxa in the SS.SSa.CFiSa.EpusOborApri biotope (45.05±7.12). The SS.SMx.OMx.PoVen biotope was represented by one station (ENV054, in the north of the Morven North Benthic Subtidal Ecology Study Area) and was comprised of 52 taxa. The SS.SSa.CFiSa biotope also had the highest mean number of individuals (264.36±63.19). The biotope with the lowest number of individuals was SS.SMx.OMx.PoVen at station ENV054, with 122 individuals.

5.2.3.4 The SS.SMx.OMx.PoVen biotope at station ENV054 had the highest diversity indices (d=10.62, H'=3.66). The other biotopes were relatively similar for these metrics.

5.2.3.5 Pielou's evenness scores (J') and the Simpson's index of Dominance (λ) scores were similar across the biotopes represented by more than one station, with values of J' between 0.75 and 0.77, indicating an even distribution of abundances among taxa and that the biotopes were not dominated by a high number of individuals within a small number of species. Values for λ showed the same small range across these biotopes (0.87-0.89), which indicates that all the biotopes are represented by a relatively wide diversity of species. The mixed sediment biotope SS.SMx.OMx.PoVen at station ENV054 had higher values for these indices (J'=0.93, H'=0.97).

Table 5.5: Mean (± standard deviation) univariate statistics for the preliminary infaunal benthic biotopes for the Survey Area

Biotope	S	N	Biomass (g)	d	J'	H'	λ
SS.SMx. OMx.poVen	52	122	0.79	10.62	0.93	3.66	0.97
SS.SSa.CFiSa	51.08±5.8	264.36±63.19	5.48±7.81	9.02±0.93	0.76±0.06	2.97±0.25	0.88±0.05
SS.SSa.CFiSa. ApriBatPo	47.09±7.08	257.06±93.52	3.34±4.69	8.39±1.07	0.75±0.09	2.87±0.35	0.87±0.07
SS.SSa.CFiSa. EpusOborApri	45.05±7.12	261.35±104.44	2.45±2.45	8.00±0.90	0.77±0.06	2.91±0.21	0.89±0.04

5.2.3.6 Figure 5.6 to Figure 5.8 show the mean number of taxa, individuals, abundance and biomass for each of the major faunal groups (i.e. Annelida (Polychaeta), Crustacea, Mollusca, Echinodermata and Other) in each of the biotopes identified within the Survey Area.

5.2.3.7 As shown in Figure 5.6, the proportions of the number of taxa in each major taxonomic group were similar across the biotopes, which mirrored the patterns in the mean abundance and diversity indices, with Annelida (Polychaeta) and Mollusca comprising the highest proportion of taxa in all biotopes. All major taxonomic groups were represented in all biotopes.

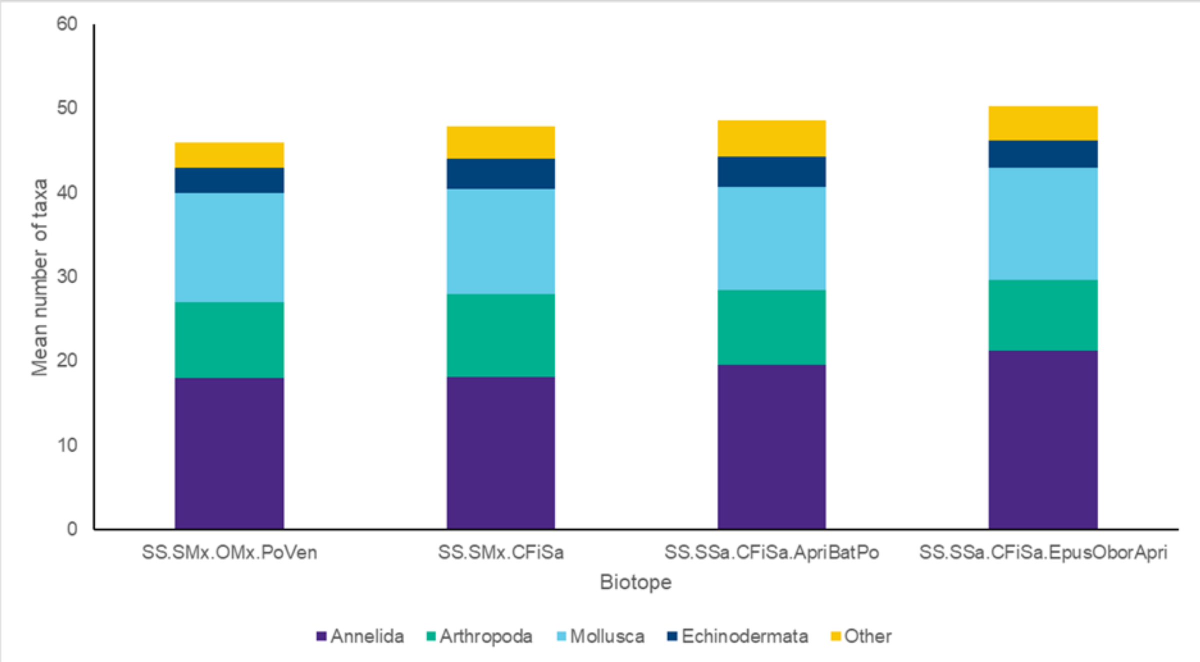

Figure 5.6: Mean abundance per taxa per taxonomic group for each infaunal biotope for the Survey Area

5.2.3.8 The distribution of numbers of individuals across the taxonomic groups within each biotope in the Survey Area is shown in Figure 5.7, with the biotopes represented by more than one station being relatively similar to each other for this measure. Specifically, the results indicated the presence of high numbers of Annelida (Polychaeta) in these biotopes, with Mollusca being the next most abundant group. A slight difference in distribution of individuals was noted in the EpusOborApri biotope with the Mollusca comprising a higher proportion of the overall community, and therefore Annelida (Polychaeta) being a smaller proportion, compared to the other biotopes. However, this slight decrease was not reflected in the number of taxa, with EpusOborApri having the highest number of Annelida taxa.

5.2.3.9 The SS.SMx.OMx.PoVen biotope (station ENV054) had a distinct distribution of individuals compared to the other biotopes, with overall numbers of individuals being approximately half of that found in other biotopes. This biotope recorded lower numbers of individuals across all taxonomic groups, except the “other” category which was highest in this biotope.

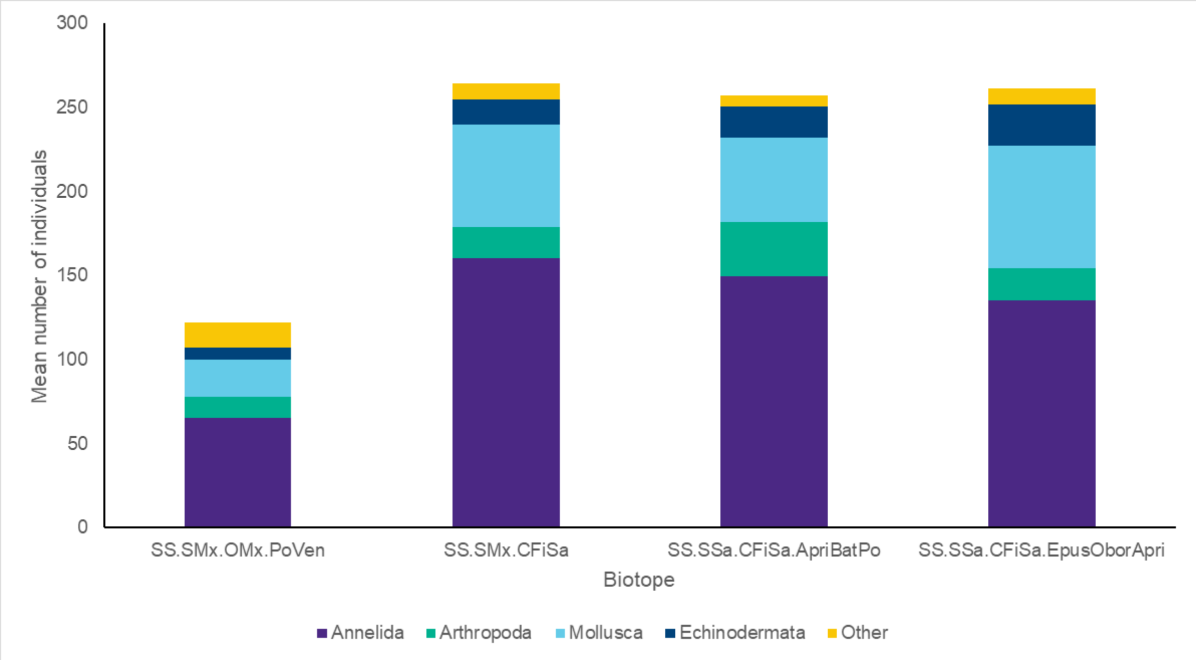

Figure 5.7: Mean abundance of individuals per taxonomic group for each infaunal biotope for the Survey Area

5.2.3.10 The mean biomass (g blotted wet weight) for the Survey Area is shown in Figure 5.8, and was highest in the SS.SMx.OMx.cFiSa biotope, with this biotope being dominated by Echinodermata. Specifically, this was due to the presence of two of the highest weights recorded of the common heart urchin E. cordatum at two stations (ENV025 within the Morven South Boundary and ENV064 in the west of the Morven North Benthic Subtidal Ecology Study Area) within this biotope. This high biomass was due to this individual species, as the pattern was not reflected in the mean abundance of Echinodermata taxa or individuals. The most significantly different biotope was SS.SMx.OMx.PoVen, which was represented by the ENV054 station only, with this biotope having the lowest total biomass overall and being dominated by Annelida, with very few other taxonomic groups providing any additional biomass.

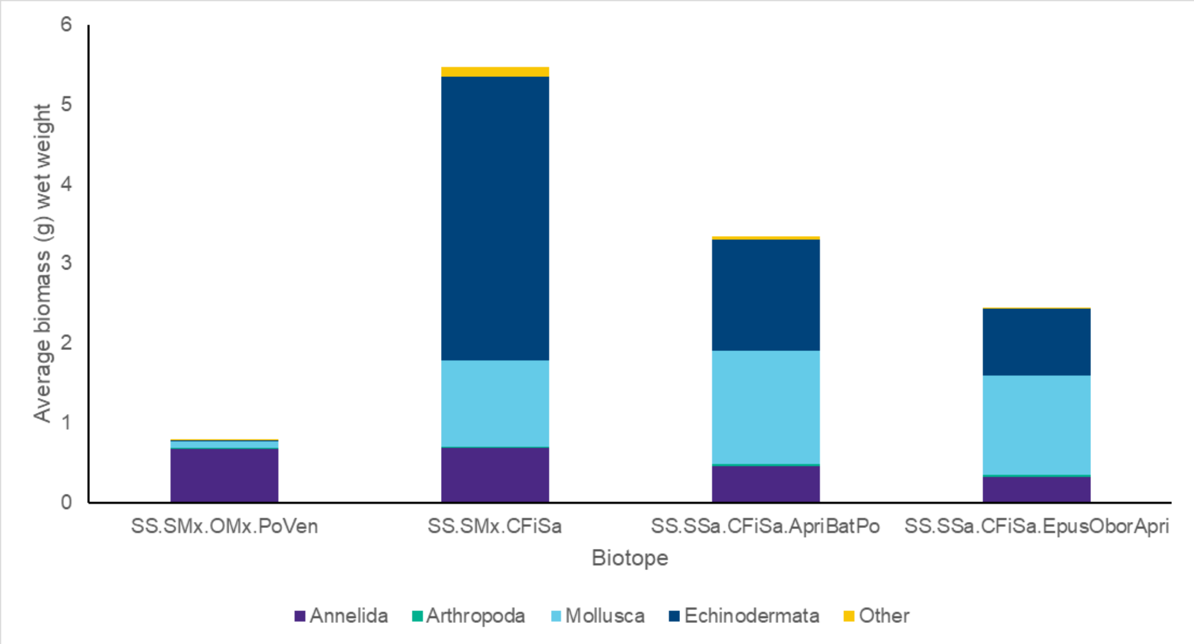

Figure 5.8: Mean biomass (g wet weight) per taxonomic group for each infaunal biotope for the Survey Area

5.2.3.11 A total of 28 taxonomic groups based on class were detected from the sediment infaunal eDNA analysis. Only 13 species of macrofauna were detected via eDNA, all of which were polychaetes. Of these, five were also recorded in the infaunal dataset. Four of the species detected via eDNA were also recorded at genus level in the infaunal dataset (Owenia fusiformis, Dipolydoraiardiai, Spio filicornis, Notomastus latericeus), and these are taxa with unresolved or challenging taxonomy, meaning the species level identifications from the eDNA analysis are not reliable. The remaining four species detected via DNA likely represent additional diversity not detected via the traditional analysis: Sphaerodoridium minutum, Amphicorina ascidicola, Apistobranchus typicus, Arenicola marina.

5.2.3.12 The eDNA results did not reveal any additional trends in diversity compared to the traditional morphological analysis. Full results are presented in Appendix E.

5.3 Results – Epifaunal Analysis

5.3.1 Seabed Imagery

Morven North Benthic Subtidal Ecology Study Area

5.3.1.1 The sediments recorded in the seabed imagery from the Morven North Benthic Subtidal Ecology Study Area largely comprised of circalittoral sandy mud and circalittoral fine sands with minor to moderate amounts of shell fragments (Figure 5.9 and Figure 5.10). Relatively few epifaunal species were recorded, with visible species typically dominated by annelids and molluscs. The most abundant fauna present was the broad group Animalia tube, which could not be further refined from the camera footage (Figure 5.10), followed by the bryozoan Flustridae, and the polychaete Ampharete falcata. The images in Figure 5.9 and Figure 5.10 were chosen as being broadly representative of the seabed type and fauna present across the Morven North Benthic Subtidal Ecology Study Area; most other images comprised largely featureless sand and mud habitats. The areas of increased shell fragments or gravel were associated with increased numbers of fauna including Serpulidae and faunal turfs. The DDV footage indicated the presence of the same species with the same distribution as the epifaunal component of the infaunal grab samples.

5.3.1.2 The 'scarce tube-dwelling anemone' Arachnanthus sarsi, which is listed as a PMF in Scottish offshore waters (Marine and Coastal Access Act, 2009a; JNCC, 2012) and is classified as "a rare mobile species in Scottish waters" on the Scottish Biodiversity List (2020), was observed at three stations. Three individuals were observed, one each at stations ENV031, ENV83 and ENV092 in the Morven North Benthic Subtidal Ecology Study Area.

Morven South Benthic Subtidal Ecology Study Area

5.3.1.3 The sediments recorded in the seabed imagery from the Morven South Benthic Subtidal Ecology Study Area largely comprised of circalittoral sandy mud and circalittoral fine sands with minor to moderate amounts of shell fragments (Figure 5.10). Relatively few epifaunal species were recorded, with visible species typically dominated by annelids and molluscs. The most abundant fauna present was the broad group Animalia tube, which could not be further refined from the camera footage (Figure 5.10), followed by the bryozoan Flustridae, and the polychaete Ampharete falcata. The image in Figure 5.10 was chosen as being broadly representative of the seabed type and fauna present across the Morven South Benthic Subtidal Ecology Study Area; most other images comprised largely featureless sand and mud habitats. The areas of increased shell fragments or gravel were associated with increased numbers of fauna including Serpulidae and faunal turfs. The DDV footage indicated the presence of the same species with the same distribution as the epifaunal component of the infaunal grab samples.

5.3.1.4 The "scarce tube-dwelling anemone" Arachnanthus sarsi was observed at one station. One individual was observed at station ENV011 in the Morven South Benthic Subtidal Ecology Study Area.

Figure 5.9: Circalittoral fine sand with moderate numbers of shell fragments at ENV030 (located within the Morven North Boundary)

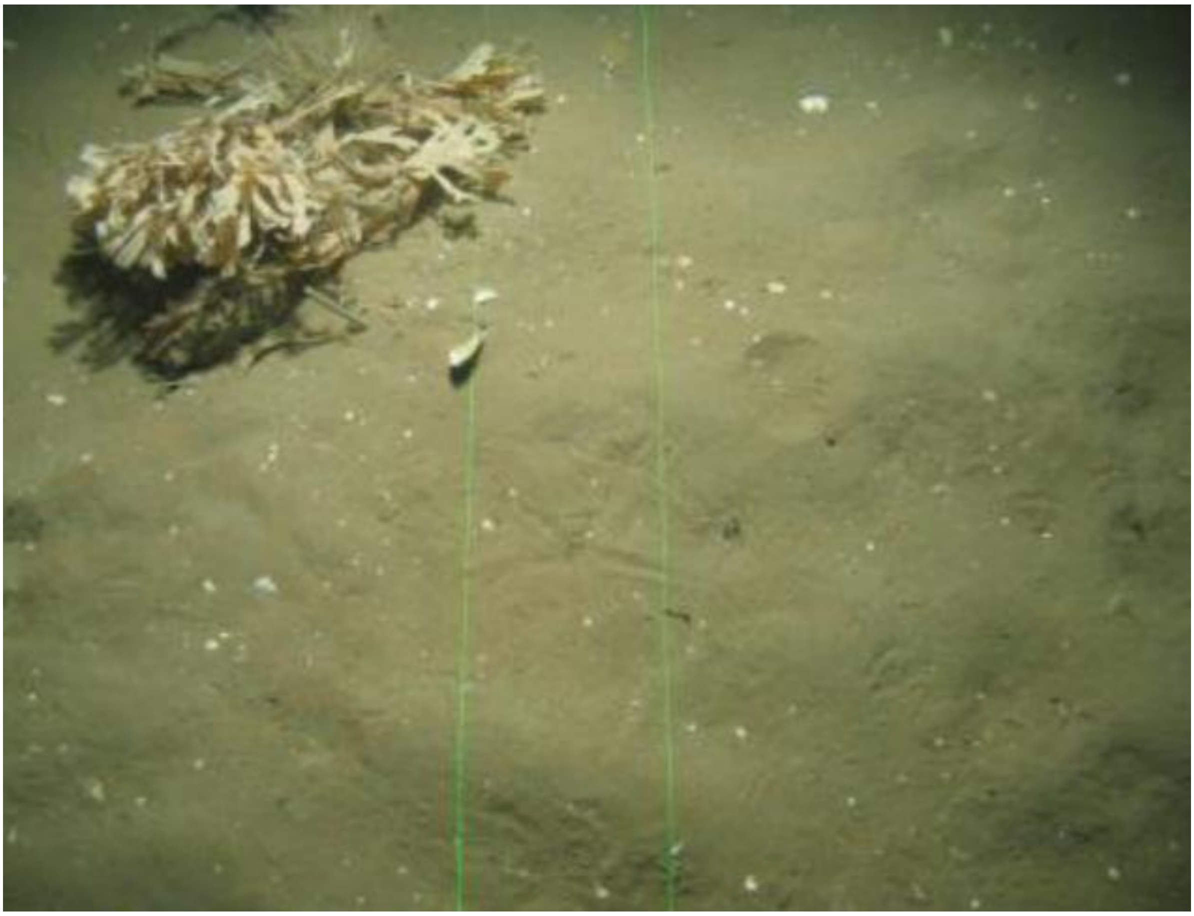

Figure 5.10: Circalittoral fine sand with animalia tubes at ENV036 (a Shared Sampling Location)

5.3.2 Summary statistics

Morven North Benthic Subtidal Ecology Study Area

5.3.2.1 A total of 109 taxa and one category of burrow was recorded from the 81 epifauna and DDV samples during the benthic survey in the Morven North Benthic Subtidal Ecology Study Area. Of the 109 taxa, Flustridae and Scaphopoda were recorded across the greatest number of stations. 71 taxa occurred at fewer than three stations. Station ENV092 and ENV66 (in the west of the Morven North Benthic Subtidal Ecology Study Area) recorded the highest number of epifaunal taxa (36 taxa), and ENV070 (in the northeast of the Morven North Boundary) recorded the highest number of individuals (203 individuals recorded).

Morven South Benthic Subtidal Ecology Study Area

5.3.2.2 A total of 105 taxa and one category of burrow was recorded from the 60 epifauna and DDV samples during the benthic survey in the Morven South Benthic Subtidal Ecology Study Area. Of the 105 taxa, Ampharete falcata and Flustridae were recorded across the greatest number of stations. 61 taxa occurred at fewer than three stations. Station ENV092 (in the north of the Morven South Benthic Subtidal Ecology Study Area) recorded the highest number of epifaunal taxa (37 taxa), and ENV057 (in the northeast of the Morven South Benthic Subtidal Ecology Study Area) recorded the highest number of individuals (156 individuals recorded).

5.3.3 Multivariate community analysis

5.3.3.1 The following multivariate statistics were calculated for the Survey Area and are equally relevant to both the Morven North Benthic Subtidal Ecology Study Area the Morven South Benthic Subtidal Ecology Study Area.

5.3.3.2 The results of the cluster analysis, SIMPROF text and SIMPER analysis were used, together with the raw untransformed data, to assign epifaunal biotopes to stations based on the combined DDV data and the epifaunal component of the grab samples (Table 5.6). All sample stations in the Survey Area have been included in this analysis. In several instances, clusters that were identified as significantly different from each other in the SIMPROF tests were assigned the same biotope code. This was based on a review of the SIMPER results which indicated that the differences between the faunal groups could be explained by differences in abundances of characterising species rather than the presence or absence of key species. Full results of the multivariate analysis are presented in Appendix D.

5.3.3.3 The results of the hierarchical cluster analysis of the square root transformed epifaunal dataset (Table 5.6), together with the SIMPROF test, identified fourteen faunal groups (Figure 5.11) which were statistically dissimilar. The two dimensional MDS plot is presented in Figure 5.12, and the stress value of 0.24 indicates that this is a relatively good representation of the data but should be treated with caution. The three-dimensional MDS plot has not been presented as the two dimensional MDS plot presents a clearer representation of the data.

5.3.3.4 The faunal groups were all largely homogenous in terms of epifauna present, with the abundant Flustridae, Scaphopoda, and Ampharete falcata not directly matching the descriptions of any specific biotopes. Therefore, faunal groups were grouped together based on their underlying sediments, giving rise to two distinct biotopes (Table 5.6).

5.3.3.5 Specifically, faunal groups B, C, D, E, F, G, H, I, J, K, L, M, and N were grouped together and classified as circalittoral muddy sand (SS.SSa.CMuSa) with these groups covering almost all of the Survey Area. These groups matched the expected depth and sediment type for this biotope, with some minor characterising species such as Paguroidea being present at these stations where they were not found in the other biotope.

5.3.3.6 The remaining faunal group A consisted of stations ENV054 and ENV101, which are both in the north of the Morven North Benthic Subtidal Ecology Study Area. These stations were grouped together based on the presence and abundances of Serpulidae, Tubularia indivisa, and Porifera indet. in proportions not observed in other faunal groups. However, the low Bray Curtis similarity of 41.69% within this faunal group and the difference in underlying sediments (ENV054 has coarse sediments, while ENV101 is characterised by slightly gravelly muddy sand), suggest these sites can be classified as different biotopes. Therefore, ENV101 is grouped alongside all other faunal groups as SS.SSa.CMuSa, while ENV054 is classified as offshore circalittoral mixed sediment (SS.SMx.OMx).

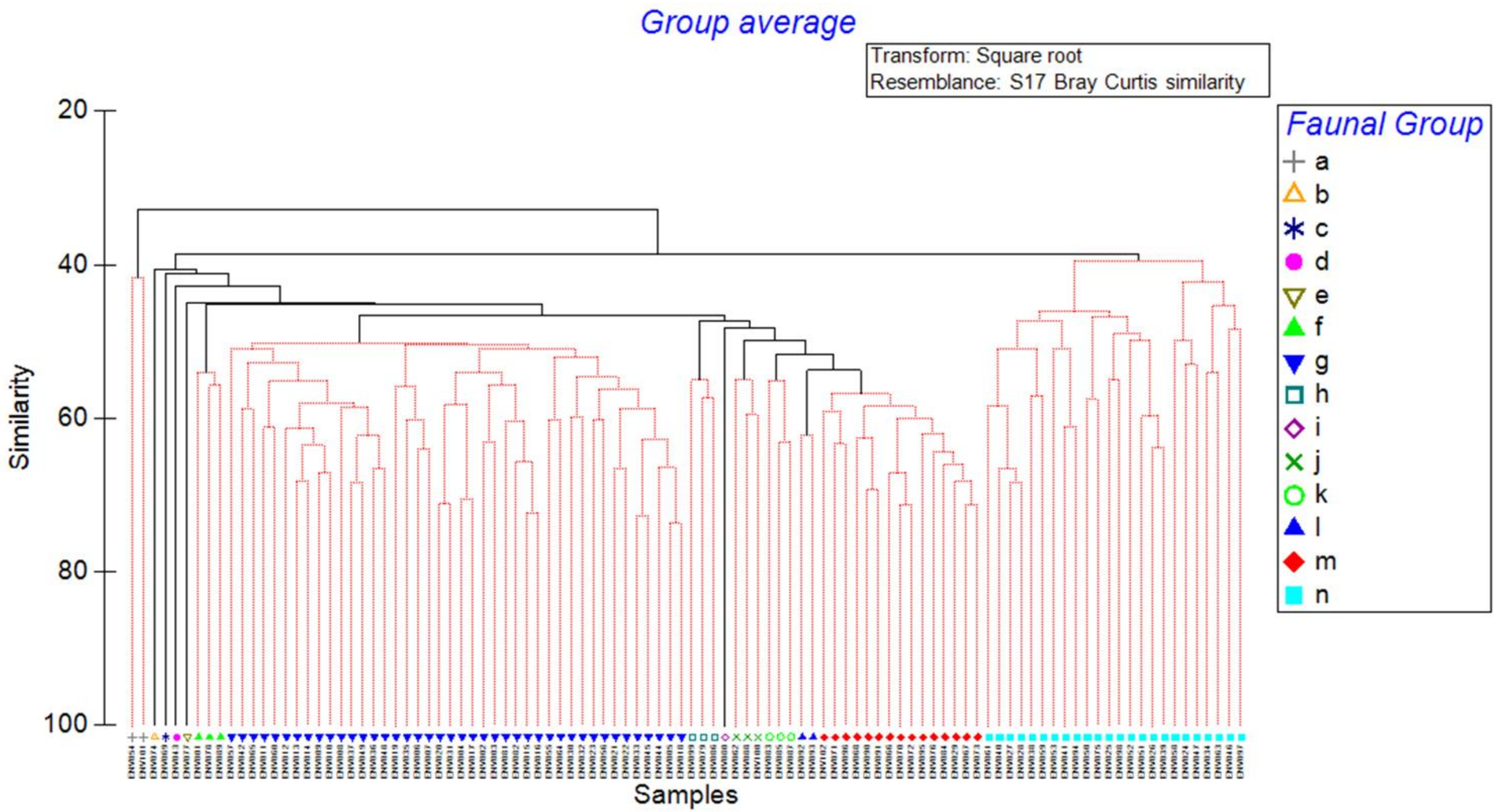

Figure 5.11: Dendrogram of epifaunal communities (from drop down video and epifaunal component of grab data) for the survey area

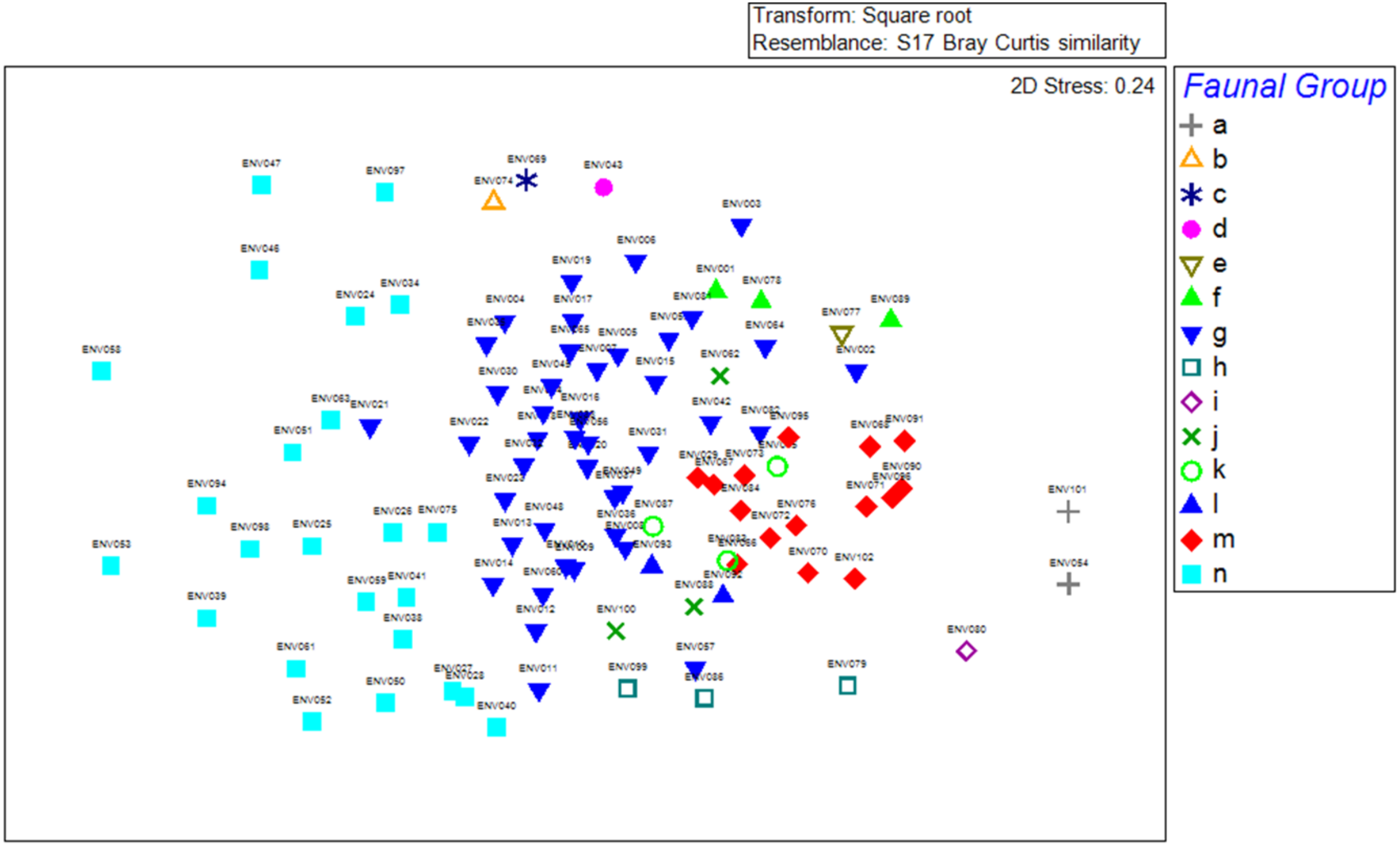

Figure 5.12: Two dimensional Multi-Dimensional Scaling plot of epifaunal communities (from drop down video and epifaunal component of grab data) for the Survey Area

Table 5.6: Summary of preliminary epifaunal biotopes identified from the site specific survey for the Survey Area

Preliminary infaunal biotope	Stations in Morven North Benthic Subtidal Ecology Study Area	Stations in Morven South Benthic Subtidal Ecology Study Area	Shared sampling locations	Water depth range (m)	Sediment classification	Characterising species	Geographic location
SS.SMx.OMx	ENV054, ENV101			64-65	Coarse sediments	Flustridae, Serpulidae., Faunal turf	North of the Morven North Benthic Subtidal Ecology Study Area.
SS.SSa.CMuSa	ENV001, ENV002, ENV003, ENV004, ENV005, ENV015, ENV016, ENV017, ENV018, ENV019, ENV029, ENV030, ENV031, ENV032, ENV033, ENV042, ENV043, ENV044, ENV045, ENV046, ENV055, ENV064,	ENV011, ENV012, ENV013, ENV014, ENV026, ENV027, ENV028, ENV040, ENV041, ENV052, ENV053, ENV059, ENV060, ENV061, ENV062, ENV088, ENV089, ENV094, ENV097, ENV098, ENV100	ENV006, ENV007, ENV008, ENV009, ENV010, ENV020, ENV021, ENV022, ENV023, ENV024, ENV025, ENV034, ENV035, ENV036, ENV037, ENV038, ENV039, ENV047, ENV048, ENV049, ENV050, ENV051,	62-82	Sand and muddy sand	Animalia tube, Flustridae, Scaphopoda, Faunal turf, Paguroidea, Alcyonium digitatum, Serpulidae	Across the Survey Area.

Preliminary infaunal biotope	Stations in Morven North Benthic Subtidal Ecology Study Area	Stations in Morven South Benthic Subtidal Ecology Study Area	Shared sampling locations	Water depth range (m)	Sediment classification	Characterising species	Geographic location
	ENV065, ENV066, ENV067, ENV068, ENV069, ENV070, ENV071, ENV072, ENV073, ENV074, ENV081, ENV082, ENV083, ENV084, ENV090, ENV091, ENV095, ENV096		ENV056, ENV057, ENV058, ENV063, ENV075, ENV076, ENV077, ENV078, ENV079, ENV080, ENV085, ENV086, ENV087, ENV092, ENV093, ENV099, ENV102				

5.3.4 Univariate analysis

5.3.4.1 The following univariate statistics were calculated for the Survey Area and are equally relevant to both the Morven North Benthic Subtidal Ecology Study Area the Morven South Benthic Subtidal Ecology Study Area.

5.3.4.2 The following univariate statistics were calculated for the combined epibenthic dataset (i.e. epibenthic components of the grabs and DDV data) for each station: number of species (S), abundance (N), Margalef's index of Richness (d), Pielou's Evenness index (J'), Shannon-Wiener Diversity index (H') and Simpson's index of Dominance (λ). The mean of each of these indices was then calculated for each of the biotopes identified from the epifaunal data and these are summarised in Table 5.7.

5.3.4.3 The biotope SS.SMx.OMx was represented by only one station, ENV054 in the north of the Morven North Benthic Subtidal Ecology Study Area. This biotope had the highest number of taxa (31), individuals (57), and the highest diversity scores (d=7.43, H'=3.2), although as this was only one station these results should be treated with caution. The relatively high number of individuals associated with this biotope were due to high abundances of Serpulidae (45) and Flustridae (25) which utilise the mixed and coarser substrates for attachment to the sediment.

5.3.4.4 The biotope SS.SSa.CMuSa was observed at all other stations, with this more homogenous sandy biotope having lower numbers of taxa and individuals than the SS.SMx.OMx biotope. The SS.SSa.CMuSa biotope had slightly lower diversity indices (d=6.5, H'=3.04), as expected from sediments with finer sediment, due to a lower number of sites for organism attachment.

5.3.4.5 Pielou's evenness (J') scores showed limited variation between the biotopes, with a value of 0.93 in the SS.SMx.OMx biotope and 0.96 in the SS.SSa.CMuSa biotope, and this was expected due to relatively similar levels of abundance within the two biotopes. The Simpson's index of Dominance (λ) also showed similar values, indicating the biotopes have a relatively similar number of species, although fewer were recorded in the SS.SMx.OMx biotope.

Table 5.7: Mean (± standard deviation) univariate statistics for epifaunal biotopes (from drop down video and grab data) for the Survey Area

Biotope	S	N	d	J'	H'	λ
SS.SMx.OMx	31	57	7.43	0.93	3.2	0.96
SS.SSa.CMuSa	24.64±6.75	37.63±11.89	6.5±1.35	0.96±0.01	3.04±0.3	0.97±0.02

5.4 Results – Habitats Assessments

5.4.1 Seapen and Burrowing Megafauna Communities

Morven North Benthic Subtidal Ecology Study Area

5.4.1.1 Seabed imagery and DDV analysis revealed that seapens were present at one station within the Morven North Benthic Subtidal Ecology Study Area (ENV074) where one seapen was observed, and at two Shared Sampling Locations (ENV21 and ENV39). Burrows were present at one station in the Morven North Benthic Subtidal Ecology Study Area (ENV083) and seven Shared Sampling Locations (ENV008, ENV036, ENV037, ENV048, ENV049, ENV063 and ENV102). Therefore, a detailed assessment of the "seapen and burrowing megafauna communities" habitat as defined by OSPAR (2010) was conducted.

5.4.1.2 The density of observed burrows ranged from 0.002 burrows per m^2 at station ENV008, to 0.006 burrows per m^2 at stations ENV048, ENV063 and ENV102. Burrows observed across the Morven North Benthic Subtidal Ecology Study Area were estimated to be between 0.3cm and 3.2cm in diameter. Based on the SACFOR abundance scale, observed burrow densities were classified as "rare" at all stations. Burrowing fauna were rarely sighted to confirm the inhabitants of the burrows, and therefore they could not confidently be attributed to any of the classified "megafauna" species within the "seapen and burrowing megafauna community" habitat classification.

5.4.1.3 Seapen density ranged from 0.005 individuals per m^2 at stations ENV021 and ENV074 to 0.006 individuals per m^2 at station ENV039. Observed specimens were measured and found to be between 0.5cm and 3.8cm in height. The resulting SACFOR scores were "rare" for all stations in the Morven North Benthic Subtidal Ecology Study Area.

5.4.1.4 The JNCC (2014b) report states that to be considered a "seapen and burrowing megafauna community" habitat, densities of burrows or mounds, together with seapens if present, should be classified as at least "frequent" or above on the SACFOR scale. Both seapens and burrows were classified as rare. Therefore, no stations showed resemblance to the "seapen and burrowing megafauna communities" habitat as defined by OSPAR (2010).

Morven South Benthic Subtidal Ecology Study Area

5.4.1.5 Seabed imagery and DDV analysis revealed that seapens were present at seven stations located in the Morven South Benthic Subtidal Ecology Study Area (ENV059, ENV060, ENV061, ENV062, ENV094, ENV097 and ENV098), and two Shared Sampling Location sites (ENV21 and ENV39). The highest abundances were recorded at stations ENV062, ENV097 and ENV098 (ENV097 shown in Figure 5.13). Burrows were present at five stations located in the Morven South Benthic Subtidal Ecology Study Area (ENV012, ENV027, ENV028, ENV040 and ENV094) and seven Shared Sampling Locations (ENV008, ENV036, ENV037, ENV048, ENV049, ENV063 and ENV102). Therefore, a detailed assessment of the "seapen and burrowing megafauna communities" habitat as defined by OSPAR (2010) was conducted.

5.4.1.6 The density of observed burrows ranged from 0.002 burrows per m^2 at station ENV008, to 0.006 burrows per m^2 at stations ENV048, ENV063, ENV094 and ENV102. Burrows observed across the Morven South Benthic Subtidal Ecology Study Area were estimated to be between 0.3cm and 3.2cm in diameter. Based on the SACFOR abundance scale, observed burrow densities were classified as "rare" at all stations. Burrowing fauna were rarely sighted to confirm the inhabitants of the burrows, and therefore they could not confidently be attributed to any of the classified "megafauna" species within the "seapen and burrowing megafauna community" habitat classification.

5.4.1.7 Seapen density ranged from 0.004 individuals per m^2 at station ENV060 to 0.107 individuals per m^2 at station ENV098. Observed specimens were measured and found to be between 0.5cm and 5.8cm in height. The resulting SACFOR scores were "rare to frequent" at station ENV062, "rare to occasional" at stations ENV097 and ENV098 (all of which are located solely within the Morven South Subtidal Ecology Study Area) and "rare" at the remaining seven stations where they were observed.

5.4.1.8 The JNCC (2014b) report states that to be considered a "seapen and burrowing megafauna community" habitat, densities of burrows or mounds, together with seapens if present, should be classified as at least "frequent" or above on the SACFOR scale. Both seapens and burrows were classified as rare, with only seapens at station ENV062 partially encompassing the "frequent" classification. Therefore, no stations showed resemblance to the "seapen and burrowing megafauna communities" habitat as defined by OSPAR (2010).

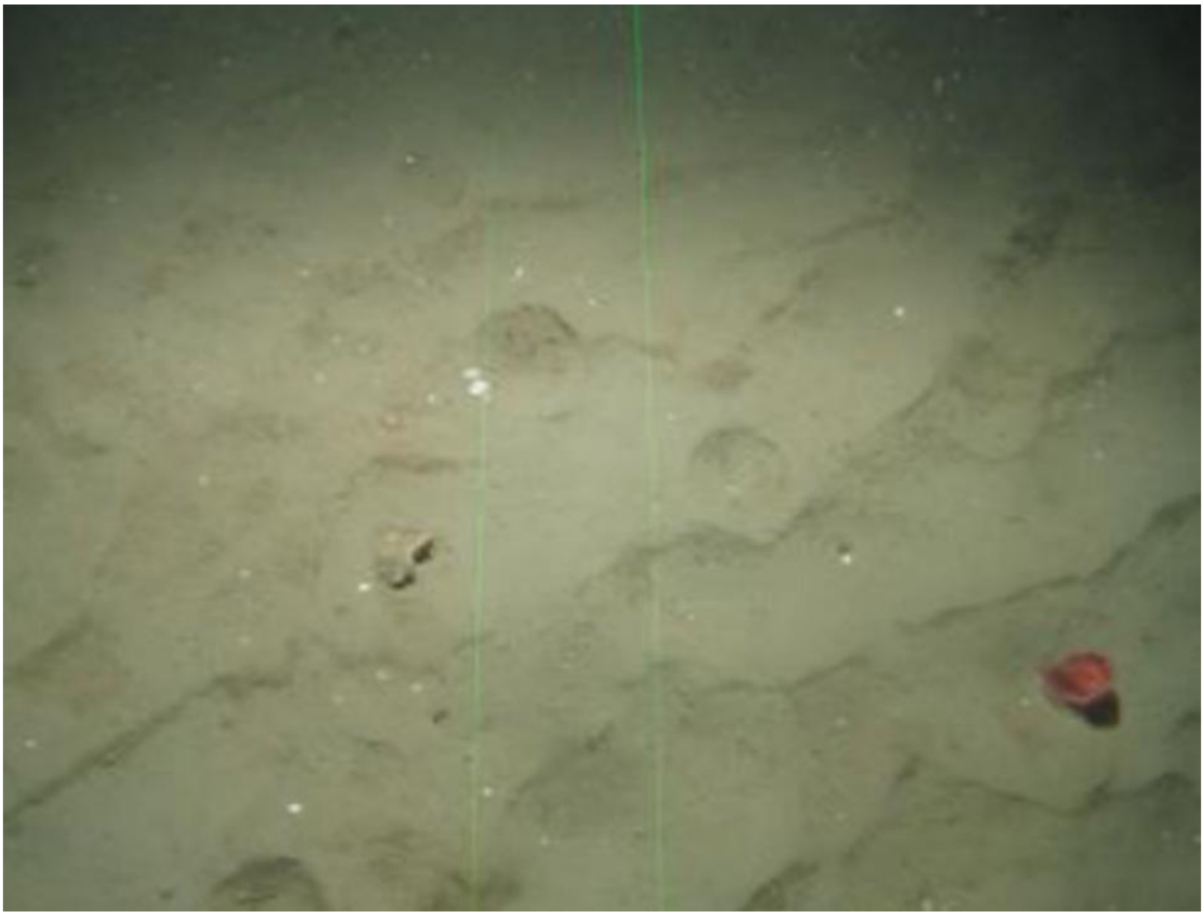

Figure 5.13: Examples of Pennatulacea seapens at station ENV097 (in the south of the Morven South Benthic Subtidal Ecology Study Area)

5.4.2 Biogenic Reefs – Sabellaria Spinulosa

Morven North Benthic Subtidal Ecology Study Area

5.4.2.1 *S. spinulosa* sand tube aggregations were observed in the form of Sabellaria "bommies" only on isolated cobbles and boulders at station ENV068, in the north of the Morven North Benthic Subtidal Ecology Study Area. The "reefiness" assessment contained a degree of subjectivity due to the sometimes cryptic nature of Sabellaria and the elevation of these potential reef structures being relatively difficult to distinguish from the elevation of the cobbles and boulders. The diversity and density of attached epifauna on these cobbles and boulders also made estimation of the percentage cover of the Sabellaria difficult and somewhat subjective, with some potential aggregations and reef structures being covered by Flustridae species.

5.4.2.2 Aggregations of Sabellaria were observed in 4 out of 45 photos at station ENV068 (Figure 5.14) with a maximum coverage of 21% and elevation of 13cm above seabed. Reviews of each 5m segment of video footage at this station confirmed that 18 of the 58 segments contained some evidence of S. spinulosa. Across each of these segments, the average presence of S. spinulosa accounted for <7% of the seabed area investigated.

5.4.2.3 Grab sampling at station ENV068 was abandoned following numerous failed attempts associated with the coarse sediments present, and S. spinulosa was not recovered in fauna samples from any other station across the survey area.

5.4.2.4 Due to the low area covered by Sabellaria tubes and aggregations; the features do not meet the required characteristics to be considered a reef based on the criteria adopted by Gubbay (2007).

Morven South Benthic Subtidal Ecology Study Area

5.4.2.5 *S. spinulosa* sand tube aggregations were not observed at any stations within the Morven South Benthic Subtidal Ecology Study Area.

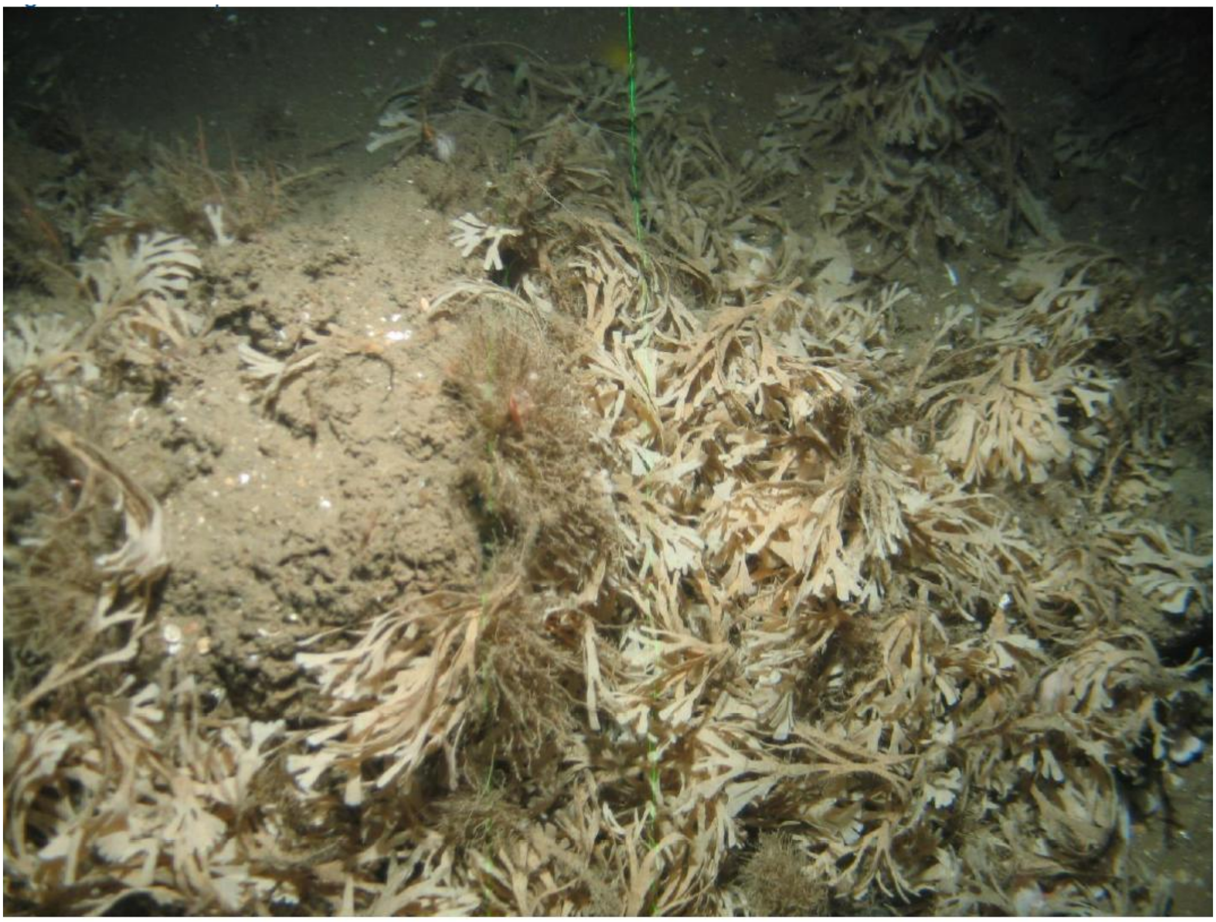

Figure 5.14: Example of Sabellaria occurrence at station ENV068 (in the north of the Morven North Benthic Subtidal Ecology Study Area)

5.4.3 Biogenic Reefs – Modiolus modiolus

Morven North Benthic Subtidal Ecology Study Area

5.4.3.1 Live common horse mussels M. modiolus were observed at 33 stations in the Morven North Benthic Subtidal Ecology Study Area, with an assessment of their resemblance to a biogenic reef habitat as defined by OSPAR (2009) therefore carried out.

5.4.3.2 Imagery and DDV footage analysis across the Morven North Benthic Subtidal Ecology Study Area identified a total of 96 common horse mussel individuals. The densities reached a maximum of 0.125 individuals m^{-2} at the Shared Sampling Location ENV079 (Figure 5.15).

These solitary individuals suggest a patchy distribution not consistent with the definition of a biogenic reef.

5.4.3.3 Therefore, no further assessment of elevation and biodiversity to determine reefiness was relevant, and their presence as solitary individuals throughout the survey area means they would not constitute a PMF or Annex I habitat (JNCC, 2012).

Morven South Benthic Subtidal Ecology Study Area

5.4.3.4 Live common horse mussels M. modiolus were observed at 21 stations in the Morven South Benthic Subtidal Ecology Study Area, with an assessment of their resemblance to a biogenic reef habitat as defined by OSPAR (2009) therefore carried out.

5.4.3.5 Imagery and DDV footage analysis across the Morven South Benthic Subtidal Ecology Study Area identified a total of 71 common horse mussel individuals. The densities reached a maximum of 0.125 individuals m^{-2} at Shared Sampling Location ENV079 (Figure 5.15). These solitary individuals suggest a patchy distribution not consistent with the definition of a biogenic reef.

5.4.3.6 Therefore, no further assessment of elevation and biodiversity to determine reefiness was relevant, and their presence as solitary individuals throughout the survey area means they would not constitute a PMF or Annex I habitat (JNCC, 2012).

Figure 5.15: Example of Modiolus modiolus at Shared Sampling Location ENV079

5.4.4 Rocky Reefs

Survey Area

5.4.4.1 Analysis of images and DDV footage was conducted to determine if features of interest had any resemblance to the rocky reef protected habitat, based on the criteria adopted by Irving (2009). This analysis was undertaken for stations across the Survey Area and is equally relevant to both the Morven North Benthic Subtidal Ecology Study Area the Morven South Benthic Subtidal Ecology Study Area.

5.4.4.2 Seabed imagery showed evidence of potential stony reef in the form of isolated cobbles or boulders or isolated patches of cobbles or scattered cobbles at 20 stations throughout the Survey Area. Most notably, at station ENV101 in the Morven North Benthic Subtidal Ecology Study Area (Figure 5.16), 37% of images (n=17) showed some evidence of cobbles or boulders, and within five of these images, the boulders covered between 10% to 24% of the image, indicating that these individual images presented a low resemblance to stony reef. However, looking at the composition of the station overall, cobbles and boulders accounted for <3% of the seabed investigated.

5.4.4.3 For completeness, each 5m segment of video footage from station ENV101 was reviewed for the presence of cobbles and boulders, which revealed that 48 of the 69 segments contained some evidence of cobbles or boulders. Most of these segments contained isolated cobbles.

Figure 5.16: Example of cobbles at station ENV101 (within the Morven North Benthic Subtidal Ecology Study Area)

5.4.4.4 Similarly, at station ENV72 in the Morven North Benthic Subtidal Ecology Study Area, 18% of images (n=10) showed some evidence of cobbles or boulders, and within four of these images, the boulders covered between 10% to 33% of the image, indicating that these individual images presented a low resemblance to stony reef (Figure 5.17). Evidence of this is further supported by the epifaunal coverage, which increased in areas of cobbles and boulders compared to the surrounding sandy area. Some examples of species known to be strong indicators of rocky reefs were observed, including *A. digitatum* and *Tubularia indivisa*. These species however were not limited to the areas of cobbles but were seen across all coarse and gravelly sediment types observed in the Survey Area.

5.4.4.5 To refine the criteria for defining areas with a "low resemblance" to Annex I stony reef, Golding *et. al.,* (2020) stated that to be regarded as having any resemblance to reef, a $25m^2$ area of seabed must be composed of at least 10% cobbles and boulders with the faunal community dominated by epifaunal species. Where an area only meets the criteria for low resemblance, a strong justification would be required to consider the area as Annex I stony reef.

5.4.4.6 All cobbles and boulders in DDV footage across the Survey Area were clearly matrix supported, with little relief overall and often comprising of small patchy extents across larger swaths of gravel or coarse shell-based material. Therefore, where images meeting one or more reef criteria were widely separated from each other, a station has been regarded as having no resemblance. Overall, based on this criterion, there was no resemblance to rocky reef at any stations within the Survey Area containing cobbles or boulders.

5.4.4.7 In terms of any potential rocky reef elsewhere, outside of individual sampling stations, the geophysical survey data from within the Morven North Boundary and Morven South Boundary were reviewed. A total of 32,424 boulders were identified across the $688km^2$ of SSS data acquired within the Morven North Boundary and Morven South Boundary, giving an approximate density of 47 boulders km-2 (0.001 boulders per $25m^2$). Based on the dimensions of these boulders, as determined from SSS data, boulders covered 0.002% of the surveyed area. However, the boulder density was greater (>20 boulders per hectare, or >0.05 boulders per $25m^2$) in some parts of the Morven North Boundary and Morven South Boundary, which therefore have the potential to represent rocky reefs.

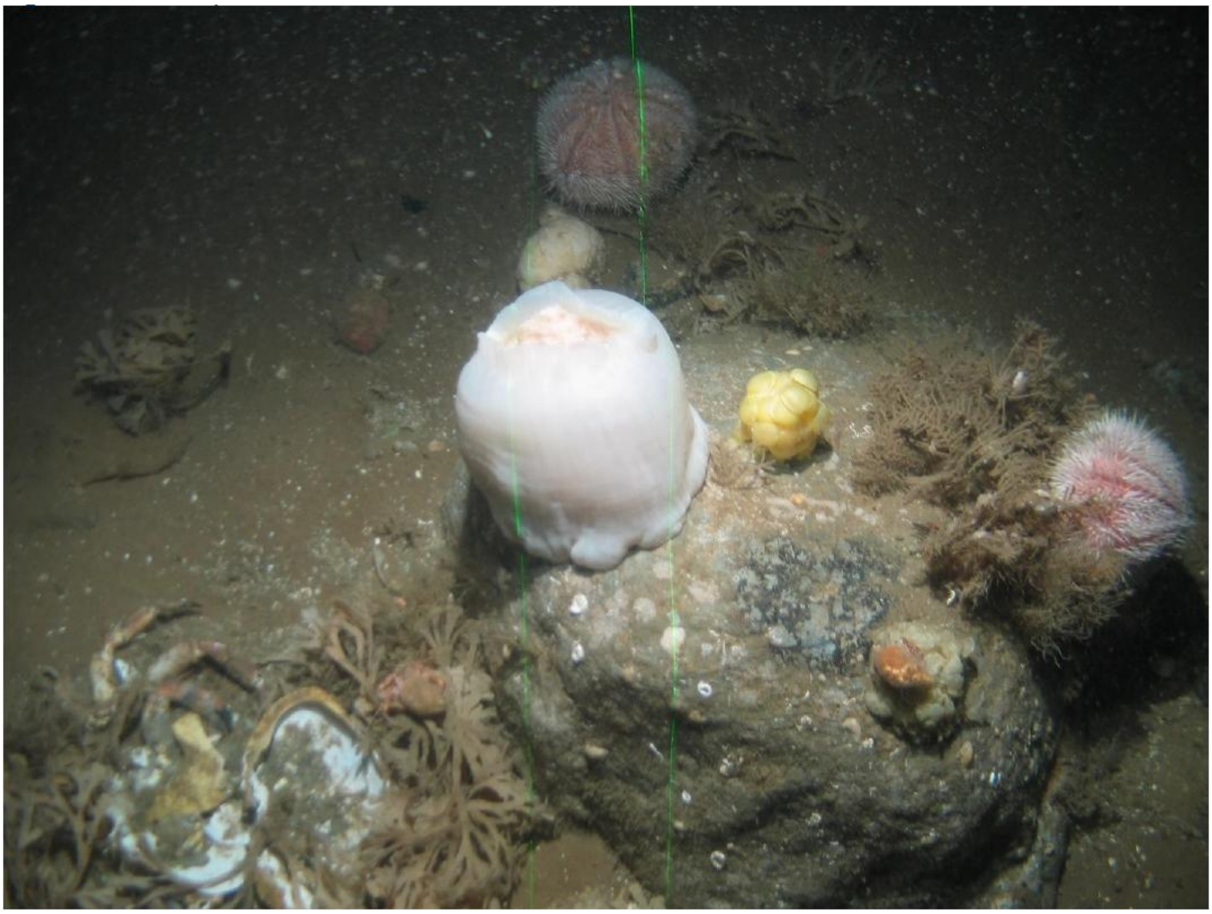

Figure 5.17: Example of cobble at station ENV072 (within the Morven North Benthic Subtidal Ecology Study Area)

5.4.5 Fragile Sponge and Anthozoan Communities on Subtidal Rocky Habitats

Morven North Benthic Subtidal Ecology Study Area

5.4.5.1 Some evidence of hard and soft substrate Porifera was observed throughout the Morven North Benthic Subtidal Ecology Study Area. Across the Survey Area, 31 stations showed evidence of either hard substate Porifera (see Figure 5.18) or soft substrate Porifera and two stations (ENV070 and ENV072 in the northeast of the Morven North Benthic Subtidal Ecology Study Area) with both categories present. However, these comprised <1% of the image pertaining to lone sponges such as *Suberites indet*. Of the hard substrate Porifera, the greatest percentage was observed at the Shared Sampling Location ENV102, accounting for 2.1% of a single image. Soft substrate Porifera at Shared Sampling Location ENV049 covered a maximum of 2.4% of a single image. Though several species of sponges and other species (*Alcyonidium diaphanum*) were present that are listed within the fragile sponge and anthozoan communities on rocky habitats (JNCC, 2008), they were at a low abundance and so were not considered representative of this habitat.

5.4.6 Morven South Benthic Subtidal Ecology Study Area

5.4.6.1 Some evidence of hard and soft substrate Porifera was observed throughout the Morven South Benthic Subtidal Ecology Study Area. Across the Survey Area, 17 stations showed evidence of either hard substate Porifera (see Figure 5.18) or soft substrate Porifera. However, these comprised <1% of the image pertaining to lone sponges such as *Suberites* *indet*. Of the hard substrate Porifera, the greatest percentage was observed at the Shared Sampling Location ENV102, accounting for 2.1% of a single image. Soft substrate Porifera at Shared Sampling Location ENV049 covered a maximum of 2.4% of a single image. Though several species of sponges and other species (*Alcyonidium diaphanum*) were present that are listed within the fragile sponge and anthozoan communities on rocky habitats (JNCC, 2008), they were at a low abundance and so were not considered representative of this habitat.

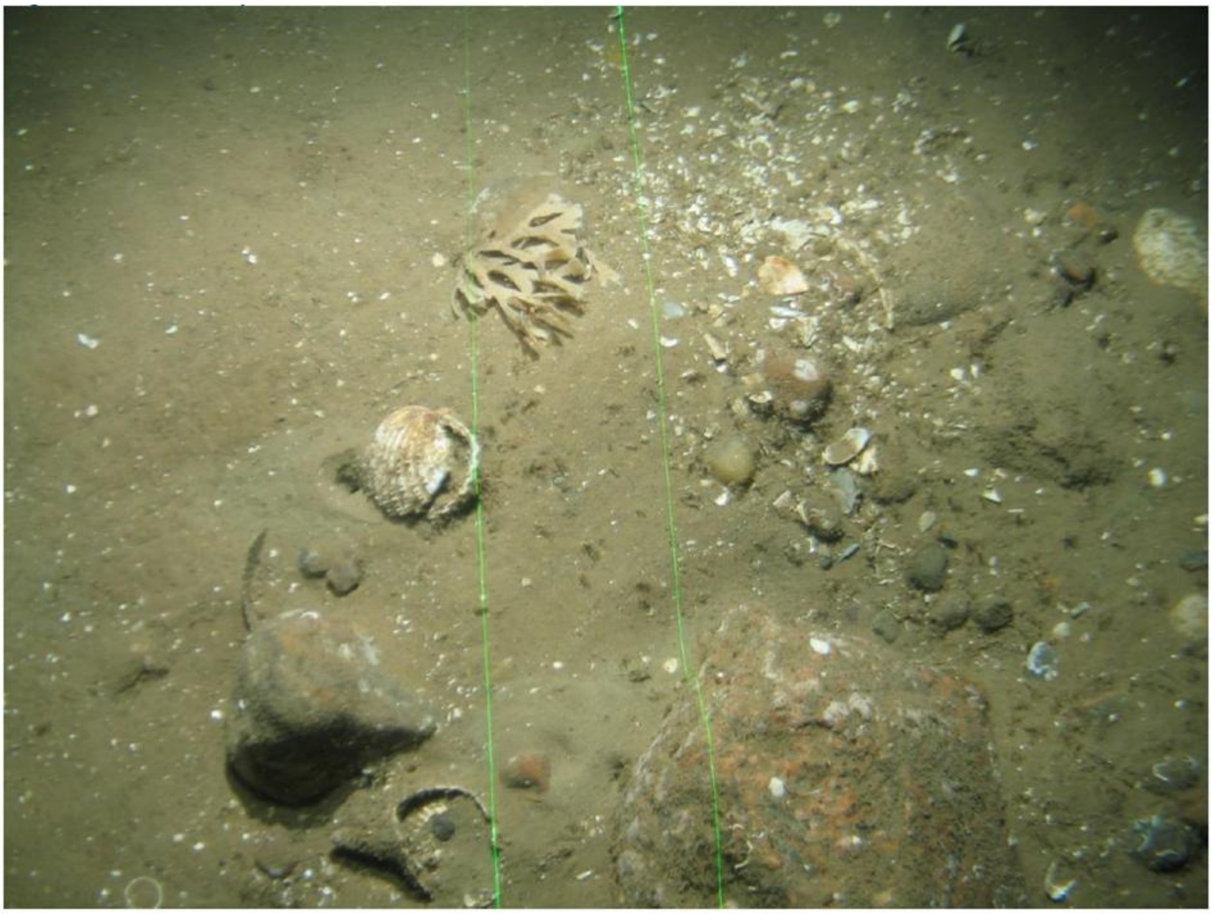

Figure 5.18: Example of hard substrate Porifera at Shared Sampling Location ENV102

5.5 Results – Combined Infaunal and Epifaunal Biotopes

Morven North Benthic Subtidal Ecology Study Area

5.5.1.1 The limited number of epifaunal species indicated the presence of only two biotopes across the Morven North Benthic Subtidal Ecology Study Area, at a relatively low resolution. The infaunal data provided the most comprehensive overview of the communities present and allowed classification of biotopes to a lower level with greater resolution. The infaunal biotopes have therefore been accepted as being representative of habitats across the Morven North Benthic Subtidal Ecology Study Area. For stations which only have DDV data (ENV001 and ENV068 in the Morven North Benthic Subtidal Ecology Study Area) the epifaunal biotope has been used. The distribution of these combined epifaunal and infaunal biotopes are presented in Figure 5.19.

Morven South Benthic Subtidal Ecology Study Area

5.5.1.2 The limited number of epifaunal species indicated the presence of only one biotope within the Morven South Benthic Subtidal Ecology Study Area, at a relatively low resolution. The infaunal data provided the most comprehensive overview of the communities present and allowed classification of biotopes to a lower level with greater resolution. The infaunal biotopes have therefore been accepted as being representative of habitats across the Morven South Benthic Subtidal Ecology Study Area. The distribution of these combined epifaunal and infaunal biotopes are presented in Figure 5.19.

Figure 5.19: Combined infaunal and epifaunal biotopes across the Survey Area

6 Summary

6.1 Morven North Benthic Subtidal Ecology Study Area

6.1.1.1 Subtidal sediments recorded across the Morven North Benthic Subtidal Ecology Study Area ranged from muddy sand to sandy gravel, with most stations classified as sand. Of these stations classified as sand, sediments tended to grade from the coarser slightly gravelly sand in the north and northwest to sand and muddy sand in the south and southeast. This broadly aligned with the desktop data which indicated slightly coarser sediment and mixed sediments in the northwest (EMODnet, 2019).

6.1.1.2 Overall, levels of contamination were low, with only one station (ENV054 located in the far north of the Morven North Benthic Subtidal Ecology Study Area) exceeding Marine Scotland AL1 and the Canadian TEL but being below Marine Scotland AL2 and Canadian PEL for arsenic. All other metals at all stations were below all thresholds. Similarly, all stations were below all thresholds for PCB and PAH contamination. Concentrations of organotins were below the limit of detection at all stations.

6.1.1.3 The benthic communities throughout the Morven North Benthic Subtidal Ecology Study Area, particularly in the north, were dominated largely by the *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) biotope. Samples broadly along the eastern edge of the Morven North Benthic Subtidal Ecology Study Area, as well as some smaller areas on the eastern edge of the Morven North Boundary, were dominated by the *Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri) biotope.Ie south of the Morven North Benthic Subtidal Ecology Study Area was dominated by the circalittoral fine sand (SS.SSa.CFiSa) biotope.

6.1.1.4 The station ENV054, in the northeast corner of the Morven North Benthic Subtidal Ecology Study Area and outside of the Morven North Boundary, was characterised by a higher proportion of gravel (32% gravel compared to the average of 1.06%) and was contaminated with arsenic. These physical conditions differed from all other stations, and the different biological community classified this station as the only polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen).

6.1.1.5 Additionally, the two stations in the north of the Morven North Benthic Subtidal Ecology Study Area where only DDV data could be gathered (ENV001 and ENV068) were characterised by fine silty sand with shell debris. The fine sedimentary environment led to the allocation of the circalittoral muddy sand (SS.SSa.CMuSa) biotope.

6.1.1.6 The habitat assessments found that some areas with high boulder density may have the potential to be classified as stony reef, although all recorded stations with boulders did not meet the criteria for defining this as Annex I habitat. Similarly, the presence of individual seapens, *S. spinulosa, M. modiolus* and sponges was recorded, but the criteria for the classification of these sensitive habitats were not met.

6.2 Morven South Benthic Subtidal Ecology Study Area

6.2.1.1 Subtidal sediments recorded across the Morven South Benthic Subtidal Ecology Study Area ranged from muddy sand to slightly gravelly sand, with most stations classified as sand. Of these stations classified as sand, sediments tended to grade from the coarser slightly gravelly sand at one station in the north to sand and muddy sand in the south. This broadly aligned with the desktop data which indicated slightly coarser sediment and mixed sediments in the northwest (EMODnet, 2019).

6.2.1.2 Levels of contamination were low, with no stations exceeding Marine Scotland AL1/AL2 or the Canadian TEL/PEL. Similarly, all stations were below all thresholds for PCB and PAH contamination. Concentrations of organotins were below the limit of detection at all stations.

6.2.1.3 The benthic communities primarily in the north and centre of the Morven South Benthic Subtidal Ecology Study Area were dominated largely by the *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) biotope. Samples broadly along the east of the Morven South Benthic Subtidal Ecology Study Area, with some smaller areas further west, were dominated by the *Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri) biotope. The south and ZoI of the Morven South Benthic Subtidal Ecology Study Area was dominated by the circalittoral fine sand (SS.SSa.CFiSa) biotope.

6.2.1.4 The habitat assessments found that some areas with high boulder density may have the potential to be classified as stony reef, although all recorded stations with boulders did not meet the criteria for defining this as Annex I habitat. Similarly, the presence of individual seapens, *S. spinulosa, M. modiolus* and sponges was recorded, but the criteria for the classification of these sensitive habitats were not met.

6.3 Important Ecological Features

6.3.1.1 IEFs are important habitats, species and ecosystems, potentially impacted by Morven North and Morven South. The CIEEM guidance was used to assess these IEFs within the Morven North and Morven South Benthic Subtidal Ecology Study Areas. IEFs can either be individual species, biotopes, or biotope groups. IEFs are then assigned an importance value based on their commercial, ecological or conservation (PMFs, SAC features, etc.) importance. Table 6.1 defines the IEF criteria, and Table 6.2 and Table 6.3 justify the IEFs based on importance rankings.

Table 6.1: Defining criteria for Important Ecological Features

Value of Important Ecological Features	Defining criteria
International	Internationally designated sites. Species or habitats protected under international law (i.e. Annex I habitats listed as qualifying interests of SACs).
National	Nationally designated sites. Species protected under national law. OSPAR List of Threatened and/or Declining Species, and International Union for Conservation of Nature (IUCN) Red List species that have nationally important populations within the Morven North or Morven South Boundaries , particularly in the context of species/habitat that may be rare or threatened in Scottish waters. Species that are listed as PMFs as they have been deemed features characteristic of Scottish marine environment and are likely to be one of the characteristic species within the Morven North or Morven South Benthic Subtidal Ecology Study Areas.
Regional	OSPAR List of Threatened and/or Declining Species, and IUCN Red List species that have regionally important populations within the Morven North or Morven South Boundaries (i.e. are locally widespread and/or abundant). Species that are of commercial value to the fisheries which operate within the Morven North or Morven South Boundaries . Species that form an important prey item for other species of conservation or commercial value and that are key components of

Value of Important Ecological Features	Defining criteria
	the benthic assemblages within the Morven North or Morven South Boundaries. Species that are listed as PMFs but are not a key contributing species to the characterisation of the Morven North or Morven South Benthic Subtidal Ecology Study Areas.
Local	Species that are of commercial importance but do not form a key component of the benthic assemblages within the Morven North or Morven South Boundaries (e.g. they may be exploited in shallower/deeper waters outside the Morven North and Morven South Boundaries). Species is common throughout Scottish waters but forms a component of the benthic assemblages in the Morven North and Morven South Boundaries .

6.3.2 Morven North Benthic Subtidal Ecology Study Area

6.3.2.1 Two IEFs have been identified in the Morven North Benthic Subtidal Ecology Study Area (Table 6.2); the nationally important "Offshore subtidal sands and gravels", which includes the biotopes SS.SMx.OMx.PoVen, SS.SSa.CFiSa, SS.SSa.CFiSa.ApriBatPo, and SS.SSa.CFiSa.EpusOborApri; and "Ocean quahog", which is of international importance. These IEFs will be carried forward for assessment within the EIA.

Table 6.2: Important Ecological Features habitats and representative groups within Morven North Benthic Subtidal Ecology Study Area

Important Ecological Features	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the Benthic Subtidal Ecology Study Area
Offshore subtidal sands and gravels	SS.SMx.OMx.PoVen SS.SSa.CFiSa SS.SSa.CFiSa.ApriBatPo SS.SSa.CFiSa.EpusOborApri	Throughout the entire Morven North Benthic Subtidal Ecology Study Area	Priority Marine Features (Scotland) Qualifying feature of Firth of Forth Banks Complex MPA BAP Priority Habitat	National
Ocean quahog	*Arctica islandica*	Within the Firth of Forth Banks MPA complex and across the Morven North Benthic Subtidal Ecology Study Area (within the Morven	Priority Marine Features (Scotland) Qualifying feature of Firth of Forth Banks Complex MPA OSPAR Annex V	International

Important Ecological Features	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the Benthic Subtidal Ecology Study Area
		North Boundary)		

6.3.3 Morven South Benthic Subtidal Ecology Study Area

6.3.3.1 Two IEFs have been identified in the Morven South Benthic Subtidal Ecology Study Area (Table 6.3); the nationally important "Offshore subtidal sands and gravels", which includes the biotopes SS.SSa.CFiSa, SS.SSa.CFiSa.ApriBatPo, and SS.SSa.CFiSa.EpusOborApri; and "Ocean quahog", which is of international importance. These IEFs will be carried forward for assessment within the EIA.

Table 6.3: Important Ecological Features habitats and representative groups within Morven South Benthic Subtidal Ecology Study Area

Important Ecological Features	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the Benthic Subtidal Ecology Study Area
Offshore subtidal sands and gravels	SS.SSa.CFiSa SS.SSa.CFiSa.ApriBatPo SS.SSa.CFiSa.EpusOborApri	Throughout the entire Morven South Benthic Subtidal Ecology Study Area	Priority Marine Features (Scotland) Qualifying feature of Firth of Forth Banks Complex MPA BAP Priority Habitat	National
Ocean quahog	*Arctica islandica*	Within the Firth of Forth Banks MPA complex and across the Morven South Benthic Subtidal Ecology Study Area (within the Morven South Boundary)	Priority Marine Features (Scotland) Qualifying feature of Firth of Forth Banks Complex MPA OSPAR Annex V	International

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Appendix A Physico-chemical Analyses

A.1 Physico-chemical Analyses

Table A. 1: Full PSA results for the Survey Area (part 1)

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV002	620551	6302391	1.51	1.61	1.73	1.91	2.22	2.48	2.71	2.88	3.31	214.52	2.22	Fine sand	0.52	Moderately well	0.11	Fine	1.30	Leptokurtic
ENV003	623255	6299193	0.91	1.39	1.59	1.76	2.16	2.47	2.72	2.92	4.01	224.60	2.15	Fine sand	0.75	Moderate	0.09	Symmetrical	1.80	Very leptokurtic
ENV004	626000	6296011	1.62	1.76	1.93	2.07	2.35	2.73	2.91	3.32	5.46	189.83	2.40	Fine sand	0.83	Moderate	0.39	Very fine	2.41	Very leptokurtic
ENV005	628723	6292812	1.59	1.69	1.82	2.01	2.27	2.57	2.81	2.97	4.82	202.91	2.30	Fine sand	0.74	Moderate	0.34	Very fine	2.35	Very leptokurtic
ENV006	631443	6289614	1.59	1.70	1.83	2.02	2.28	2.60	2.84	3.00	5.45	200.67	2.32	Fine sand	0.84	Moderate	0.38	Very fine	2.70	Very leptokurtic
ENV007	634166	6286418	1.36	1.59	1.72	1.92	2.26	2.62	2.86	3.10	5.24	206.11	2.28	Fine sand	0.87	Moderate	0.30	Fine	2.26	Very leptokurtic
ENV008	636888	6283219	0.41	0.88	1.23	1.59	2.14	2.57	2.84	3.08	5.09	238.44	2.07	Fine sand	1.11	Poor	0.07	Symmetrical	1.97	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV009	639608	6280018	0.97	1.30	1.58	1.83	2.27	2.72	2.94	3.44	5.64	208.49	2.26	Fine sand	1.05	Poor	0.21	Fine	2.14	Very leptokurtic
ENV010	642330	6276821	1.34	1.61	1.78	2.02	2.35	2.78	2.96	3.47	5.70	194.25	2.36	Fine sand	0.96	Moderate	0.29	Fine	2.34	Very leptokurtic
ENV011	645049	6273619	1.56	1.74	1.95	2.09	2.40	2.83	3.09	4.57	6.31	179.14	2.48	Fine sand	1.00	Poor	0.43	Very fine	2.63	Very leptokurtic
ENV012	647758	6270408	1.55	1.77	2.01	2.12	2.43	2.84	2.99	3.76	6.00	179.76	2.48	Fine sand	0.92	Moderate	0.37	Very fine	2.54	Very leptokurtic
ENV013	650491	6267220	1.61	1.86	2.04	2.16	2.49	2.88	3.11	3.98	6.06	171.05	2.55	Fine sand	0.94	Moderate	0.39	Very fine	2.53	Very leptokurtic
ENV014	653212	6264021	1.59	1.82	2.03	2.14	2.46	2.86	3.01	3.60	5.91	176.69	2.50	Fine sand	0.90	Moderate	0.36	Very fine	2.47	Very leptokurtic
ENV015	614556	6302812	1.18	1.54	1.64	1.80	2.15	2.44	2.64	2.85	3.41	226.23	2.14	Fine sand	0.59	Moderately well	0.05	Symmetrical	1.42	Leptokurtic
ENV016	617301	6299632	1.08	1.51	1.62	1.79	2.17	2.47	2.70	2.89	3.51	223.38	2.16	Fine sand	0.64	Moderately well	0.05	Symmetrical	1.47	Leptokurtic
ENV017	620038	6296447	1.00	1.42	1.60	1.78	2.17	2.48	2.73	2.92	4.38	222.46	2.17	Fine sand	0.79	Moderate	0.15	Fine	1.98	Very leptokurtic
ENV018	622762	6293249	1.07	1.51	1.66	1.88	2.25	2.62	2.85	2.99	4.98	209.97	2.25	Fine sand	0.89	Moderate	0.20	Fine	2.16	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV019	625487	6290053	1.34	1.57	1.68	1.85	2.20	2.49	2.75	2.94	4.32	216.22	2.21	Fine sand	0.72	Moderate	0.23	Fine	1.89	Very leptokurtic
ENV020	628212	6286857	1.09	1.44	1.60	1.78	2.18	2.52	2.81	3.02	5.31	218.01	2.20	Fine sand	0.94	Moderate	0.26	Fine	2.33	Very leptokurtic
ENV021	630919	6283688	1.15	1.53	1.67	1.87	2.24	2.60	2.84	3.02	5.16	210.25	2.25	Fine sand	0.90	Moderate	0.24	Fine	2.26	Very leptokurtic
ENV022	633686	6280452	0.77	1.12	1.39	1.63	2.10	2.48	2.74	2.93	3.98	237.11	2.08	Fine sand	0.82	Moderate	0.06	Symmetrical	1.55	Very leptokurtic
ENV023	636410	6277259	1.29	1.54	1.64	1.80	2.16	2.48	2.77	2.99	5.24	218.95	2.19	Fine sand	0.88	Moderate	0.32	Very fine	2.38	Very leptokurtic
ENV024	639143	6274103	1.27	1.53	1.62	1.75	2.11	2.43	2.62	2.85	3.38	230.51	2.12	Fine sand	0.57	Moderately well	0.11	Fine	1.29	Leptokurtic
ENV025	641857	6270894	1.09	1.45	1.62	1.82	2.23	2.65	2.89	3.27	5.55	210.81	2.25	Fine sand	0.99	Moderate	0.26	Fine	2.21	Very leptokurtic
ENV026	644578	6267695	1.39	1.60	1.75	1.98	2.30	2.70	2.91	3.33	5.37	200.14	2.32	Fine sand	0.89	Moderate	0.30	Very fine	2.25	Very leptokurtic
ENV027	647295	6264493	1.54	1.68	1.85	2.05	2.36	2.79	2.98	3.76	5.93	189.87	2.40	Fine sand	0.95	Moderate	0.36	Very fine	2.43	Very leptokurtic
ENV028	650004	6261284	1.59	1.76	1.96	2.10	2.41	2.82	2.98	3.45	5.69	182.68	2.45	Fine sand	0.87	Moderate	0.36	Very fine	2.33	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV029	611406	6300119	1.14	1.42	1.57	1.70	2.06	2.41	2.60	2.87	4.04	237.09	2.08	Fine sand	0.70	Moderately well	0.20	Fine	1.68	Very leptokurtic
ENV030	614139	6296927	0.90	1.26	1.54	1.74	2.17	2.50	2.78	2.97	5.08	222.82	2.17	Fine sand	0.94	Moderate	0.19	Fine	2.26	Very leptokurtic
ENV031	616855	6293728	1.13	1.50	1.64	1.86	2.24	2.64	2.88	3.33	5.70	209.23	2.26	Fine sand	1.00	Poor	0.27	Fine	2.39	Very leptokurtic
ENV032	619576	6290527	1.23	1.55	1.69	1.91	2.27	2.67	2.88	3.20	5.20	205.69	2.28	Fine sand	0.90	Moderate	0.25	Fine	2.14	Very leptokurtic
ENV033	622296	6287329	1.06	1.49	1.64	1.85	2.25	2.64	2.86	3.11	5.08	210.19	2.25	Fine sand	0.92	Moderate	0.21	Fine	2.10	Very leptokurtic
ENV034	625016	6284128	1.09	1.33	1.54	1.71	2.13	2.51	2.81	3.05	5.28	223.40	2.16	Fine sand	0.95	Moderate	0.29	Fine	2.12	Very leptokurtic
ENV035	627775	6280956	1.04	1.24	1.50	1.67	2.11	2.50	2.80	3.00	5.09	227.81	2.13	Fine sand	0.94	Moderate	0.26	Fine	1.99	Very leptokurtic
ENV036	630495	6277758	1.00	1.25	1.52	1.71	2.17	2.60	2.86	3.23	5.39	219.79	2.19	Fine sand	1.00	Moderate	0.24	Fine	2.04	Very leptokurtic
ENV037	633208	6274553	1.02	1.25	1.51	1.70	2.17	2.62	2.87	3.19	5.23	220.05	2.18	Fine sand	0.98	Moderate	0.24	Fine	1.89	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV038	635927	6271359	1.49	1.64	1.81	2.03	2.35	2.81	3.09	4.78	6.62	187.37	2.42	Fine sand	1.10	Poor	0.41	Very fine	2.68	Very leptokurtic
ENV039	638643	6268149	0.81	1.14	1.43	1.67	2.15	2.56	2.83	3.07	5.20	227.03	2.14	Fine sand	1.01	Poor	0.18	Fine	2.02	Very leptokurtic
ENV040	641363	6264947	1.50	1.60	1.73	1.92	2.27	2.67	2.91	3.40	5.90	202.77	2.30	Fine sand	0.96	Moderate	0.37	Very fine	2.38	Very leptokurtic
ENV041	644082	6261748	1.51	1.62	1.77	1.98	2.31	2.75	2.97	3.86	6.11	196.40	2.35	Fine sand	1.00	Moderate	0.37	Very fine	2.44	Very leptokurtic
ENV042	610906	6294170	0.90	1.36	1.60	1.81	2.20	2.52	2.79	2.96	4.83	218.09	2.20	Fine sand	0.89	Moderate	0.16	Fine	2.26	Very leptokurtic
ENV043	613640	6290983	0.75	1.12	1.44	1.68	2.16	2.55	2.83	3.10	5.42	226.53	2.14	Fine sand	1.06	Poor	0.17	Fine	2.21	Very leptokurtic
ENV044	616375	6287797	1.00	1.19	1.41	1.65	2.14	2.55	2.80	2.97	4.61	230.31	2.12	Fine sand	0.89	Moderate	0.16	Fine	1.63	Very leptokurtic
ENV045	619093	6284629	1.19	1.57	1.76	2.02	2.34	2.76	2.95	3.56	5.80	196.15	2.35	Fine sand	1.00	Moderate	0.26	Fine	2.52	Very leptokurtic
ENV046	621844	6281416	1.09	1.37	1.56	1.73	2.14	2.51	2.80	2.99	5.00	222.65	2.17	Fine sand	0.90	Moderate	0.26	Fine	2.05	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV047	624574	6278223	0.72	1.06	1.26	1.54	2.09	2.55	2.82	3.01	5.04	240.12	2.06	Fine sand	1.04	Poor	0.15	Fine	1.75	Very leptokurtic
ENV048	627301	6274992	0.87	1.18	1.46	1.74	2.25	2.71	2.92	3.37	5.54	216.09	2.21	Fine sand	1.07	Poor	0.16	Fine	1.98	Very leptokurtic
ENV049	630023	6271801	1.08	1.38	1.61	1.86	2.29	2.71	2.90	3.14	4.97	208.19	2.26	Fine sand	0.91	Moderate	0.16	Fine	1.87	Very leptokurtic
ENV050	632737	6268661	1.00	1.26	1.54	1.77	2.25	2.71	2.92	3.38	5.68	212.12	2.24	Fine sand	1.06	Poor	0.22	Fine	2.03	Very leptokurtic
ENV051	635472	6265441	1.05	1.36	1.62	1.93	2.35	2.81	2.99	4.18	6.25	199.80	2.32	Fine sand	1.13	Poor	0.21	Fine	2.41	Very leptokurtic
ENV052	638190	6262240	1.33	1.63	1.85	2.08	2.47	2.91	3.35	5.05	6.82	170.33	2.55	Fine sand	1.21	Poor	0.38	Very fine	2.70	Very leptokurtic
ENV053	640911	6259040	1.44	1.66	1.87	2.08	2.43	2.87	3.17	4.46	6.22	177.91	2.49	Fine sand	1.05	Poor	0.37	Very fine	2.47	Very leptokurtic
ENV054	613686	6318222	-3.84	-3.50	-2.88	-1.54	0.16	1.78	2.30	2.79	4.17	1101.67	-0.14	Very coarse sand	2.51	Very poor	-0.09	Symmetrical	0.99	Mesokurtic
ENV055	622891	6305906	0.31	0.94	1.51	1.76	2.21	2.57	2.83	3.00	5.24	220.43	2.18	Fine sand	1.08	Poor	0.08	Symmetrical	2.49	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV056	635629	6292272	1.65	1.91	2.05	2.15	2.43	2.82	2.98	3.95	6.04	178.64	2.48	Fine sand	0.90	Moderate	0.42	Very fine	2.66	Very leptokurtic
ENV057	637913	6288257	1.95	2.06	2.15	2.28	2.62	2.96	3.44	5.01	6.82	149.85	2.74	Fine sand	1.06	Poor	0.50	Very fine	2.90	Very leptokurtic
ENV058	645320	6279865	1.53	1.73	1.97	2.10	2.38	2.78	2.96	3.61	5.91	184.71	2.44	Fine sand	0.91	Moderate	0.39	Very fine	2.61	Very leptokurtic
ENV059	652230	6270186	1.75	2.03	2.12	2.25	2.60	2.96	3.48	5.12	6.73	150.36	2.73	Fine sand	1.10	Poor	0.47	Very fine	2.84	Very leptokurtic
ENV060	659318	6257459	1.53	1.69	1.87	2.07	2.42	2.86	3.14	4.22	6.31	179.49	2.48	Fine sand	1.04	Poor	0.39	Very fine	2.47	Very leptokurtic
ENV061	652017	6255316	1.53	1.60	1.70	1.84	2.18	2.49	2.79	3.00	5.26	213.96	2.22	Fine sand	0.84	Moderate	0.38	Very fine	2.36	Very leptokurtic
ENV062	640658	6251440	1.53	1.88	2.07	2.22	2.60	2.94	3.28	4.36	6.32	159.20	2.65	Fine sand	1.03	Poor	0.34	Very fine	2.70	Very leptokurtic
ENV063	628919	6264308	1.12	1.47	1.70	2.01	2.40	2.84	3.02	4.06	5.90	193.50	2.37	Fine sand	1.05	Poor	0.20	Fine	2.36	Very leptokurtic
ENV064	617704	6277598	1.55	1.83	2.04	2.17	2.53	2.96	4.18	5.82	7.27	132.33	2.92	Fine sand	1.40	Poor	0.60	Very fine	2.96	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV065	609859	6286958	0.57	1.04	1.35	1.64	2.14	2.54	2.83	3.12	5.42	232.67	2.10	Fine sand	1.10	Poor	0.14	Fine	2.21	Very leptokurtic
ENV066	605487	6294063	1.00	1.48	1.63	1.84	2.22	2.55	2.81	2.98	5.08	214.66	2.22	Fine sand	0.91	Moderate	0.21	Fine	2.36	Very leptokurtic
ENV067	603702	6297690	-0.75	1.04	1.55	1.78	2.20	2.53	2.81	2.99	5.51	219.88	2.19	Fine sand	1.26	Poor	0.01	Symmetrical	3.41	Extremely leptokurtic
ENV069	609482	6308998	0.17	0.56	0.90	1.22	1.78	2.23	2.40	2.56	2.91	309.00	1.69	Medium sand	0.79	Moderate	-0.17	Coarse	1.11	Mesokurtic
ENV070	619774	6303252	0.91	1.34	1.59	1.81	2.21	2.53	2.79	2.96	4.86	218.24	2.20	Fine sand	0.90	Moderate	0.16	Fine	2.26	Very leptokurtic
ENV071	621781	6300917	1.33	1.58	1.70	1.89	2.22	2.50	2.76	2.95	4.58	213.47	2.23	Fine sand	0.76	Moderate	0.24	Fine	2.20	Very leptokurtic
ENV072	617764	6299090	1.25	1.56	1.68	1.86	2.21	2.49	2.74	2.92	4.25	216.19	2.21	Fine sand	0.72	Moderate	0.18	Fine	1.96	Very leptokurtic
ENV073	616531	6295067	1.22	1.56	1.69	1.89	2.24	2.57	2.81	2.98	4.87	210.51	2.25	Fine sand	0.83	Moderate	0.24	Fine	2.21	Very leptokurtic
ENV074	627626	6287597	1.26	1.55	1.66	1.81	2.17	2.47	2.75	2.98	5.24	219.03	2.19	Fine sand	0.88	Moderate	0.30	Very fine	2.48	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV075	634828	6283797	1.23	1.52	1.64	1.81	2.20	2.57	2.85	3.26	5.60	213.22	2.23	Fine sand	0.97	Moderate	0.32	Very fine	2.36	Very leptokurtic
ENV076	629350	6280887	0.70	1.07	1.30	1.58	2.05	2.45	2.73	2.94	4.66	245.77	2.02	Fine sand	0.96	Moderate	0.13	Fine	1.85	Very leptokurtic
ENV077	630509	6279165	1.02	1.35	1.59	1.80	2.23	2.66	2.89	3.30	5.57	212.21	2.24	Fine sand	1.02	Poor	0.24	Fine	2.16	Very leptokurtic
ENV078	623259	6279407	0.82	1.12	1.31	1.55	1.96	2.41	2.69	2.96	5.06	252.22	1.99	Medium sand	0.99	Moderate	0.26	Fine	2.01	Very leptokurtic
ENV079	640824	6275383	0.78	1.12	1.37	1.62	2.09	2.47	2.73	2.93	3.95	239.21	2.06	Fine sand	0.82	Moderate	0.06	Symmetrical	1.52	Very leptokurtic
ENV080	637942	6270427	0.61	0.96	1.17	1.47	1.93	2.36	2.53	2.79	3.11	271.94	1.88	Medium sand	0.72	Moderate	-0.09	Symmetrical	1.15	Leptokurtic
ENV081	613106	6302222	1.16	1.47	1.60	1.76	2.15	2.48	2.80	3.24	6.10	219.87	2.19	Fine sand	1.05	Poor	0.34	Very fine	2.81	Very leptokurtic
ENV082	618084	6304296	0.94	1.27	1.54	1.73	2.15	2.47	2.72	2.92	4.57	227.57	2.14	Fine sand	0.84	Moderate	0.15	Fine	2.01	Very leptokurtic
ENV083	618841	6288070	1.01	1.40	1.62	1.85	2.25	2.65	2.88	3.22	5.36	210.33	2.25	Fine sand	0.97	Moderate	0.21	Fine	2.21	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV084	622094	6283784	1.07	1.50	1.65	1.88	2.27	2.70	2.93	3.49	5.85	205.45	2.28	Fine sand	1.04	Poor	0.26	Fine	2.38	Very leptokurtic
ENV085	629081	6284890	1.10	1.47	1.61	1.77	2.17	2.49	2.79	3.01	5.46	219.27	2.19	Fine sand	0.96	Moderate	0.28	Fine	2.48	Very leptokurtic
ENV086	637889	6278798	1.31	1.55	1.66	1.81	2.17	2.47	2.75	2.97	5.22	218.86	2.19	Fine sand	0.87	Moderate	0.31	Very fine	2.41	Very leptokurtic
ENV087	635342	6277208	1.11	1.54	1.68	1.89	2.27	2.72	2.96	4.03	6.15	202.26	2.31	Fine sand	1.08	Poor	0.31	Very fine	2.49	Very leptokurtic
ENV088	642712	6266174	1.53	1.69	1.89	2.07	2.40	2.83	3.00	3.81	6.19	185.83	2.43	Fine sand	0.98	Moderate	0.35	Very fine	2.53	Very leptokurtic
ENV089	646892	6262662	1.14	1.52	1.67	1.88	2.28	2.73	2.96	3.90	5.92	202.82	2.30	Fine sand	1.05	Poor	0.29	Fine	2.32	Very leptokurtic
ENV090	611789	6293361	0.51	1.12	1.54	1.76	2.19	2.54	2.80	2.97	4.98	221.26	2.18	Fine sand	0.99	Moderate	0.10	Fine	2.35	Very leptokurtic
ENV091	611450	6292277	-0.02	1.15	1.58	1.85	2.26	2.69	2.95	4.31	6.54	208.61	2.26	Fine sand	1.33	Poor	0.15	Fine	3.20	Extremely leptokurtic
ENV092	630065	6275774	0.85	1.21	1.51	1.72	2.20	2.66	2.90	3.38	5.50	217.22	2.20	Fine sand	1.05	Poor	0.21	Fine	2.03	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV093	632443	6269503	0.82	1.22	1.53	1.78	2.27	2.76	2.97	4.15	6.29	208.94	2.26	Fine sand	1.19	Poor	0.22	Fine	2.29	Very leptokurtic
ENV094	638115	6261427	1.28	1.59	1.80	2.05	2.43	2.86	3.08	3.96	6.11	184.81	2.44	Fine sand	1.05	Poor	0.27	Fine	2.44	Very leptokurtic
ENV095	607480	6297696	0.89	1.52	1.66	1.87	2.23	2.54	2.81	2.99	5.17	212.82	2.23	Fine sand	0.93	Moderate	0.20	Fine	2.61	Very leptokurtic
ENV096	620646	6274261	1.01	1.20	1.42	1.63	2.09	2.52	2.85	3.38	5.85	230.15	2.12	Fine sand	1.09	Poor	0.31	Very fine	2.22	Very leptokurtic
ENV097	648103	6250451	1.51	1.59	1.68	1.82	2.17	2.49	2.80	3.09	5.29	214.61	2.22	Fine sand	0.85	Moderate	0.39	Very fine	2.31	Very leptokurtic
ENV098	650414	6265595	1.62	1.87	2.04	2.16	2.49	2.90	3.23	4.54	6.42	166.34	2.59	Fine sand	1.02	Poor	0.44	Very fine	2.68	Very leptokurtic
ENV099	638553	6271250	0.59	1.08	1.34	1.60	2.06	2.45	2.74	2.98	5.27	242.43	2.04	Fine sand	1.06	Poor	0.17	Fine	2.25	Very leptokurtic
ENV100	649146	6268794	1.39	1.67	1.91	2.09	2.42	2.85	3.05	4.19	6.14	181.56	2.46	Fine sand	1.00	Poor	0.33	Very fine	2.58	Very leptokurtic
ENV101	623192	6301487	1.03	1.40	1.59	1.77	2.19	2.61	2.92	4.16	6.33	212.34	2.24	Fine sand	1.13	Poor	0.33	Very fine	2.59	Very leptokurtic

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value	Kurtosis Description
ENV102	635420	6284406	1.19	1.53	1.64	1.80	2.17	2.47	2.70	2.89	3.78	222.50	2.17	Fine sand	0.66	Moderately well	0.12	Fine	1.60	Very leptokurtic

Table A. 2: Full PSA results for the Survey Area (part 2)

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV002	194.94	2.36	Fine sand	1.14	Poor	4.60	Very fine	33.27	Very leptokurtic	4.02	95.81	0.17	Sand	Sand and muddy sand	2.22	Fine sand	2.50	Fine sand				
ENV003	207.55	2.27	Fine sand	1.40	Poor	2.72	Very fine	19.94	Very leptokurtic	5.01	93.75	1.24	Slightly gravelly sand	Sand and muddy sand	2.16	Fine sand	2.50	Fine sand				
ENV004	159.15	2.65	Fine sand	1.38	Poor	3.65	Very fine	20.40	Very leptokurtic	7.63	92.17	0.20	Sand	Sand and muddy sand	2.35	Fine sand	2.50	Fine sand				
ENV005	176.15	2.51	Fine sand	1.29	Poor	3.72	Very fine	24.15	Very leptokurtic	6.15	93.50	0.35	Sand	Sand and	2.27	Fine sand	2.50	Fine sand				

Sample	Mean μm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
														muddy sand								
ENV006	167.88	2.57	Fine sand	1.33	Poor	3.87	Very fine	20.97	Very leptokurtic	7.33	92.65	0.02	Sand	Sand and muddy sand	2.28	Fine sand	2.50	Fine sand				
ENV007	183.45	2.45	Fine sand	1.52	Poor	1.93	Very fine	16.64	Very leptokurtic	7.04	91.49	1.47	Slightly gravelly sand	Sand and muddy sand	2.26	Fine sand	2.50	Fine sand				
ENV008	219.15	2.19	Fine sand	1.66	Poor	1.29	Fine	12.57	Very leptokurtic	6.67	91.19	2.14	Slightly gravelly sand	Sand and muddy sand	2.14	Fine sand	2.50	Fine sand	-3.50	Pebble		
ENV009	175.06	2.51	Fine sand	1.49	Poor	2.96	Very fine	15.40	Very leptokurtic	8.38	91.49	0.13	Sand	Sand and muddy sand	2.27	Fine sand	2.50	Fine sand				
ENV010	160.93	2.64	Fine sand	1.44	Poor	3.16	Very fine	16.56	Very leptokurtic	8.56	91.26	0.17	Sand	Sand and muddy sand	2.35	Fine sand	2.50	Fine sand				
ENV011	143.00	2.81	Fine sand	1.54	Poor	2.97	Very fine	13.79	Very leptokurtic	11.52	88.43	0.04	Muddy sand	Sand and muddy sand	2.40	Fine sand	2.50	Fine sand	5.00	Coarse silt		

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV012	148.26	2.75	Fine sand	1.45	Poor	3.07	Very fine	15.58	Very leptokurtic	9.37	90.46	0.17	Sand	Sand and muddy sand	2.43	Fine sand	2.50	Fine sand				
ENV013	141.98	2.82	Fine sand	1.46	Poor	2.93	Very fine	15.08	Very leptokurtic	9.94	89.78	0.28	Sand	Sand and muddy sand	2.49	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV014	145.56	2.78	Fine sand	1.40	Poor	3.31	Very fine	16.78	Very leptokurtic	9.04	90.92	0.04	Sand	Sand and muddy sand	2.46	Fine sand	2.50	Fine sand				
ENV015	208.73	2.26	Fine sand	1.24	Poor	3.33	Very fine	26.60	Very leptokurtic	4.07	95.16	0.77	Sand	Sand and muddy sand	2.15	Fine sand	2.50	Fine sand				
ENV016	205.37	2.28	Fine sand	1.28	Poor	3.59	Very fine	27.04	Very leptokurtic	4.27	95.22	0.51	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV017	201.35	2.31	Fine sand	1.35	Poor	3.26	Very fine	21.44	Very leptokurtic	5.37	94.01	0.62	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV018	182.99	2.45	Fine sand	1.38	Poor	3.46	Very fine	20.21	Very leptokurtic	6.50	93.23	0.27	Sand	Sand and muddy sand	2.25	Fine sand	2.50	Fine sand				

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV019	190.77	2.39	Fine sand	1.26	Poor	4.15	Very fine	26.05	Very leptokurtic	5.36	94.58	0.06	Sand	Sand and muddy sand	2.20	Fine sand	2.50	Fine sand				
ENV020	188.77	2.41	Fine sand	1.42	Poor	3.18	Very fine	17.65	Very leptokurtic	7.10	92.59	0.31	Sand	Sand and muddy sand	2.18	Fine sand	2.50	Fine sand				
ENV021	181.69	2.46	Fine sand	1.37	Poor	3.40	Very fine	19.25	Very leptokurtic	7.04	92.81	0.15	Sand	Sand and muddy sand	2.24	Fine sand	2.50	Fine sand				
ENV022	215.85	2.21	Fine sand	1.33	Poor	3.27	Very fine	21.82	Very leptokurtic	4.97	94.42	0.62	Sand	Sand and muddy sand	2.10	Fine sand	2.50	Fine sand				
ENV023	187.97	2.41	Fine sand	1.37	Poor	3.42	Very fine	19.51	Very leptokurtic	6.98	92.70	0.33	Sand	Sand and muddy sand	2.16	Fine sand	2.50	Fine sand				
ENV024	206.34	2.28	Fine sand	1.18	Poor	4.72	Very fine	32.68	Very leptokurtic	4.10	95.83	0.07	Sand	Sand and muddy sand	2.11	Fine sand	2.50	Fine sand				
ENV025	179.72	2.48	Fine sand	1.42	Poor	3.16	Very fine	16.64	Very leptokurtic	7.62	92.28	0.10	Sand	Sand and muddy sand	2.23	Fine sand	2.50	Fine sand				

Sample	Mean μ m	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV026	169.05	2.56	Fine sand	1.36	Poor	3.45	Very fine	18.83	Very leptokurtic	7.84	92.07	0.08	Sand	Sand and muddy sand	2.30	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV027	154.01	2.70	Fine sand	1.43	Poor	3.22	Very fine	15.98	Very leptokurtic	9.45	90.50	0.05	Sand	Sand and muddy sand	2.36	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV028	151.47	2.72	Fine sand	1.39	Poor	3.54	Very fine	18.71	Very leptokurtic	8.41	91.59	0.00	Sand	Sand and muddy sand	2.41	Fine sand	2.50	Fine sand				
ENV029	213.73	2.23	Fine sand	1.37	Poor	2.88	Very fine	21.79	Very leptokurtic	5.03	94.02	0.94	Sand	Sand and muddy sand	2.06	Fine sand	2.50	Fine sand				
ENV030	197.26	2.34	Fine sand	1.42	Poor	3.03	Very fine	17.59	Very leptokurtic	6.49	93.12	0.39	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV031	176.73	2.50	Fine sand	1.46	Poor	2.97	Very fine	15.59	Very leptokurtic	8.15	91.53	0.32	Sand	Sand and muddy sand	2.24	Fine sand	2.50	Fine sand				
ENV032	176.39	2.50	Fine sand	1.35	Poor	3.41	Very fine	19.37	Very leptokurtic	7.44	92.42	0.15	Sand	Sand and muddy sand	2.27	Fine sand	2.50	Fine sand	5.00	Coarse silt		

Sample	Mean μm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV033	183.20	2.45	Fine sand	1.38	Poor	3.27	Very fine	18.68	Very leptokurtic	6.81	92.98	0.21	Sand	Sand and muddy sand	2.25	Fine sand	2.50	Fine sand				
ENV034	193.10	2.37	Fine sand	1.43	Poor	3.27	Very fine	18.19	Very leptokurtic	7.21	92.57	0.22	Sand	Sand and muddy sand	2.13	Fine sand	2.50	Fine sand				
ENV035	201.53	2.31	Fine sand	1.44	Poor	2.81	Very fine	17.54	Very leptokurtic	6.87	92.47	0.66	Sand	Sand and muddy sand	2.11	Fine sand	2.50	Fine sand				
ENV036	190.42	2.39	Fine sand	1.47	Poor	2.82	Very fine	16.04	Very leptokurtic	7.71	91.81	0.48	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV037	191.41	2.39	Fine sand	1.41	Poor	3.10	Very fine	17.01	Very leptokurtic	7.24	92.62	0.14	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV038	145.12	2.78	Fine sand	1.63	Poor	2.81	Very fine	12.33	Very leptokurtic	11.84	88.13	0.04	Muddy sand	Sand and muddy sand	2.35	Fine sand	2.50	Fine sand	6.50	Fine silt		
ENV039	197.51	2.34	Fine sand	1.43	Poor	3.09	Very fine	16.92	Very leptokurtic	6.95	92.84	0.21	Sand	Sand and muddy sand	2.15	Fine sand	2.50	Fine sand				

Sample	Mean μm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV040	166.35	2.59	Fine sand	1.46	Poor	3.32	Very fine	16.80	Very leptokurtic	8.50	91.40	0.10	Sand	Sand and muddy sand	2.27	Fine sand	2.50	Fine sand				
ENV041	158.84	2.65	Fine sand	1.51	Poor	2.90	Very fine	14.44	Very leptokurtic	9.70	89.95	0.35	Sand	Sand and muddy sand	2.31	Fine sand	2.50	Fine sand	5.00	Coarse silt	6.50	Fine silt
ENV042	194.41	2.36	Fine sand	1.40	Poor	3.12	Very fine	18.85	Very leptokurtic	6.15	93.24	0.60	Sand	Sand and muddy sand	2.20	Fine sand	2.50	Fine sand				
ENV043	197.52	2.34	Fine sand	1.50	Poor	2.63	Very fine	14.95	Very leptokurtic	7.39	91.87	0.74	Sand	Sand and muddy sand	2.16	Fine sand	2.50	Fine sand				
ENV044	204.25	2.29	Fine sand	1.34	Poor	3.23	Very fine	19.28	Very leptokurtic	5.85	93.92	0.24	Sand	Sand and muddy sand	2.14	Fine sand	2.50	Fine sand				
ENV045	162.63	2.62	Fine sand	1.48	Poor	3.00	Very fine	15.60	Very leptokurtic	8.98	90.86	0.16	Sand	Sand and muddy sand	2.34	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV046	195.72	2.35	Fine sand	1.39	Poor	3.29	Very fine	19.56	Very leptokurtic	6.69	93.02	0.29	Sand	Sand and muddy sand	2.14	Fine sand	2.50	Fine sand				

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV047	208.34	2.26	Fine sand	1.43	Poor	3.01	Very fine	16.71	Very leptokurtic	6.86	93.02	0.12	Sand	Sand and muddy sand	2.09	Fine sand	2.50	Fine sand				
ENV048	182.77	2.45	Fine sand	1.48	Poor	2.75	Very fine	14.69	Very leptokurtic	8.13	91.71	0.16	Sand	Sand and muddy sand	2.25	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV049	181.64	2.46	Fine sand	1.32	Poor	3.33	Very fine	19.44	Very leptokurtic	6.50	93.43	0.07	Sand	Sand and muddy sand	2.29	Fine sand	2.50	Fine sand				
ENV050	178.93	2.48	Fine sand	1.47	Poor	2.92	Very fine	15.05	Very leptokurtic	8.21	91.70	0.09	Sand	Sand and muddy sand	2.25	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV051	159.85	2.65	Fine sand	1.59	Poor	2.59	Very fine	12.50	Very leptokurtic	10.37	89.43	0.21	Muddy sand	Sand and muddy sand	2.35	Fine sand	2.50	Fine sand	5.50	Medium silt		
ENV052	135.25	2.89	Fine sand	1.69	Poor	2.58	Very fine	11.12	Very leptokurtic	12.82	87.05	0.13	Muddy sand	Sand and muddy sand	2.47	Fine sand	2.50	Fine sand	6.50	Fine silt		
ENV053	145.01	2.79	Fine sand	1.51	Poor	2.83	Very fine	13.26	Very leptokurtic	11.18	88.75	0.07	Muddy sand	Sand and muddy sand	2.43	Fine sand	2.50	Fine sand	5.00	Coarse silt		

Sample	Mean μm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV054	913.15	0.13	Coarse sand	2.58	Very poor	0.64	Fine	4.32	Leptokurtic	5.19	62.82	31.99	Sandy gravel	Coarse sediments	0.16	Coarse sand	2.50	Fine sand	0.50	Coarse sand	-0.50	Very coarse sand
ENV055	206.78	2.27	Fine sand	1.68	Poor	1.42	Very fine	13.25	Very leptokurtic	6.92	90.96	2.12	Slightly gravelly sand	Sand and muddy sand	2.21	Fine sand	2.50	Fine sand	-3.50	Pebble		
ENV056	151.82	2.72	Fine sand	1.63	Poor	1.54	Very fine	13.63	Very leptokurtic	9.85	88.45	1.69	Slightly gravelly muddy sand	Sand and muddy sand	2.43	Fine sand	2.50	Fine sand	-3.50	Pebble		
ENV057	122.23	3.03	Very fine sand	1.70	Poor	2.03	Very fine	11.90	Very leptokurtic	13.22	85.86	0.93	Muddy sand	Sand and muddy sand	2.62	Fine sand	3.00	Fine sand				
ENV058	153.60	2.70	Fine sand	1.43	Poor	3.18	Very fine	16.09	Very leptokurtic	9.13	90.76	0.11	Sand	Sand and muddy sand	2.38	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV059	120.63	3.05	Very fine sand	1.61	Poor	2.78	Very fine	12.08	Very leptokurtic	14.02	85.97	0.01	Muddy sand	Sand and muddy sand	2.60	Fine sand	2.50	Fine sand	5.00	Coarse silt		

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV060	144.42	2.79	Fine sand	1.53	Poor	3.05	Very fine	14.29	Very leptokurtic	10.53	89.46	0.01	Muddy sand	Sand and muddy sand	2.42	Fine sand	2.50	Fine sand				
ENV061	180.37	2.47	Fine sand	1.35	Poor	3.94	Very fine	21.91	Very leptokurtic	6.86	93.12	0.01	Sand	Sand and muddy sand	2.18	Fine sand	2.50	Fine sand				
ENV062	132.36	2.92	Fine sand	1.50	Poor	2.95	Very fine	14.05	Very leptokurtic	10.89	89.06	0.05	Muddy sand	Sand and muddy sand	2.60	Fine sand	3.00	Fine sand				
ENV063	157.24	2.67	Fine sand	1.49	Poor	2.79	Very fine	13.85	Very leptokurtic	10.17	89.73	0.10	Muddy sand	Sand and muddy sand	2.40	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV064	116.87	3.10	Very fine sand	1.83	Poor	2.37	Very fine	9.31	Very leptokurtic	16.70	83.24	0.07	Muddy sand	Sand and muddy sand	2.53	Fine sand	2.50	Fine sand	6.50	Fine silt		
ENV065	206.36	2.28	Fine sand	1.61	Poor	2.06	Very fine	13.67	Very leptokurtic	7.39	91.20	1.41	Slightly gravelly sand	Sand and muddy sand	2.14	Fine sand	2.50	Fine sand				
ENV066	189.35	2.40	Fine sand	1.41	Poor	3.07	Very fine	18.18	Very leptokurtic	6.65	92.76	0.59	Sand	Sand and muddy sand	2.22	Fine sand	2.50	Fine sand				

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV067	215.10	2.22	Fine sand	1.85	Poor	0.77	Fine	10.65	Very leptokurtic	7.41	87.85	4.73	Slightly gravelly sand	Sand and muddy sand	2.20	Fine sand	2.50	Fine sand	-3.50	Pebble		
ENV069	289.32	1.79	Medium sand	1.28	Poor	3.19	Very fine	24.46	Very leptokurtic	2.90	96.19	0.91	Sand	Sand and muddy sand	1.78	Medium sand	2.00	Medium sand				
ENV070	194.20	2.36	Fine sand	1.36	Poor	3.25	Very fine	19.70	Very leptokurtic	6.33	93.37	0.30	Sand	Sand and muddy sand	2.21	Fine sand	2.50	Fine sand				
ENV071	189.64	2.40	Fine sand	1.29	Poor	3.57	Very fine	22.84	Very leptokurtic	5.77	93.81	0.42	Sand	Sand and muddy sand	2.22	Fine sand	2.50	Fine sand				
ENV072	193.26	2.37	Fine sand	1.23	Poor	3.98	Very fine	25.80	Very leptokurtic	5.24	94.59	0.17	Sand	Sand and muddy sand	2.21	Fine sand	2.50	Fine sand				
ENV073	185.14	2.43	Fine sand	1.35	Poor	3.28	Very fine	20.66	Very leptokurtic	6.35	93.25	0.40	Sand	Sand and muddy sand	2.24	Fine sand	2.50	Fine sand				
ENV074	188.75	2.41	Fine sand	1.36	Poor	3.40	Very fine	18.93	Very leptokurtic	7.07	92.73	0.20	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				

Sample	Mean μ m	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV075	179.90	2.47	Fine sand	1.44	Poor	3.20	Very fine	17.04	Very leptokurtic	7.97	91.77	0.26	Sand	Sand and muddy sand	2.20	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV076	217.42	2.20	Fine sand	1.41	Poor	3.16	Very fine	18.84	Very leptokurtic	5.91	93.71	0.38	Sand	Sand and muddy sand	2.05	Fine sand	2.50	Fine sand				
ENV077	184.97	2.43	Fine sand	1.55	Poor	2.21	Very fine	14.87	Very leptokurtic	7.86	91.23	0.91	Sand	Sand and muddy sand	2.23	Fine sand	2.50	Fine sand				
ENV078	219.62	2.19	Fine sand	1.48	Poor	2.93	Very fine	16.96	Very leptokurtic	6.64	92.58	0.78	Sand	Sand and muddy sand	1.96	Medium sand	2.00	Medium sand				
ENV079	216.60	2.21	Fine sand	1.30	Poor	3.47	Very fine	22.30	Very leptokurtic	4.93	94.88	0.19	Sand	Sand and muddy sand	2.09	Fine sand	2.50	Fine sand				
ENV080	250.11	2.00	Medium sand	1.30	Poor	3.11	Very fine	24.42	Very leptokurtic	3.56	95.56	0.89	Sand	Sand and muddy sand	1.93	Medium sand	2.50	Fine sand				
ENV081	183.40	2.45	Fine sand	1.56	Poor	2.92	Very fine	14.80	Very leptokurtic	8.21	91.12	0.66	Sand	Sand and muddy sand	2.15	Fine sand	2.50	Fine sand				

Sample	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV082	202.97	2.30	Fine sand	1.32	Poor	3.65	Very fine	22.00	Very leptokurtic	5.63	94.31	0.06	Sand	Sand and muddy sand	2.15	Fine sand	2.50	Fine sand				
ENV083	181.63	2.46	Fine sand	1.46	Poor	2.88	Very fine	16.42	Very leptokurtic	7.51	92.00	0.49	Sand	Sand and muddy sand	2.25	Fine sand	2.50	Fine sand				
ENV084	172.17	2.54	Fine sand	1.52	Poor	2.78	Very fine	14.34	Very leptokurtic	8.81	90.79	0.41	Sand	Sand and muddy sand	2.27	Fine sand	2.50	Fine sand				
ENV085	190.16	2.39	Fine sand	1.46	Poor	2.80	Very fine	16.66	Very leptokurtic	7.36	92.04	0.61	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV086	187.71	2.41	Fine sand	1.37	Poor	3.53	Very fine	19.97	Very leptokurtic	6.80	92.98	0.22	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV087	177.67	2.49	Fine sand	1.83	Poor	0.83	Fine	11.12	Very leptokurtic	10.06	87.32	2.63	Slightly gravelly muddy sand	Sand and muddy sand	2.27	Fine sand	2.50	Fine sand	-3.50	Pebble	5.00	Coarse silt
ENV088	149.46	2.74	Fine sand	1.50	Poor	3.04	Very fine	14.92	Very leptokurtic	9.54	90.25	0.21	Sand	Sand and	2.40	Fine sand	2.50	Fine sand	6.50	Fine silt		

Sample	Mean μm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
														muddy sand								
ENV089	166.91	2.58	Fine sand	1.52	Poor	2.80	Very fine	14.05	Very leptokurtic	9.78	90.00	0.23	Sand	Sand and muddy sand	2.28	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV090	207.16	2.27	Fine sand	1.55	Poor	1.91	Very fine	14.38	Very leptokurtic	6.60	90.96	2.44	Slightly gravelly sand	Sand and muddy sand	2.19	Fine sand	2.50	Fine sand				
ENV091	180.66	2.47	Fine sand	1.88	Poor	1.49	Very fine	9.42	Very leptokurtic	10.61	86.06	3.33	Slightly gravelly muddy sand	Sand and muddy sand	2.26	Fine sand	2.50	Fine sand	6.50	Fine silt	5.50	Medium silt
ENV092	191.48	2.38	Fine sand	1.57	Poor	1.97	Very fine	13.55	Very leptokurtic	8.27	90.50	1.22	Slightly gravelly sand	Sand and muddy sand	2.20	Fine sand	2.50	Fine sand	5.00	Coarse silt	-3.00	Pebble
ENV093	171.34	2.55	Fine sand	1.68	Poor	2.28	Very fine	11.56	Very leptokurtic	10.32	88.94	0.74	Muddy sand	Sand and muddy sand	2.27	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV094	150.26	2.73	Fine sand	1.51	Poor	2.99	Very fine	14.53	Very leptokurtic	9.89	90.07	0.03	Sand	Sand and	2.43	Fine sand	2.50	Fine sand	5.00	Coarse silt		

Sample	Mean μm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
														muddy sand								
ENV095	194.27	2.36	Fine sand	1.56	Poor	1.75	Very fine	15.16	Very leptokurtic	6.87	91.14	2.00	Slightly gravelly sand	Sand and muddy sand	2.23	Fine sand	2.50	Fine sand				
ENV096	193.13	2.37	Fine sand	1.54	Poor	2.79	Very fine	14.09	Very leptokurtic	8.63	90.99	0.38	Sand	Sand and muddy sand	2.09	Fine sand	2.50	Fine sand	5.00	Coarse silt		
ENV097	180.90	2.47	Fine sand	1.36	Poor	3.86	Very fine	21.32	Very leptokurtic	7.07	92.92	0.02	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				
ENV098	134.90	2.89	Fine sand	1.52	Poor	2.99	Very fine	13.67	Very leptokurtic	11.41	88.59	0.00	Muddy sand	Sand and muddy sand	2.49	Fine sand	2.50	Fine sand				
ENV099	219.95	2.18	Fine sand	1.63	Poor	1.71	Very fine	13.82	Very leptokurtic	6.78	91.18	2.03	Slightly gravelly sand	Sand and muddy sand	2.06	Fine sand	2.50	Fine sand				
ENV100	147.72	2.76	Fine sand	1.50	Poor	2.91	Very fine	14.16	Very leptokurtic	10.47	89.41	0.12	Muddy sand	Sand and muddy sand	2.42	Fine sand	2.50	Fine sand	5.00	Coarse silt		

Sample	Mean μ m	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness Description	Kurtosis value	Kurtosis description	Fines%	Sands%	Gravels%	Folk modified	Folk Eunis	Median	Description	1st Local maxima	Description	2nd Local ,axima	Description	3rd Local Maxima	Description
ENV101	176.10	2.51	Fine sand	1.68	Poor	2.22	Very fine	11.69	Very leptokurtic	10.29	88.61	1.10	Slightly gravelly muddy sand	Sand and muddy sand	2.19	Fine sand	2.50	Fine sand	6.50	Fine silt	5.50	Medium silt
ENV102	199.23	2.33	Fine sand	1.26	Poor	4.25	Very fine	27.98	Very leptokurtic	4.64	95.26	0.09	Sand	Sand and muddy sand	2.17	Fine sand	2.50	Fine sand				

Appendix B Sediment Contaminants Analysis

B.1 Concentrations of metals within the Survey Area

Table B. 1: Concentrations of metals within the Survey Area

Station	Easting	Northing	Arsenic	Mercury	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
Unit			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
MS AL1			20	0.25	0.4	40	40	20	50	130
MS AL2			70	1.5	4	370	300	150	400	600
CSQG TEL			7.24	0.13	0.7	52.3	18.7	-	30.2	124
CSQG PEL			41.6	0.7	4.2	160	108	-	112	271
ENV003	623255	6299193	5.1	<0.01	<0.2	17.5	3.8	5.8	8.7	17.9
ENV005	628723	6292812	3.6	<0.01	<0.2	14.6	2.4	3.8	8.5	26.2
ENV007	634166	6286418	3.7	<0.01	<0.2	13.5	2.8	3.9	8.3	16.5
ENV009	639608	6280018	3.5	<0.01	<0.2	17.2	2.6	4.3	8.1	18.1
ENV011	645049	6273619	3.2	<0.01	<0.2	12.8	2.3	4.0	7.6	17.0
ENV013	650491	6267220	3.2	<0.01	<0.2	13.1	2.7	4.6	8.5	18.2
ENV016	617301	6299632	4.6	<0.01	<0.2	20.6	5.1	5.7	9.2	19.9
ENV018	622762	6293249	4.4	<0.01	<0.2	16.9	2.9	4.1	8.8	19.3

Station	Easting	Northing	Arsenic	Mercury	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
ENV020	628212	6286857	3.9	<0.01	<0.2	14.9	2.3	3.7	7.9	19.7
ENV022	633686	6280452	4.3	<0.01	<0.2	14.1	2.5	12.0	9.4	15.7
ENV024	639143	6274103	4.3	<0.01	<0.2	18.3	2.8	3.6	8.5	15.9
ENV026	644578	6267695	3.3	<0.01	<0.2	14.0	3.1	4.2	8.7	19.2
ENV028	650004	6261284	3.4	<0.01	<0.2	15.2	2.7	3.9	7.8	16.8
ENV029	611406	6300119	7.2	<0.01	<0.2	18.1	3.7	7.3	10.4	18.5
ENV031	616855	6293728	5.0	0.04	<0.2	15.5	2.5	4.1	9.4	18.5
ENV033	622296	6287329	4.4	<0.01	<0.2	14.4	3.3	4.1	9.3	17.1
ENV035	627775	6280956	5.0	<0.01	<0.2	14.2	3.0	3.8	9.6	17.8
ENV037	633208	6274553	4.0	<0.01	<0.2	15.4	2.7	4.1	8.7	17.7
ENV039	638643	6268149	4.3	<0.01	<0.2	18.9	3.5	4.9	9.1	24.9
ENV041	644082	6261748	3.4	<0.01	<0.2	12.5	2.3	3.7	7.6	18.2
ENV042	610906	6294170	4.3	<0.01	<0.2	14.9	2.7	3.9	8.7	17.0
ENV044	616375	6287797	4.9	<0.01	<0.2	14.3	3.4	3.9	9.6	16.8
ENV046	621844	6281416	4.6	<0.01	<0.2	18.7	2.7	5.0	9.4	17.3
ENV048	627301	6274992	4.5	<0.01	<0.2	21.0	5.7	6.2	9.7	18.3

Station	Easting	Northing	Arsenic	Mercury	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
ENV050	632737	6268661	4.2	<0.01	<0.2	18.1	2.9	4.5	9.1	18.0
ENV052	638190	6262240	3.1	<0.01	<0.2	17.4	3.0	4.7	8.9	17.3
ENV054	613686	6318222	27.0	<0.01	<0.2	19.0	4.3	9.1	23.4	26.6
ENV057	637913	6288257	4.2	<0.01	<0.2	17.3	3.2	5.0	9.5	18.2
ENV058	645320	6279865	3.8	<0.01	<0.2	15.4	4.1	4.9	8.3	20.3
ENV060	659318	6257459	3.3	<0.01	<0.2	14.9	2.7	4.2	7.7	15.4
ENV062	640658	6251440	3.7	<0.01	<0.2	24.3	3.6	5.4	9.2	20.0
ENV064	617704	6277598	3.6	<0.01	<0.2	14.6	3.0	4.5	8.5	18.1
ENV066	605487	6294063	5.8	<0.01	<0.2	17.8	3.4	4.6	10.0	21.3
ENV071	621781	6300917	4.1	<0.01	<0.2	17.3	3.1	4.5	8.8	20.8
ENV073	616531	6295067	4.8	<0.01	<0.2	15.5	3.0	5.0	9.4	21.1
ENV075	634828	6283797	3.3	<0.01	<0.2	16.5	3.3	4.2	8.3	18.0
ENV077	630509	6279165	4.1	<0.01	<0.2	14.8	3.2	4.8	8.4	16.6
ENV078	623259	6279407	5.3	<0.01	<0.2	19.3	3.6	4.9	9.3	22.6
ENV079	640824	6275383	4.3	<0.01	<0.2	15.4	3.6	4.0	8.6	18.8
ENV081	613106	6302222	5.6	<0.01	<0.2	21.4	4.2	4.9	10.1	36.7

Station	Easting	Northing	Arsenic	Mercury	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
ENV082	618084	6304296	5.0	<0.01	<0.2	14.5	2.8	3.9	9.2	18.8
ENV084	622094	6283784	5.0	<0.01	<0.2	19.3	4.1	5.3	9.3	17.8
ENV086	637889	6278798	4.2	<0.01	<0.2	14.8	4.8	5.2	9.2	17.7
ENV087	635342	6277208	3.7	<0.01	<0.2	14.1	2.8	5.3	8.2	16.9
ENV092	630065	6275774	4.3	<0.01	<0.2	21.7	5.7	6.0	9.3	18.7
ENV094	638115	6261427	3.6	<0.01	<0.2	18.5	3.3	4.7	8.4	18.3
ENV096	620646	6274261	5.3	<0.01	<0.2	19.4	5.4	5.8	9.4	19.2
ENV098	650414	6265595	3.0	<0.01	<0.2	12.6	2.5	4.7	7.6	15.1
ENV100	649146	6268794	3.5	<0.01	<0.2	18.9	3.1	4.7	9.2	21.8
ENV102	635420	6284406	4.1	<0.01	<0.2	17.1	4.8	5.8	9.2	21.2

B.2 Concentration of PCBs recorded in sediments within the Survey Area

Table B. 2: Concentration of PCBs recorded in sediments within the Survey Area

Station	Easting	Northing	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Total ICES-7 PCBs
Units			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
MS AL1			-	-	-	-	-	-	-	10
MS AL2			-	-	-	-	-	-	-	1000

Station	Easting	Northing	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Total ICES-7 PCBs
ENV003	623255	6299193	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV005	628723	6292812	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV007	634166	6286418	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV009	639608	6280018	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV011	645049	6273619	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV013	650491	6267220	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV016	617301	6299632	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV018	622762	6293249	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV020	628212	6286857	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV022	633686	6280452	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV024	639143	6274103	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable

Station	Easting	Northing	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Total ICES-7 PCBs
ENV026	644578	6267695	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV028	650004	6261284	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV029	611406	6300119	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV031	616855	6293728	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV033	622296	6287329	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV035	627775	6280956	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV037	633208	6274553	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV039	638643	6268149	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV041	644082	6261748	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV042	610906	6294170	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV044	616375	6287797	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable

Station	Easting	Northing	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Total ICES-7 PCBs
ENV046	621844	6281416	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV048	627301	6274992	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV050	632737	6268661	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV052	638190	6262240	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV054	613686	6318222	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV057	637913	6288257	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV058	645320	6279865	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV060	659318	6257459	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV062	640658	6251440	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV064	617704	6277598	0.05	0.09	0.13	0.2	0.13	0.14	0.13	0.87
ENV066	605487	6294063	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable

Station	Easting	Northing	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Total ICES-7 PCBs
ENV071	621781	6300917	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV073	616531	6295067	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV075	634828	6283797	<0.08	0.14	0.19	0.09	<0.08	0.09	<0.08	0.51
ENV077	630509	6279165	0.21	0.37	0.5	0.58	0.39	0.44	0.38	2.87
ENV078	623259	6279407	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV079	640824	6275383	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV081	613106	6302222	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV082	618084	6304296	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV084	622094	6283784	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV086	637889	6278798	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV087	635342	6277208	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV092	630065	6275774	0.18	0.20	<0.08	<0.08	<0.08	<0.08	<0.08	0.38

Station	Easting	Northing	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Total ICES-7 PCBs
ENV094	638115	6261427	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV096	620646	6274261	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV098	650414	6265595	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV100	649146	6268794	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable
ENV102	635420	6284406	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	Not Quantifiable

B.3 Concentrations of PAHs in sediments within the Survey Area

Table B. 3: Concentrations of PAHs in sediments within the Survey Area

Station	Easting	Northing	Anthracene	Phenanthrene	Naphthalene	Dibenzothiophene	Fluoranthene	Pyrene	Benzanthracene	Chrysene	Benzfluoranthrenes	Benzopyrenes	Dibenzoanthanthrenes	Idenopyrene	Benzperylene
Unit			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
MS AL1			-	-	-	-	-	-	-	-	-	-	-	-	20
MS AL2			-	-	-	-	-	-	-	-	-	-	-	-	180
ENV003	623255	6299193	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	2.59	2.59	2.59
ENV005	628723.3	6292812	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	1.44	1.44	1.44
ENV007	634166.1	6286418	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.63	1.63	4.54	4.54	4.54
ENV009	639608.3	6280018	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.53	1.53	4.42	4.42	4.42
ENV011	645048.5	6273619	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	3.43	3.43	6.18	6.18	6.18
ENV013	650491	6267220	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.88	5.88	8.51	8.51	8.51

Station	Easting	Northing	Anthracene	Phenanthrene	Naphthalene	Dibenzothiophene	Fluoranthene	Pyrene	Benzanthracene	Chrysene	Benzfluoranthrenes	Benzopyrenes	Dibenzoanthanthrenes	Idenopyrene	Benzperylene
ENV016	617301	6299632	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.47	3.47	3.47
ENV018	622761.8	6293249	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.64	1.64	4.49	4.49	4.49
ENV020	628211.8	6286857	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.39	1.39	3.74	3.74	3.74
ENV022	633685.5	6280452	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.82	3.82	3.82
ENV024	639143.4	6274103	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.30	3.30	3.30
ENV026	644578	6267695	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.07	5.07	7.66	7.66	7.66
ENV028	650004.2	6261284	4.97	4.97	<1	<1	5.06	5.06	3.79	3.79	8.78	8.78	9.60	9.60	9.60
ENV029	611406.1	6300119	NQ	NQ	1.47	<1	NQ	NQ	NQ	NQ	NQ	NQ	2.61	2.61	2.61
ENV031	616855.1	6293728	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.53	3.53	3.53
ENV033	622296	6287329	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	4.00	4.00	4.00

Station	Easting	Northing	Anthracene	Phenanthrene	Naphthalene	Dibenzothiophene	Fluoranthene	Pyrene	Benzanthracene	Chrysene	Benzfluoranthrenes	Benzopyrenes	Dibenzoanthanthrenes	Idenopyrene	Benzperylene
ENV035	627774.8	6280956	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.53	1.53	4.29	4.29	4.29
ENV037	633207.6	6274553	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	4.71	4.71	4.71
ENV039	638643.2	6268149	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.98	1.98	5.62	5.62	5.62
ENV041	644082.2	6261748	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.16	3.16	3.16
ENV042	610906.3	6294170	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
ENV044	616375	6287797	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.32	1.32	3.54	3.54	3.54
ENV046	621844	6281416	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.81	3.81	3.81
ENV048	627301.3	6274992	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	2.19	2.19	5.65	5.65	5.65
ENV050	632736.9	6268661	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	3.48	3.48	6.11	6.11	6.11
ENV052	638190.1	6262240	NQ	NQ	<1	<1	1.44	1.44	NQ	NQ	7.98	7.98	9.87	9.87	9.87

Station	Easting	Northing	Anthracene	Phenanthrene	Naphthalene	Dibenzothiophene	Fluoranthene	Pyrene	Benzanthracene	Chrysene	Benzfluoranthrenes	Benzopyrenes	Dibenzoanthanthrenes	Idenopyrene	Benzperylene
ENV054	613685.8	6318222	3.27	3.27	<1	<1	13.89	13.89	7.43	7.43	14.38	14.38	6.03	6.03	6.03
ENV057	637913.1	6288257	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.47	5.47	6.82	6.82	6.82
ENV058	645319.9	6279865	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.66	5.66	7.26	7.26	7.26
ENV060	659318.3	6257459	NQ	NQ	<1	<1	1.47	1.47	NQ	NQ	5.59	5.59	7.41	7.41	7.41
ENV062	640658.4	6251440	3.51	3.51	<1	<1	5.28	5.28	1.39	1.39	7.48	7.48	10.40	10.40	10.40
ENV064	617704	6277598	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.53	5.53	7.21	7.21	7.21
ENV066	605487	6294063	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	2.91	2.91	2.91
ENV071	621780.9	6300917	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	2.88	2.88	2.88
ENV073	616530.9	6295067	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.52	3.52	3.52
ENV075	634827.8	6283797	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.31	1.31	3.67	3.67	3.67

Station	Easting	Northing	Anthracene	Phenanthrene	Naphthalene	Dibenzothiophene	Fluoranthene	Pyrene	Benzanthracene	Chrysene	Benzfluoranthrenes	Benzopyrenes	Dibenzoanthanthrenes	Idenopyrene	Benzperylene
ENV077	630509.3	6279165	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	4.30	4.30	4.98	4.98	4.98
ENV078	623258.8	6279407	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.29	1.29	3.98	3.98	3.98
ENV079	640823.6	6275383	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.65	1.65	4.66	4.66	4.66
ENV081	613106.1	6302222	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
ENV082	618083.6	6304296	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
ENV084	622094.3	6283784	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.98	1.98	5.02	5.02	5.02
ENV086	637888.6	6278798	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	NQ	NQ	3.4114286	3.4114286	3.4114286
ENV087	635342.4	6277208	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	4.77	4.77	5.66	5.66	5.66
ENV092	630064.6	6275774	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.45	1.45	4.69	4.69	4.69
ENV094	638115.3	6261427	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.64	5.64	6.88	6.88	6.88

Station	Easting	Northing	Anthracene	Phenanthrene	Naphthalene	Dibenzothiophene	Fluoranthene	Pyrene	Benzanthracene	Chrysene	Benzfluoranthrenes	Benzopyrenes	Dibenzoanthanthrenes	Idenopyrene	Benzperylene
ENV096	620645.9	6274261	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.65	1.65	4.19	4.19	4.19
ENV098	650414.2	6265595	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.88	5.88	7.58	7.58	7.58
ENV100	649146.4	6268794	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	5.97	5.97	7.12	7.12	7.12
ENV102	635420.3	6284406	NQ	NQ	<1	<1	NQ	NQ	NQ	NQ	1.38	1.38	4.23	4.23	4.23

Appendix C Raw Data Results of Benthic Infaunal Univariate Analysis

C.1 Raw Data Results of Benthic Infaunal Univariate Analysis

S= number of species, N= Abundance, d = Margalef's index of Richness; J' = Pielou's Evenness index; H' = Shannon-Wiener Diversity index; I = Simpson's index of Dominance.

Table C. 1: Raw Data Results of Benthic Infaunal Univariate Analysis

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV002	620551	6302391	SS.SSa.CFiSa.ApriBatPo	34	249	5.981	0.7536	2.658	0.8943
ENV003	623255	6299193	SS.SSa.CFiSa.ApriBatPo	43	240	7.663	0.7025	2.642	0.8286
ENV004	626000	6296011	SS.SSa.CFiSa.ApriBatPo	42	245	7.453	0.8085	3.022	0.9297
ENV005	628723	6292812	SS.SSa.CFiSa.ApriBatPo	58	385	9.575	0.7076	2.873	0.8593
ENV006	631443	6289614	SS.SSa.CFiSa.EpusOborApri	48	311	8.188	0.7494	2.901	0.8892
ENV007	634166	6286418	SS.SSa.CFiSa.EpusOborApri	56	375	9.28	0.7689	3.095	0.9246
ENV008	636888	6283219	SS.SSa.CFiSa.EpusOborApri	45	309	7.674	0.7903	3.008	0.9186
ENV009	639608	6280018	SS.SSa.CFiSa.EpusOborApri	40	234	7.149	0.8017	2.957	0.9267
ENV010	642330	6276821	SS.SSa.CFiSa.EpusOborApri	50	314	8.523	0.7739	3.027	0.912

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV011	645049	6273619	SS.SSa.CFiSa.EpusOborApri	50	367	8.298	0.7063	2.763	0.8561
ENV012	647758	6270408	SS.SSa.CFiSa.EpusOborApri	43	265	7.527	0.8061	3.032	0.9254
ENV013	650491	6267220	SS.SSa.CFiSa.EpusOborApri	47	206	8.634	0.8322	3.204	0.9363
ENV014	653212	6264021	SS.SSa.CFiSa.EpusOborApri	54	530	8.449	0.6437	2.568	0.8132
ENV015	614556	6302812	SS.SSa.CFiSa.ApriBatPo	41	214	7.454	0.8386	3.114	0.9376
ENV016	617301	6299632	SS.SSa.CFiSa.ApriBatPo	43	224	7.761	0.7362	2.769	0.879
ENV017	620038	6296447	SS.SSa.CFiSa.ApriBatPo	47	277	8.179	0.6908	2.66	0.8387
ENV018	622762	6293249	SS.SSa.CFiSa.ApriBatPo	39	183	7.294	0.7688	2.816	0.8831
ENV019	625487	6290053	SS.SSa.CFiSa.ApriBatPo	41	214	7.454	0.7396	2.747	0.8573
ENV020	628212	6286857	SS.SSa.CFiSa.ApriBatPo	40	230	7.172	0.6552	2.417	0.7708
ENV021	630919	6283688	SS.SSa.CFiSa.ApriBatPo	51	333	8.609	0.6676	2.625	0.8056
ENV022	633686	6280452	SS.SSa.CFiSa.ApriBatPo	62	502	9.809	0.54	2.229	0.6819

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV023	636410	6277259	SS.SSa.CFiSa.ApriBatPo	52	368	8.632	0.6605	2.61	0.8063
ENV024	639143	6274103	SS.SSa.CFiSa.ApriBatPo	56	430	9.07	0.6828	2.749	0.8609
ENV025	641857	6270894	SS.SMx.OMx.PoVen	50	327	8.463	0.7733	3.025	0.9116
ENV026	644578	6267695	SS.SMx.OMx.PoVen	43	226	7.748	0.7497	2.82	0.8852
ENV027	647295	6264493	SS.SMx.OMx.PoVen	42	208	7.681	0.8345	3.119	0.9297
ENV028	650004	6261284	SS.SSa.CFiSa.EpusOborApri	52	229	9.386	0.8368	3.306	0.9448
ENV029	611406	6300119	SS.SSa.CFiSa.ApriBatPo	44	217	7.993	0.7917	2.996	0.9068
ENV030	614139	6296927	SS.SSa.CFiSa.ApriBatPo	55	234	9.899	0.8073	3.235	0.9347
ENV031	616855	6293728	SS.SSa.CFiSa.ApriBatPo	42	212	7.654	0.8354	3.122	0.9366
ENV032	619576	6290527	SS.SSa.CFiSa.ApriBatPo	38	160	7.29	0.7913	2.878	0.8903
ENV033	622296	6287329	SS.SSa.CFiSa.ApriBatPo	49	266	8.597	0.6257	2.435	0.7828
ENV034	625016	6284128	SS.SSa.CFiSa.ApriBatPo	58	405	9.494	0.664	2.696	0.8075

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV035	627775	6280956	SS.SSa.CFiSa.ApriBatPo	49	290	8.466	0.6898	2.685	0.8229
ENV036	630495	6277758	SS.SSa.CFiSa.ApriBatPo	44	322	7.446	0.6629	2.509	0.7867
ENV037	633208	6274553	SS.SSa.CFiSa.ApriBatPo	48	404	7.831	0.6388	2.473	0.7787
ENV038	635927	6271359	SS.SSa.CFiSa.ApriBatPo	57	445	9.183	0.5711	2.309	0.6947
ENV039	638643	6268149	SS.SSa.CFiSa.ApriBatPo	45	147	8.817	0.8927	3.398	0.9588
ENV040	641363	6264947	SS.SSa.CFiSa.EpusOborApri	49	348	8.202	0.7296	2.839	0.8584
ENV041	644082	6261748	SS.SSa.CFiSa.EpusOborApri	47	372	7.772	0.6681	2.572	0.8154
ENV042	610906	6294170	SS.SSa.CFiSa.ApriBatPo	54	213	9.886	0.8733	3.484	0.9592
ENV043	613640	6290983	SS.SSa.CFiSa.ApriBatPo	45	153	8.747	0.8857	3.371	0.9585
ENV044	616375	6287797	SS.SSa.CFiSa.ApriBatPo	56	302	9.632	0.7867	3.167	0.9175
ENV045	619093	6284629	SS.SSa.CFiSa.ApriBatPo	41	162	7.862	0.8066	2.995	0.9197
ENV046	621844	6281416	SS.SSa.CFiSa.EpusOborApri	43	140	8.499	0.7965	2.996	0.8904

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV047	624574	6278223	SS.SSa.CFiSa.ApriBatPo	44	182	8.263	0.7549	2.857	0.8614
ENV048	627301	6274992	SS.SSa.CFiSa.EpusOborApri	36	138	7.103	0.7863	2.818	0.89
ENV049	627301	6274992	SS.SMx.OMx.PoVen	49	370	8.117	0.6462	2.515	0.7791
ENV050	630023	6271801	SS.SSa.CFiSa.ApriBatPo	43	148	8.405	0.7692	2.893	0.8653
ENV051	632737	6268661	SS.SMx.OMx.PoVen	46	369	7.613	0.5978	2.289	0.734
ENV052	638190	6262240	SS.SSa.CFiSa.ApriBatPo	58	405	9.494	0.6733	2.734	0.8317
ENV053	640911	6259040	SS.SMx.OMx.PoVen	46	196	8.526	0.7732	2.96	0.8924
ENV054	613686	6318222	SS.SMx.OMx.PoVen	52	122	10.62	0.9266	3.661	0.9745
ENV055	622891	6305906	SS.SSa.CFiSa.ApriBatPo	47	401	7.674	0.5493	2.115	0.7213
ENV056	635629	6292272	SS.SSa.CFiSa.EpusOborApri	52	228	9.393	0.746	2.947	0.8888
ENV057	637913	6288257	SS.SSa.CFiSa.EpusOborApri	50	273	8.735	0.8229	3.219	0.9402
ENV058	645320	6279865	SS.SMx.OMx.PoVen	53	250	9.418	0.7369	2.926	0.8755

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV059	652230	6270186	SS.SMx.OMx.PoVen	55	313	9.398	0.7729	3.097	0.9148
ENV060	659318	6257459	SS.SMx.OMx.PoVen	46	252	8.138	0.7156	2.74	0.8389
ENV061	652017	6255316	SS.SSa.CFiSa.ApriBatPo	37	166	7.042	0.8122	2.933	0.9193
ENV062	640658	6251440	SS.SMx.OMx.PoVen	53	329	8.972	0.7613	3.022	0.9031
ENV063	628919	6264308	SS.SMx.OMx.PoVen	50	228	9.025	0.8148	3.187	0.9206
ENV064	617704	6277598	SS.SMx.OMx.PoVen	61	271	10.71	0.8102	3.331	0.9345
ENV065	609859	6286958	SS.SSa.CFiSa.ApriBatPo	53	169	10.14	0.8808	3.497	0.9589
ENV066	605487	6294063	SS.SSa.CFiSa.ApriBatPo	64	290	11.11	0.8547	3.555	0.96
ENV067	603702	6297690	SS.SSa.CFiSa.ApriBatPo	54	193	10.07	0.8725	3.48	0.9561
ENV069	609482	6308998	SS.SSa.CFiSa.ApriBatPo	44	289	7.589	0.7549	2.856	0.8915
ENV070	619774	6303252	SS.SSa.CFiSa.ApriBatPo	31	217	5.576	0.7513	2.58	0.8637
ENV071	621781	6300917	SS.SSa.CFiSa.ApriBatPo	43	254	7.585	0.7577	2.85	0.8838

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV072	617764	6299090	SS.SSa.CFiSa.ApriBatPo	50	306	8.561	0.7715	3.018	0.9237
ENV073	616531	6295067	SS.SSa.CFiSa.ApriBatPo	52	245	9.271	0.7931	3.134	0.9247
ENV074	627626	6287597	SS.SSa.CFiSa.ApriBatPo	38	146	7.424	0.7733	2.813	0.8687
ENV075	634828	6283797	SS.SSa.CFiSa.ApriBatPo	46	247	8.168	0.7271	2.784	0.8394
ENV076	629350	6280887	SS.SMx.OMx.PoVen	50	242	8.927	0.7777	3.042	0.9131
ENV077	630509	6279165	SS.SMx.OMx.PoVen	62	416	10.11	0.6562	2.708	0.8354
ENV078	623259	6279407	SS.SSa.CFiSa.ApriBatPo	42	181	7.887	0.8397	3.139	0.9276
ENV079	640824	6275383	SS.SSa.CFiSa.EpusOborApri	31	145	6.028	0.7498	2.575	0.863
ENV080	637942	6270427	SS.SSa.CFiSa.EpusOborApri	30	84	6.545	0.8881	3.021	0.9412
ENV081	613106	6302222	SS.SSa.CFiSa.ApriBatPo	45	134	8.984	0.8121	3.091	0.9235
ENV082	618084	6304296	SS.SSa.CFiSa.ApriBatPo	41	173	7.762	0.7746	2.876	0.8924
ENV083	618841	6288070	SS.SMx.OMx.PoVen	50	228	9.025	0.7926	3.101	0.9238

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV084	622094	6283784	SS.SMx.OMx.PoVen	51	237	9.144	0.7907	3.109	0.9107
ENV085	629081	6284890	SS.SSa.CFiSa.ApriBatPo	57	284	9.913	0.7076	2.861	0.8404
ENV086	637889	6278798	SS.SSa.CFiSa.ApriBatPo	50	461	7.989	0.5357	2.096	0.659
ENV087	635342	6277208	SS.SMx.OMx.PoVen	54	260	9.531	0.6756	2.695	0.8144
ENV088	642712	6266174	SS.SMx.OMx.PoVen	51	265	8.961	0.7219	2.838	0.848
ENV089	646892	6262662	SS.SMx.OMx.PoVen	41	216	7.441	0.7492	2.782	0.8698
ENV090	611789	6293361	SS.SSa.CFiSa.ApriBatPo	49	182	9.224	0.8621	3.355	0.9536
ENV091	611450	6292277	SS.SSa.CFiSa.ApriBatPo	49	153	9.542	0.8752	3.406	0.9562
ENV092	630065	6275774	SS.SSa.CFiSa.EpusOborApri	39	170	7.399	0.7175	2.629	0.8446
ENV093	632443	6269503	SS.SMx.OMx.PoVen	61	338	10.3	0.7348	3.021	0.8974
ENV094	638115	6261427	SS.SMx.OMx.PoVen	49	195	9.103	0.7631	2.97	0.8912
ENV095	607480	6297696	SS.SSa.CFiSa.ApriBatPo	42	136	8.346	0.8315	3.108	0.9306

Station	Easting	Northing	Biotope	S	N	d	J'	H'(loge)	I
ENV096	620646	6274261	SS.SMx.OMx.PoVen	51	148	10.01	0.884	3.476	0.9597
ENV097	648103	6250451	SS.SMx.OMx.PoVen	48	235	8.609	0.7963	3.082	0.9048
ENV098	650414	6265595	SS.SSa.CFiSa.ApriBatPo	43	217	7.807	0.7352	2.765	0.8541
ENV099	638553	6271250	SS.SMx.OMx.PoVen	63	283	10.98	0.8031	3.327	0.9258
ENV100	649146	6268794	SS.SMx.OMx.PoVen	52	207	9.564	0.7529	2.975	0.8751
ENV101	623192	6301487	SS.SSa.CFiSa.ApriBatPo	47	276	8.184	0.6767	2.606	0.8347
ENV102	635420	6284406	SS.SSa.CFiSa.EpusOborApri	39	189	7.249	0.7542	2.763	0.8896

Appendix D Infaunal Multivariate Analysis Results

D.1 Infaunal Multivariate Analysis Results

Table D. 1: Infaunal Multivariate Analysis Results

SIMPER					
Similarity Percentages - species contributions					
One-Way Analysis					
Data worksheet					
Name: Data2					
Data type: Abundance					
Sample selection: All					
Variable selection: All					
Parameters					
Resemblance: S17 Bray Curtis similarity					
Cut off for low contributions: 90.00%					
Factor Groups					
Sample	WOJuv				
ENV002	e				
ENV015	e				
ENV029	e				
ENV055	e				

SIMPER					
ENV069	e				
ENV070	e				
ENV081	e				
ENV082	e				
ENV003	g				
ENV004	g				
ENV016	g				
ENV017	g				
ENV018	g				
ENV031	g				
ENV042	g				
ENV043	g				
ENV045	g				
ENV095	g				
ENV005	j				
ENV006	h				
ENV007	h				
ENV008	h				
ENV009	h				
ENV010	h				
ENV011	h				
ENV012	h				
ENV013	h				
ENV014	h				

SIMPER					
ENV028	h				
ENV040	h				
ENV041	h				
ENV056	h				
ENV057	h				
ENV019	n				
ENV032	n				
ENV035	n				
ENV039	n				
ENV047	n				
ENV050	n				
ENV071	n				
ENV075	n				
ENV078	n				
ENV085	n				
ENV098	n				
ENV020	f				
ENV074	f				
ENV021	o				
ENV022	o				
ENV023	o				
ENV024	o				
ENV034	o				
ENV037	o				

SIMPER					
ENV086	o				
ENV025	m				
ENV026	m				
ENV027	m				
ENV049	m				
ENV051	m				
ENV053	m				
ENV058	m				
ENV059	m				
ENV060	m				
ENV062	m				
ENV063	m				
ENV064	m				
ENV077	m				
ENV087	m				
ENV088	m				
ENV089	m				
ENV094	m				
ENV097	m				
ENV099	m				
ENV100	m				
ENV030	c				
ENV061	c				
ENV033	p				

SIMPER					
ENV036	p				
ENV038	p				
ENV052	p				
ENV044	l				
ENV065	l				
ENV066	l				
ENV072	l				
ENV073	l				
ENV046	i				
ENV048	i				
ENV079	i				
ENV092	i				
ENV102	i				
ENV054	a				
ENV067	d				
ENV090	d				
ENV091	d				
ENV101	d				
ENV076	k				
ENV083	k				
ENV084	k				
ENV093	k				
ENV096	k				
ENV080	b				

SIMPER					
Group e					
Average similarity: 52.15					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	7.41	7.7	5.82	14.77	14.77
Bathyporeia elegans	3.64	3.83	2.74	7.35	22.12
Scoloplos armiger	3.66	3.38	3.59	6.48	28.59
Abra	3.19	3.02	2.23	5.78	34.38
Bathyporeia	3.06	3	1.64	5.74	40.12
THRACIOIDEA	2.93	2.97	1.68	5.7	45.82
Ophelia borealis	3.05	2.43	2.62	4.66	50.48
Ophiocten affinis	3.16	2.25	1.13	4.32	54.8
Spiophanes kroyeri	2.37	2.16	2.45	4.14	58.95
Sthenelais limicola	1.83	1.94	3.86	3.72	62.66
Spio goniocephala	2.16	1.38	1.24	2.64	65.3
Abra prismatica	1.45	1.18	1.34	2.27	67.57
Pholoe baltica	1.18	1.1	1.59	2.12	69.69
NEMERTEA	1.34	0.97	0.98	1.86	71.55
Owenia	1.16	0.9	1.02	1.73	73.27
Lanice conchilega	1.22	0.87	0.99	1.67	74.94
Amphiuridae	1	0.82	1.01	1.57	76.52
Cochlodesma praetenue	1.5	0.81	0.85	1.55	78.07
Eudorellopsis deformis	1.15	0.74	0.69	1.41	79.49
Cerianthus lloydii	0.95	0.73	1.01	1.4	80.88

SIMPER					
Ennucula tenuis	0.8	0.72	1.05	1.39	82.27
Chaetozone christiei	0.85	0.69	1.04	1.32	83.59
Nephtys	0.95	0.63	0.71	1.21	84.81
Travisia forbesii	0.77	0.48	0.72	0.93	85.73
Fabulina fabula	0.96	0.48	0.5	0.92	86.65
Eteone cf. longa	0.68	0.45	0.73	0.87	87.52
Paramphilochoides odontonyx	0.63	0.45	0.73	0.86	88.38
Philinidae	0.72	0.45	0.73	0.86	89.24
Amphiura filiformis	0.83	0.45	0.5	0.85	90.1
Group g					
Average similarity: 57.42					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	6.45	6.67	3.77	11.62	11.62
Abra	4.55	4.78	4.26	8.32	19.94
Lanice conchilega	3.41	3.79	5	6.6	26.54
Ophiocten affinis	3.41	3.54	3.44	6.17	32.71
Scoloplos armiger	3.02	3.33	4.18	5.81	38.51
THRACIOIDEA	2.75	2.81	4.58	4.89	43.41
Sthenelais limicola	2.47	2.51	3.16	4.37	47.77
CEPHALASPIDEA	2.33	2.38	3.04	4.15	51.93
Spiophanes kroyeri	2.09	2.26	3.03	3.94	55.87
Abra prismatica	2.02	2.14	4.3	3.73	59.6
Echinocyamus pusillus	1.84	1.82	2.98	3.18	62.78

SIMPER					
Bathyporeia	1.94	1.66	1.61	2.89	65.67
Amphiuridae	1.39	1.36	1.74	2.37	68.04
Bathyporeia tenuipes	1.39	1.32	1.71	2.29	70.33
Ennucula tenuis	1.42	1.29	1.68	2.25	72.58
Bathyporeia elegans	1.86	1.22	0.89	2.13	74.71
GASTROPODA	1.19	1.12	1.82	1.95	76.66
Phaxas pellucidus	1.24	1.1	1.22	1.92	78.58
Pholoe baltica	1.22	0.92	1.15	1.6	80.19
Amphiura filiformis	1.24	0.77	0.89	1.35	81.53
Eudorellopsis deformis	1.16	0.74	0.89	1.28	82.82
Harpinia antennaria	1.03	0.73	0.88	1.28	84.09
Cerianthus lloydii	0.81	0.62	0.92	1.08	85.17
Ophelia borealis	1.04	0.6	0.88	1.05	86.22
Retusa	1.22	0.57	0.62	1	87.22
Scolelepis	0.8	0.49	0.68	0.85	88.07
Goniada maculata	0.79	0.48	0.69	0.83	88.9
Cochlodesma praetenue	1.01	0.47	0.51	0.83	89.73
Edwardsia claparedii	0.64	0.45	0.7	0.78	90.51
Group j					
Less than 2 samples in group					
Group h					
Average similarity: 58.84					

SIMPER					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	8.25	6.55	3.16	11.13	11.13
Lanice conchilega	5.48	4.74	5.12	8.06	19.19
Abra	4.7	4.2	5.23	7.15	26.33
Scoloplos armiger	3.62	3.27	5.3	5.56	31.89
THRACIOIDEA	3.33	3.03	5.08	5.15	37.05
Ophiocten affinis	3.44	2.99	3.67	5.09	42.13
CEPHALASPIDEA	3.29	2.75	3.44	4.67	46.81
Retusa	3.28	2.73	2.29	4.64	51.44
Echinocyamus pusillus	3.12	2.69	3.87	4.57	56.01
Spiophanes kroyeri	2.63	2.07	2.72	3.52	59.53
Ennucula tenuis	2.17	1.54	1.5	2.61	62.14
SIPUNCULA	2.12	1.52	1.5	2.59	64.73
Sthenelais limicola	1.92	1.5	2.05	2.55	67.28
Eudorellopsis deformis	1.87	1.26	1.36	2.15	69.43
Paramphinome jeffreysii	1.58	1.05	1.32	1.79	71.22
Cylichna cylindracea	1.35	0.91	1.45	1.55	72.77
NEMERTEA	1.17	0.87	1.52	1.48	74.26
Bathyporeia	1.53	0.87	1.07	1.48	75.74
Amphiuridae	1.51	0.8	0.78	1.37	77.11
Amphiura filiformis	1.5	0.77	0.82	1.3	78.41
Pholoe baltica	1	0.68	1.18	1.15	79.56
Bathyporeia tenuipes	1.16	0.65	0.89	1.1	80.66
Abra prismatica	1.15	0.62	0.9	1.06	81.72

SIMPER					
Bathyporeia elegans	1.37	0.59	0.7	1	82.72
Gattyana	0.91	0.56	0.95	0.95	83.67
Argissa hamatipes	0.86	0.55	0.97	0.94	84.61
Diplocirrus glaucus	0.83	0.46	0.79	0.78	85.38
Cerianthus lloydii	0.9	0.45	0.76	0.76	86.14
Scolelepis bonnieri	1.1	0.44	0.63	0.75	86.89
Thyasiridae	0.81	0.44	0.79	0.75	87.64
Nephtys	0.81	0.44	0.78	0.74	88.38
Chaetozone christiei	0.7	0.42	0.8	0.71	89.1
Lagis koreni	1.07	0.37	0.63	0.63	89.73
GASTROPODA	0.74	0.35	0.65	0.6	90.33
Group n					
Average similarity: 60.44					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	8.11	8.77	4.13	14.51	14.51
Scoloplos armiger	3.88	4.29	4.6	7.1	21.6
THRACIOIDEA	3.13	3.54	6.74	5.86	27.46
Ophiocten affinis	2.46	2.39	3.53	3.96	31.42
Spiophanes kroyeri	2.48	2.38	2.94	3.93	35.36
Abra	2.31	2.33	1.95	3.86	39.21
Eudorellopsis deformis	2.11	2.31	3.78	3.82	43.04
Lanice conchilega	2.32	2.24	3.17	3.71	46.74
Echinocyamus pusillus	2.02	2.14	3.2	3.54	50.29

SIMPER					
Bathyporeia elegans	2.06	2.1	1.94	3.48	53.77
Sthenelais limicola	1.84	1.95	3.45	3.23	57
Bathyporeia	1.96	1.9	2.82	3.14	60.14
Ennucula tenuis	1.78	1.78	1.87	2.95	63.09
Amphiura filiformis	1.77	1.77	1.74	2.93	66.01
Retusa	1.57	1.49	1.81	2.47	68.48
NEMERTEA	1.53	1.46	1.91	2.42	70.9
Abra prismatica	1.95	1.36	0.94	2.24	73.14
Scolelepis bonnieri	1.24	1.18	1.86	1.96	75.1
GASTROPODA	1.08	1.05	2.05	1.74	76.84
Sphaerodoropsis baltica	1.11	1.01	1.3	1.68	78.52
Pholoe baltica	1.3	0.97	1.29	1.61	80.13
Cylichna cylindracea	1.15	0.95	1.28	1.57	81.7
Ophelia borealis	1.19	0.83	0.92	1.38	83.08
Nephtys	0.99	0.71	0.96	1.17	84.25
Amphiuridae	1.14	0.68	0.71	1.13	85.38
SIPUNCULA	0.91	0.66	0.99	1.09	86.47
Scalibregma inflatum	0.97	0.53	0.75	0.88	87.34
Pariambus typicus	0.8	0.51	0.76	0.85	88.19
Perioculodes longimanus	0.67	0.48	0.77	0.8	88.99
Antalis entalis	0.62	0.39	0.6	0.65	89.64
Harpinia antennaria	0.66	0.38	0.59	0.63	90.27
Group f					

SIMPER					
Average similarity: 57.19					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	8.67	10.38	#######i	18.15	18.15
Lanice conchilega	3.94	5.74	#######	10.04	28.19
THRACIOIDEA	2.64	3.63	#######	6.35	34.54
Scalibregma inflatum	2.34	3.32	#######	5.8	40.34
Abra prismatica	2.34	3.32	#######	5.8	46.13
Sthenelais limicola	1.87	2.57	#######	4.49	50.62
SIPUNCULA	1.87	2.57	#######	4.49	55.11
Pholoe baltica	1.83	2.1	#######	3.67	58.78
Glycera alba	1.41	2.1	#######	3.67	62.45
Ophelina acuminata	1.41	2.1	#######	3.67	66.11
Scoloplos armiger	2.29	2.1	#######	3.67	69.78
Scolelepis bonnieri	1.41	2.1	#######	3.67	73.45
Spiophanes kroyeri	2.64	2.1	#######	3.67	77.11
Lagis koreni	1.57	2.1	#######	3.67	80.78
Eudorellopsis deformis	1.57	2.1	#######	3.67	84.44
Diplocirrus glaucus	1	1.48	#######	2.59	87.04
Owenia	1.21	1.48	#######	2.59	89.63
Bathyporeia	1.37	1.48	#######	2.59	92.22
Group o					
Average similarity: 66.00					

SIMPER					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	13.69	11.75	11.34	17.81	17.81
THRACIOIDEA	4.85	4.24	5.61	6.43	24.24
Bathyporeia	4.54	3.6	6.24	5.46	29.7
Scoloplos armiger	4.28	3.36	5.18	5.09	34.78
Abra	3.46	2.98	9.41	4.52	39.3
Bathyporeia elegans	3.78	2.81	5.39	4.25	43.55
Spiophanes kroyeri	2.77	2.26	8.84	3.43	46.98
Eudorellopsis deformis	2.85	2.16	2.63	3.27	50.25
Echinocyamus pusillus	2.33	1.96	7.45	2.97	53.23
Sphaerodoropsis baltica	2.48	1.92	4.44	2.91	56.14
Lanice conchilega	2.36	1.74	3.12	2.63	58.77
Tanaissus danica	2.27	1.74	3.13	2.63	61.4
Scolelepis bonnieri	2	1.65	5.91	2.5	63.89
Retusa	2.41	1.45	1.2	2.19	66.09
Sthenelais limicola	1.82	1.35	2.45	2.05	68.13
Ophelia borealis	1.77	1.33	3.72	2.01	70.14
Ophiocten affinis	1.8	1.18	1.45	1.79	71.93
Owenia	1.52	1.12	3.85	1.7	73.63
Amphiura filiformis	1.49	1	1.48	1.52	75.15
Abra prismatica	1.59	0.99	1.38	1.5	76.64
Amphiuridae	1.57	0.91	1.27	1.38	78.03
Scalibregma inflatum	1.35	0.86	1.46	1.31	79.33
Ampelisca brevicornis	1.03	0.74	1.46	1.12	80.46

SIMPER					
NEMERTEA	1.4	0.69	0.87	1.05	81.51
Chaetozone christiei	0.98	0.68	1.51	1.04	82.54
Nephtys	1.27	0.59	0.89	0.89	83.43
Spisula	1.13	0.59	0.9	0.89	84.32
Ennucula tenuis	1.04	0.57	0.91	0.87	85.19
Bathyporeia tenuipes	0.98	0.53	0.9	0.8	85.99
SIPUNCULA	1.09	0.52	0.85	0.79	86.78
Ophelina acuminata	0.94	0.52	0.9	0.79	87.57
Galathowenia	0.94	0.51	0.9	0.77	88.34
Perioculodes longimanus	0.89	0.5	0.91	0.76	89.1
BIVALVIA	0.95	0.45	0.93	0.68	89.78
Exogone naidina	0.77	0.45	0.93	0.68	90.46
Group m					
Average similarity: 58.96					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	9.01	8.61	7.54	14.6	14.6
Scoloplos armiger	4.92	4.42	4.17	7.5	22.1
THRACIOIDEA	3.88	3.68	5.97	6.24	28.34
Abra	3.22	3.08	4.47	5.22	33.56
Spiophanes kroyeri	3.17	2.98	5.61	5.06	38.62
Lanice conchilega	2.4	1.86	1.82	3.16	41.78
Echinocyamus pusillus	2.06	1.77	2.84	3	44.78
NEMERTEA	1.78	1.7	5.11	2.88	47.66

SIMPER					
Eudorellopsis deformis	2.08	1.69	2.01	2.86	50.52
Sthenelais limicola	1.79	1.67	4.94	2.83	53.36
Retusa	1.93	1.63	2.1	2.76	56.12
SIPUNCULA	1.86	1.62	2.5	2.74	58.86
Ennucula tenuis	2.02	1.59	2.2	2.7	61.56
Abra prismatica	1.69	1.31	1.66	2.23	63.79
Amphiura filiformis	1.79	1.25	1.38	2.11	65.9
Scalibregma inflatum	1.83	1.23	1.61	2.08	67.99
Sphaerodoropsis baltica	1.55	1.2	1.4	2.04	70.03
Bathyporeia	1.57	1.08	1.32	1.84	71.87
Ophelina acuminata	1.36	0.95	1.4	1.61	73.48
Amphiuridae	1.55	0.86	0.76	1.46	74.93
Paramphinome jeffreysii	1.3	0.8	0.9	1.35	76.28
Pholoe baltica	1.15	0.78	1.21	1.32	77.6
Thyasiridae	1.1	0.76	1.01	1.29	78.89
Cylichna cylindracea	1.12	0.76	1.03	1.28	80.17
Ophiocten affinis	1.24	0.71	0.89	1.2	81.37
Scolelepis bonnieri	1.1	0.68	0.89	1.15	82.51
Lagis koreni	0.81	0.61	1.09	1.03	83.54
Antalis entalis	0.87	0.45	0.71	0.77	84.31
Goniada maculata	0.71	0.44	0.82	0.75	85.06
Cerianthus lloydii	0.81	0.43	0.71	0.73	85.79
Harpinia antennaria	0.82	0.42	0.7	0.72	86.51
Chaetozone christiei	0.77	0.41	0.71	0.69	87.2

SIMPER					
Kurtiella bidentata	1	0.4	0.6	0.68	87.88
Diplocirrus glaucus	0.69	0.34	0.63	0.57	88.45
Phaxas pellucidus	0.68	0.34	0.63	0.57	89.02
Bathyporeia elegans	0.83	0.29	0.47	0.49	89.51
Chamelea striatula	0.62	0.29	0.54	0.48	89.99
Akanthophoreus gracilis	0.6	0.28	0.55	0.47	90.47
Group c					
Average similarity: 51.74					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Abra	5.87	7.28	#######	14.06	14.06
Bathyporeia	4.46	5.15	#######	9.95	24.01
Ophiocten affinis	3.67	4.5	#######	8.7	32.71
Spiophanes bombyx	4.37	3.53	#######	6.82	39.53
Bathyporeia elegans	2.82	3.3	#######	6.38	45.91
THRACIOIDEA	2.64	3.06	#######	5.91	51.82
Lanice conchilega	2.12	2.5	#######	4.82	56.64
Retusa	2.09	2.16	#######	4.18	60.82
Sthenelais limicola	1.93	1.76	#######	3.41	64.23
Bathyporeia tenuipes	1.57	1.76	#######	3.41	67.64
Gari fervensis	1.41	1.76	#######	3.41	71.06
Spiophanes kroyeri	1.21	1.25	#######	2.41	73.47
Eudorellopsis deformis	1.82	1.25	#######	2.41	75.88
Pontocrates altamarinus	1.21	1.25	#######	2.41	78.29

SIMPER					
Argissa hamatipes	1	1.25	#######	2.41	80.7
Hippomedon denticulatus	1	1.25	#######	2.41	83.12
CEPHALASPIDEA	1.37	1.25	#######	2.41	85.53
Abra prismatica	2.08	1.25	#######	2.41	87.94
Montacuta substriata	1	1.25	#######	2.41	90.35
Group p					
Average similarity: 63.66					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	12.67	11.51	19.81	18.08	18.08
Scoloplos armiger	5.9	5.31	4.92	8.33	26.41
THRACIOIDEA	4.13	3.85	10.71	6.04	32.46
Spiophanes kroyeri	2.79	2.47	6.56	3.89	36.34
Lanice conchilega	2.83	2.32	5.95	3.65	39.99
Scalibregma inflatum	2.5	2.19	4.04	3.44	43.43
Abra	2.78	2.12	12.45	3.34	46.76
Ennucula tenuis	2.19	1.93	3.45	3.03	49.8
Bathyporeia	2.31	1.88	3.04	2.96	52.75
Sphaerodoropsis baltica	2.03	1.8	16.63	2.82	55.58
Echinocyamus pusillus	2.16	1.64	3.73	2.58	58.16
Abra prismatica	1.83	1.6	5.68	2.52	60.68
Ophelina acuminata	1.49	1.43	11.78	2.25	62.93
NEMERTEA	1.87	1.37	3.67	2.16	65.08
Amphiura filiformis	1.55	1.36	4.12	2.14	67.23

SIMPER					
Bathyporeia tenuipes	1.65	1.29	3.42	2.02	69.25
Pholoe baltica	1.47	1.26	4.87	1.99	71.24
Amphiuridae	1.9	1.18	2.98	1.85	73.09
Sthenelais limicola	1.62	1.02	0.91	1.6	74.68
Pontocrates altamarinus	1.1	1.01	11.78	1.59	76.28
Ampelisca brevicornis	1.1	1.01	11.78	1.59	77.87
Harpinia antennaria	1	1.01	11.78	1.59	79.46
Kurtiella bidentata	1.83	0.81	0.7	1.27	80.73
Phascolion (Phascolion) strombus strombus	1.37	0.75	0.91	1.18	81.91
Aricidea (Aricidea) minuta	1.14	0.74	0.91	1.17	83.08
Nephtys	1.31	0.7	0.84	1.09	84.17
Eudorellopsis deformis	1.52	0.68	0.77	1.07	85.25
Bathyporeia elegans	1.32	0.68	0.91	1.06	86.31
Retusa	1.36	0.64	0.85	1.01	87.31
Galathowenia	0.96	0.55	0.88	0.86	88.17
Thyasira flexuosa	0.96	0.55	0.88	0.86	89.03
Scolelepis	0.85	0.53	0.91	0.83	89.87
Timoclea ovata	0.93	0.53	0.91	0.83	90.7
Group I					
Average similarity: 61.09					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	6.21	5.3	7	8.68	8.68
Scoloplos armiger	5.14	4.67	7.52	7.65	16.33

SIMPER					
THRACIOIDEA	5.14	4.38	5.57	7.17	23.5
Ophiocten affinis	3.84	3.53	11.09	5.78	29.28
Abra	3.71	3.27	5.68	5.36	34.64
Spiophanes kroyeri	2.98	2.6	10.5	4.25	38.9
Bathyporeia	3.19	2.35	5.48	3.84	42.74
Sthenelais limicola	2.41	2.14	6.57	3.5	46.23
Amphiura filiformis	2.25	2	6.41	3.28	49.51
NEMERTEA	2.16	1.92	18.03	3.15	52.65
Echinocyamus pusillus	2.21	1.85	4.84	3.02	55.68
Ophelia borealis	2.49	1.68	2.23	2.75	58.43
Pholoe baltica	2.02	1.53	3.01	2.5	60.92
Scalibregma inflatum	1.83	1.45	13.16	2.38	63.3
Nephtys	1.73	1.19	1.16	1.94	65.25
Bathyporeia elegans	2.13	1.17	1.14	1.91	67.16
Chaetozone christiei	1.25	1.12	7.6	1.84	69
Lanice conchilega	1.39	1.08	4.56	1.77	70.77
Eudorellopsis deformis	1.52	1.02	1.14	1.66	72.43
SIPUNCULA	1.26	0.92	1.15	1.51	73.94
Harpinia antennaria	1.41	0.91	1.14	1.49	75.42
Bathyporeia tenuipes	1.29	0.87	1.05	1.42	76.85
Abra prismatica	1.05	0.72	1.12	1.17	78.02
Ennucula tenuis	1.19	0.7	1.1	1.15	79.17
Hippomedon denticulatus	0.97	0.68	1.11	1.11	80.28
Aricidea (Aricidea) minuta	1.19	0.67	1.06	1.1	81.37

SIMPER					
CEPHALASPIDEA	0.97	0.64	1.13	1.05	82.43
Gari fervensis	0.97	0.63	1.15	1.03	83.46
Spio goniocephala	0.97	0.62	1.13	1.02	84.48
Prionospio cirrifera agg.	0.8	0.6	1.15	0.99	85.46
Scolelepis bonnieri	0.88	0.6	1.15	0.99	86.45
Timoclea ovata	0.95	0.59	1.16	0.97	87.42
Phoronis	0.8	0.58	1.16	0.95	88.37
Aonides paucibranchiata	0.85	0.41	0.62	0.68	89.05
Philinidae	0.85	0.41	0.62	0.68	89.73
Ampelisca brevicornis	0.95	0.38	0.59	0.62	90.35
Group i					
Average similarity: 57.26					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	6.49	9.45	14.16	16.51	16.51
THRACIOIDEA	5.02	6.65	3.89	11.61	28.13
Scoloplos armiger	3.53	5.25	15.5	9.17	37.3
Ennucula tenuis	2.19	2.86	2.58	4.99	42.29
Abra	2.17	2.74	5.18	4.79	47.07
Sthenelais limicola	1.74	2.32	3.99	4.06	51.13
Amphiuridae	1.52	2.15	4.21	3.75	54.88
Antalis entalis	1.33	2.01	4.88	3.51	58.39
Spiophanes kroyeri	1.44	1.7	1.16	2.98	61.36
Cylichna cylindracea	1.52	1.53	1.13	2.68	64.04

SIMPER					
Echinocyamus pusillus	1.64	1.46	1	2.55	66.6
Amphiura filiformis	1.47	1.46	1.15	2.55	69.14
Ophelina acuminata	1.23	1.23	1.11	2.15	71.29
Lanice conchilega	1.18	1.22	1.09	2.14	73.43
Bathyporeia elegans	1.42	1.19	0.99	2.08	75.51
Chamelea striatula	1.11	1.13	1.11	1.97	77.47
Pholoe baltica	1.03	0.99	1.13	1.73	79.21
Scolelepis bonnieri	0.88	0.98	1.16	1.72	80.93
Bathyporeia	0.88	0.97	1.16	1.7	82.63
Sphaerodoropsis baltica	0.8	0.93	1.16	1.62	84.25
Pariambus typicus	0.95	0.93	1.16	1.62	85.87
Retusa	1.18	0.83	0.61	1.44	87.32
Abra prismatica	1.04	0.82	0.62	1.44	88.75
Scalibregma inflatum	0.97	0.67	0.62	1.18	89.93
Eudorellopsis deformis	0.88	0.57	0.6	1	90.93
Group a					
Less than 2 samples in group					
Group d					
Average similarity: 53.07					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scoloplos armiger	4.63	4.95	14.03	9.33	9.33
Spiophanes bombyx	5.59	4.41	3.85	8.3	17.63

SIMPER					
Spiophanes kroyeri	3.22	3.55	11.87	6.69	24.32
THRACIOIDEA	3.25	3.34	4.13	6.29	30.61
Scalibregma inflatum	2.98	2.45	1.8	4.62	35.23
Tanaopsis graciloides	2.36	2.28	9.06	4.29	39.52
Pholoe baltica	2.75	2.27	2.2	4.28	43.8
Galathowenia	1.79	1.94	6.23	3.65	47.45
Ophiocten affinis	1.65	1.88	11.89	3.54	50.98
Abra	1.64	1.75	12.99	3.3	54.29
Amphiura filiformis	1.97	1.69	2.21	3.19	57.47
Owenia	1.39	1.44	5.36	2.72	60.19
Ophelina acuminata	1.66	1.44	6.23	2.71	62.9
Bathyporeia elegans	1.47	1.27	7.53	2.4	65.3
Glycera alba	1.1	1.2	27.42	2.25	67.55
Harpinia antennaria	1.48	1.04	0.91	1.96	69.51
Lanice conchilega	1.56	0.97	0.88	1.83	71.35
Nephtyidae	1.32	0.87	0.91	1.64	72.98
Sthenelais limicola	1.27	0.82	0.91	1.55	74.53
Ennucula tenuis	1.3	0.75	0.84	1.42	75.95
Fabulina fabula	1.18	0.74	0.86	1.4	77.35
NEMERTEA	1.12	0.72	0.86	1.36	78.71
Cerianthus lloydii	1.1	0.69	0.88	1.3	80.01
Lumbrineris aniara agg.	1.16	0.68	0.89	1.28	81.28
Timoclea ovata	1.16	0.66	0.89	1.25	82.53
Kurtiella bidentata	1.1	0.66	0.89	1.24	83.78

SIMPER					
Goniada maculata	0.93	0.6	0.91	1.12	84.9
Philinidae	0.75	0.6	0.91	1.12	86.02
Phaxas pellucidus	0.75	0.6	0.91	1.12	87.14
SIPUNCULA	0.85	0.6	0.91	1.12	88.26
Ampelisca brevicornis	0.93	0.58	0.91	1.1	89.36
Amphiuridae	1.17	0.43	0.41	0.81	90.17
Group k					
Average similarity: 62.26					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	7.04	6.36	4.45	10.21	10.21
THRACIOIDEA	4.48	4.45	10.93	7.14	17.36
Scoloplos armiger	4.36	4.1	5.23	6.59	23.95
Abra	3.33	3.22	8.51	5.18	29.12
Lanice conchilega	3.2	2.57	4.76	4.13	33.25
Scalibregma inflatum	3.06	2.56	3.03	4.11	37.36
Pholoe baltica	2.63	2.32	4.42	3.73	41.09
Spiophanes kroyeri	2.62	2.05	2.05	3.3	44.39
SIPUNCULA	1.93	1.94	5.48	3.11	47.5
Amphiura filiformis	2.07	1.85	4.74	2.96	50.47
Eudorellopsis deformis	1.76	1.7	5.04	2.73	53.2
NEMERTEA	1.66	1.65	10.77	2.66	55.86
Galathowenia	1.74	1.64	2.95	2.63	58.49
Echinocyamus pusillus	1.73	1.56	3.3	2.51	61

SIMPER					
Bathyporeia	1.62	1.46	4.98	2.35	63.34
Kurtiella bidentata	2.49	1.43	4.54	2.29	65.64
Sthenelais limicola	1.49	1.35	2.94	2.18	67.81
Ophelina acuminata	1.65	1.3	3.64	2.08	69.89
CEPHALASPIDEA	1.38	1.28	3.64	2.06	71.95
Ophiocten affinis	1.31	1.24	4.94	1.99	73.94
Bathyporeia elegans	1.31	1.23	5.59	1.98	75.92
Chaetozone christiei	1.33	1.14	9.14	1.83	77.75
Abra prismatica	1.26	0.97	1.13	1.55	79.3
Ennucula tenuis	1.28	0.84	1.06	1.35	80.65
Retusa	1.2	0.75	1.07	1.21	81.86
BIVALVIA	1.03	0.7	1.12	1.13	82.99
Diplocirrus glaucus	1.03	0.7	1.15	1.12	84.11
Phyllodoce groenlandica	0.97	0.69	1.14	1.12	85.23
Glycera alba	0.8	0.66	1.15	1.06	86.29
Owenia	0.85	0.46	0.62	0.73	87.02
Ophelia borealis	1.09	0.43	0.59	0.69	87.71
Nephtys	0.77	0.38	0.61	0.61	88.32
Sphaerodoropsis baltica	0.77	0.37	0.61	0.59	88.91
Harpinia antennaria	0.6	0.35	0.62	0.57	89.48
Cylichna cylindracea	0.8	0.35	0.62	0.57	90.05
Group b					
Less than 2 samples in group					

i The '#####' refers to groups that have only two stations, SIM/SD requires at least three stations to create a value.

Appendix E eDNA Analysis

E.1 Overview

7.1.1.1 One sample was collected from each of the 100 stations across the Survey Area; of these, a subset of 50 samples were sent to the laboratory for analysis. The remaining samples were retained as spares.

E.1.1 Summary Statistics

7.1.1.2 Of the 1066 detected bacterial and infaunal Operational Taxonomic Units (OTUs)a greater percentage of infaunal OTUs were identified to species level (13%) compared to the bacteria OTUs (1%), possibly due to the larger pool of reference material for infaunal OTUs.

Table E. 1: OTU Detections per Target and Percentage Successfully Classified

Target	Number of samples analysed	Number of Samples containing Operational Taxonomic Units	Number of Operational Taxonomic Units	Phylum (%)	Class (%)	Order (%)	Family (%)	Genus (%)	Species (%)
Bacteria	50	50	645	78	58	33	24	6	1
Infauna	50	50	421	100	78	92	80	36	13

Bacteria

7.1.1.3 The bacterial data set identified 22 taxonomic groups based on class, with the proportional contributions of these taxonomic groups across the Survey Area detailed in Table E. 2 and presented for each station in Table A. 1. The 'Other' category comprised 272 OTUs which could not be identified to class.

7.1.1.4 The most detected taxonomic group across the Survey Area (n=272) was the "Other" which accounted for 42% of OTUs. The second most abundant taxonomic group was the Gammaproteobacteria (n=119) accounting for 18% of OTUs. Gammaproteobacteria dominance is likely, given it is one of the richest classes within the bacteria kingdom (Williams *et al*., 2010). The relative dominance of 'Other' within the proportional contributions was partly due to the inability to determine these OTUs further than phylum (n=9) or domain (n=145).

7.1.1.5 Of the 645 bacterial OTUs, a total of 103 (16%) were present in all sediment samples, while 116 (18%) occurred in a single sediment sample. The relatively high numbers of widespread OTUs and lone OTUs across the survey area suggested that the community had been subject to relatively little disturbance.

Table E. 2: Contribution of Gross Sediment Bacterial Operational Taxonomic Unit Groups

Group by class	Reads		Operational Taxonomic Units	
	Number	Proportional Contribution %	Abundance	Proportional Contribution %
Acidobacteriae	118043	5	29	4
Acidimicrobiia	16765	<1	2	<1
Actinomycetia	74866	3	22	3
Alphaproteobacteria	117123	5	47	7
Anaerolineae	9275	<1	4	<1
Bacilli	653	<1	1	<1
Bacteriovoracia	177	<1	2	<1
Bacteroidia	93414	4	45	7
Clostridia	27	<1	1	<1

Group by class	Reads		Operational Taxonomic Units	
Cyanobacteriia	8145	<1	2	<1
Desulfobacteria	14112	<1	1	<1
Desulfobulbia	73	<1	1	<1
Gammaproteobacteria	602395	27	119	18
Gracilibacteria	39	<1	1	<1
Kiritimatiellae	1654	<1	10	2
Nitrospiria	1465	<1	1	<1
Oligoflexia	154	<1	1	<1
Phycisphaerae	4754	<1	2	<1
Planctomycetes	114425	5	55	9
Thermoleophilia	305	<1	2	<1

Group by class	Reads		Operational Taxonomic Units	
Verrucomicrobiae	19243	<1	25	4
Other	1038887	46	272	42
Total	2235994	100	645	100

‘Other’ includes the 119 (18%) OTUs that could not be identified beyond Phylum and the 145 (22%) OTUs that could not be identified beyond domain.

Infauna

7.1.1.6 A total of 28 taxonomic groups based on class were detected from the sediment infaunal data sets with the proportional contribution of these taxonomic groups across the Survey Area detailed in Table E. 3 and presented for each sample in Table A. 1. The "Other" category comprised the 91 OTUs which could not be identified to class.

7.1.1.7 The Nematoda Adenophorea (n=175) was the most abundant taxonomic group across the Survey Area and accounted for 42% of OTUs. The second most abundant group was the 'Other' group (n=91, 22%). The relative abundance of 'Other' within the proportional contributions was partly due to the inability to determine these OTUs further than phylum (n=90) or kingdom (n=1).

7.1.1.8 Eleven infaunal taxonomic groups (Actinopterygii, Ascidiacea, Enteropneusta, Hoplonemertea, Insecta, Malacostraca, Palaeonemertea, Sagittoidea, Scaphopoda, Scyphozoa and Thaliacea) were represented by a single OTU.

7.1.1.9 Of the 421 infaunal OTUs, a total of 123 (29%) were present in a single sample across the Survey Area . However, unlike the bacterial data set, none was detected in all samples. The absence of a consistent infaunal community as well as a relatively high proportion of lone OTUs suggest the community heterogeneity across the survey area may have been under sampled for the infaunal size class.

Table E. 3: Contribution of Gross Sediment Infaunal Operational Taxonomic Unit Groups

Group by Class	Operational Taxonomic Units		Operational Taxonomic Units	
	Number	Proportional Contribution %	Abundance	Proportional Contribution %
Actinopterygii	38	<1	1	<1
Adenophorea	857359	41	175	42
Anthozoa	2298	<1	4	1
Appendicularia	8663	<1	2	<1
Arachnida	64459	3	6	1
Ascidiacea	117	<1	1	<1
Bivalvia	399	<1	2	<1
Clitellata	7984	<1	2	<1
Echinoidea	12492	<1	2	<1
Enteropneusta	581	<1	1	<1

Group by Class	Operational Taxonomic Units		Operational Taxonomic Units	
Eurotatoria	8459	<1	6	1
Gastropoda	49098	2	4	1
Hexanauplia	277799	13	45	11
Hoplonemertea	20512	1	1	<1
Hydrozoa	107364	5	10	2
Insecta	39	<1	1	<1
Malacostraca	344	<1	1	<1
Ophiuroidea	1578	<1	2	<1
Ostracoda	85134	4	6	1
Palaeonemertea	73	<1	1	<1
Pilidiophora	1029	<1	2	<1

Group by Class	Operational Taxonomic Units		Operational Taxonomic Units	
Polychaeta	238071	12	49	12
Sagittoidea	23	<1	1	<1
Scaphopoda	139	<1	1	<1
Scyphozoa	6501	<1	1	<1
Sipunculidea	694	<1	2	<1
Thaliacea	55	<1	1	<1
Other	318616	15	91	22
Total	2069918	100	421	100

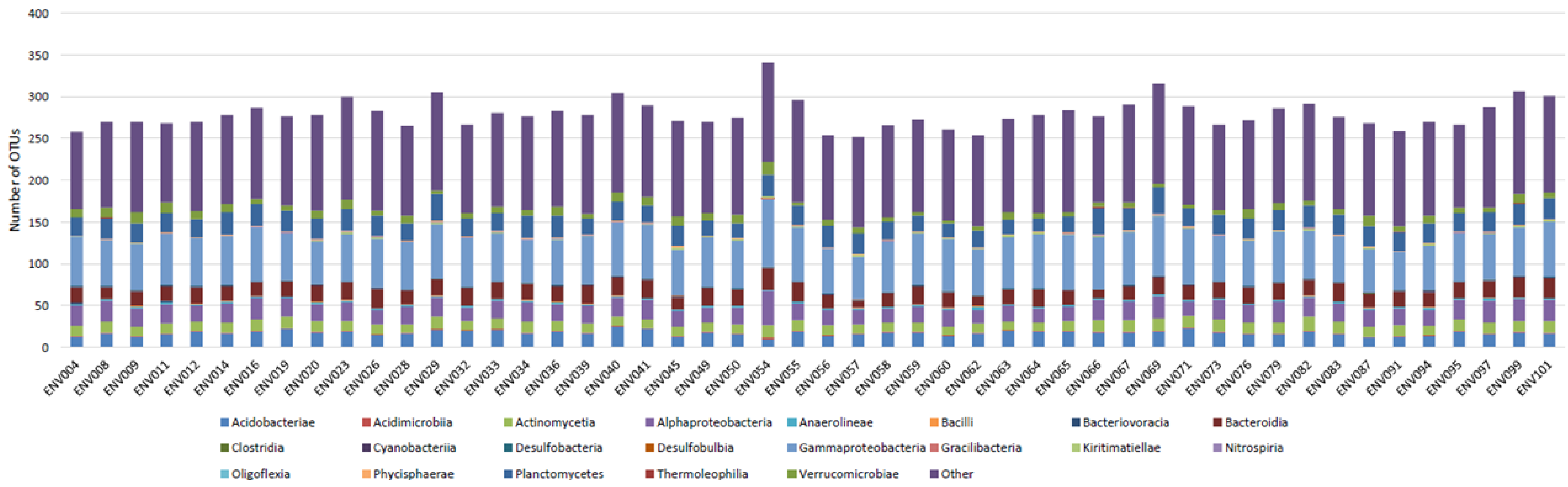

Figure E. 1: Contributions of Gross Sediment Bacteria OTU Taxonomic Groups by Samples

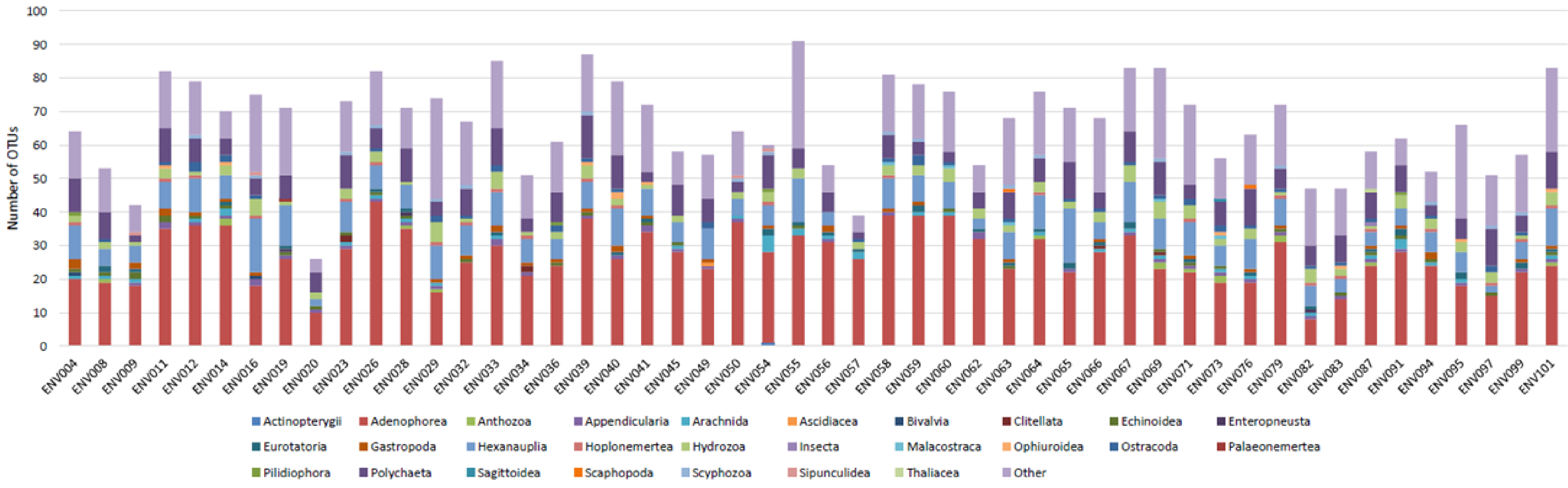

Figure E. 2: Contributions of Gross Sediment Infaunal OTU Taxonomic Groups by Samples

7.1.1.10 Comparative taxonomic heat trees detailing the number of OTUs across the Survey Area from bacterial taxa down to the order rank is presented in Figure E. 3 (left) and the taxonomic heat trees detailing the discrete infaunal taxa OTUs down to the order rank are presented in Figure E. 3 (right). The nodes (circles) represent the taxon whilst the lines detail the hierarchical relationships between taxa. The colour scale and relative width of the nodes represent the number of OTUs for each taxon. Labels without nodes represent missing taxa. Summary statistics for the sediment bacterial and infaunal richness are detailed in Table E. 4.

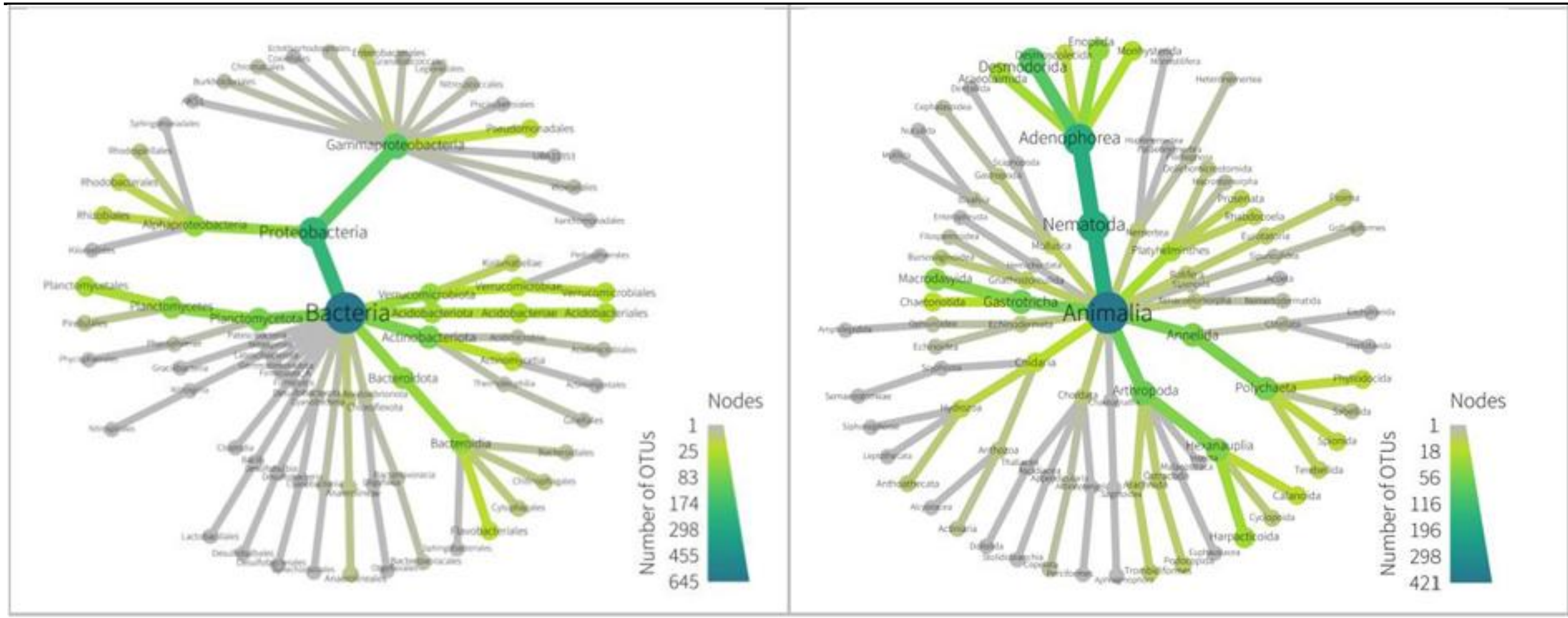

Figure E. 3: Sediment bacterial taxonomic heat trees of the number of Operational Taxonomic Units (left) and sediment infaunal taxonomic heat trees of the number of Operational Taxonomic Units (right)

Table E. 4: Summary of Sediment Bacterial and Infaunal Richness

	Bacterial	Infaunal
Minimum	252	26
Maximum	341	91
Mean	279	66
±SD	17	14

7.1.1.11 By using reads as a proxy for abundance or biomass, OTU ranking provides additional information on the dominance structure of the bacterial, infaunal community in the Survey Area and results are presented in Table E. 5 to Table E. 6.

7.1.1.12 Of the top ten ranked bacterial OTUs within the Survey Area (Table E. 5), six were Proteobacteria, one each was Acidobacteriota, Bacteroidota and Actinobacteriota and the other two could not be identified beyond the kingdom bacteria. Other than at the sandy gravel Station ENV054, Bacteria IM-3ND16P recorded the highest number of reads at every station, accounting for 13% to 24% of total reads. At Station ENV054 where Gammaproteobacteria IM-49D8MH recorded the most reads, accounting for 6% of the total reads at this station.

7.1.1.13 Of the top ten ranked infaunal OTUs within the Survey Area (Table E. 6), seven were Nematoda, two were Arthropoda and one each was Gastrotricha, Annelida and Cnidaria. Compared with the bacterial data set, there was more variation across the Survey Area, with Desmodorella IM-30F4AS recording the highest number of reads at 11 of the 50 stations, Aegisthidae IM-WM1554 at seven stations and Nephtyidae IM-V80QNW at four.

7.1.1.14 Results of the OTU ranking and fidelity scores can give a further indication of an OTU’s distribution, with results ≥0.8 and ≤1.2 indicating a generally even distribution of an OTU, and values outside of this range representing a patchier distribution. The two most dominant bacteria within the top ten (Table E. 5) fell within this range indicating an even distribution of these OTUs. The remaining bacteria top ten and the entire infaunal top ten recorded fidelity values outside of this range. Furthermore, there was notable reordering of infaunal OTUs when ranked by reads rather than score, consistent with a patchy distribution.

Table E. 5: Bacterial Operational Taxonomic Units Ranking

Score	Reads	Taxon	Total rank score	fidelity	Total reads	Present at number of stations (out of 50)
1	1	Bacteria IM-3ND16P	499	1.00	446451	50
2	2	Gammaproteobacteria IM-49D8MH	445	0.99	83339	50
3	3	Gammaproteobacteria IM-5E5B5X	277	0.69	47833	50
3	4	Gammaproteobacteria IM-65MO9C	277	0.69	45940	50
4	5	Bacteria IM-33X7BG	226	0.65	40830	50
5	6	Gammaproteobacteria IM-9QCQ08	210	0.70	39745	50
6	7	Acidobacteriaceae IM-P87B3X	129	0.52	33473	50
7	8	Flavobacteriaceae IM-598GJS	110	0.55	31929	50
8	10	Gammaproteobacteria IM-8QS7N5	90	0.60	28429	50
9	9	Actinobacteriota IM-ID4M60	72	0.72	28443	49

10	13	Alphaproteobacteria IM-72K6VM	59	1.18	24722	50

Table E. 6: Infaunal Operational Taxonomic Units Ranking

Score	Reads	Taxon	Total rank score	Fidelity	Total reads	Present at number of stations (out of 50)
1	1	Desmodorella IM-30F4AS	236	0.47	136676	44
2	2	Aegisthidae IM-WM1554	171	0.38	111739	48
3	4	Desmodoridae IM-8D6JR5	148	0.37	73392	37
4	3	Lauratonematidae IM-8TAQB0	139	0.40	75942	45
5	5	Microlaimidae IM-761UIS	132	0.44	69600	42
6	13	Leptonemella IM-49Q94K	78	0.31	34869	41
7	9	Urodasys IM-A7J78S	72	0.36	40410	38
8	16	Leptolaimus IM-L9NTG3	65	0.43	32295	34
9	7	Nephtyidae IM-V80QNW	64	0.64	49542	28

10	10	Oncholaimidae IM-86N6VA	61	1.22	36435	24
12	6	Podocopida IM-7W7C8K	56	NA	51450	9
15	8	Anthoathecata IM-17OP8Z	43	NA	44252	31

7.1.1.15 OTU accumulation plots for the sediment bacterial and infaunal data sets are presented in and Figure E. 5. Each plot shows the increasing total number of different OTUs detected as samples are pooled. Two lines are plotted; the first (plotted in blue and often referred to as the Sobs curve) adds the new taxa to those already recorded, in sample order. The second line (plotted in red and often referred to as the Ugland, Gray, Ellingsen (UGE) curve) is smooth, as it is an average output based on the samples being added in a random order 999 times (Ugland *et al*., 2003). Notable changes in the slope of the Sobs curve compared to the UGE curve can be an indication of differences in the community composition. Further, the relative position of the Sobs curve above or below that of the UGE curve can reflect the number of OTUs versus expectations had all sample been equal.

7.1.1.16 The Sobs curve for the sediment bacterial data set (Figure E. 4) began below the UGE curve until the addition of the sandy gravel Station ENV054, where 68 additional OTUs were added, 43 of which were unique to this station. This is consistent with the notable change in seabed type recorded at this station, markedly shifting the faunal community, and leading to the preceding stations appearing relatively below average in terms of their OTU richness and diversity. This notable step-up at Station ENV054, however, masks some more subtle shifts in community among the preceding stations. For example, the Sobs curve on addition of Stations ENV029 and ENV045 was also notably (>100%) steeper than the UGE curve. After Station ENV054, there were further subtle shifts in community with the Sobs curve, on addition of Station ENV069, again notably (>100%) steeper than the UGE curve. There were also several stations between ENV073 and ENV091 where no new OTUs were added. The Sobs and UGE curve from the Survey Area continued to rise with the addition of the last sample, though the rate of increase was small (2 OTUs added to the Sobs and UGE with the addition of the last station (ENV101)).

7.1.1.17 The Sobs curve for the sediment infaunal data set (Figure E. 5) also began below the UGE curve until the addition of the sandy gravel Station ENV054, where 27 additional OTUs were added, 18 of which were unique to this station. After Station ENV054, there were further subtle shifts in community with the Sobs curve, on addition of Station ENV055, ENV067 and ENV069, again notably (>100%) steeper than the UGE curve. There were also three stations (ENV083, ENV094 and ENV099) where no new OTUs were added, however, the Sobs and UGE curve continued to rise, albeit by a small amount (2 OTUs) with the addition of the last sample.

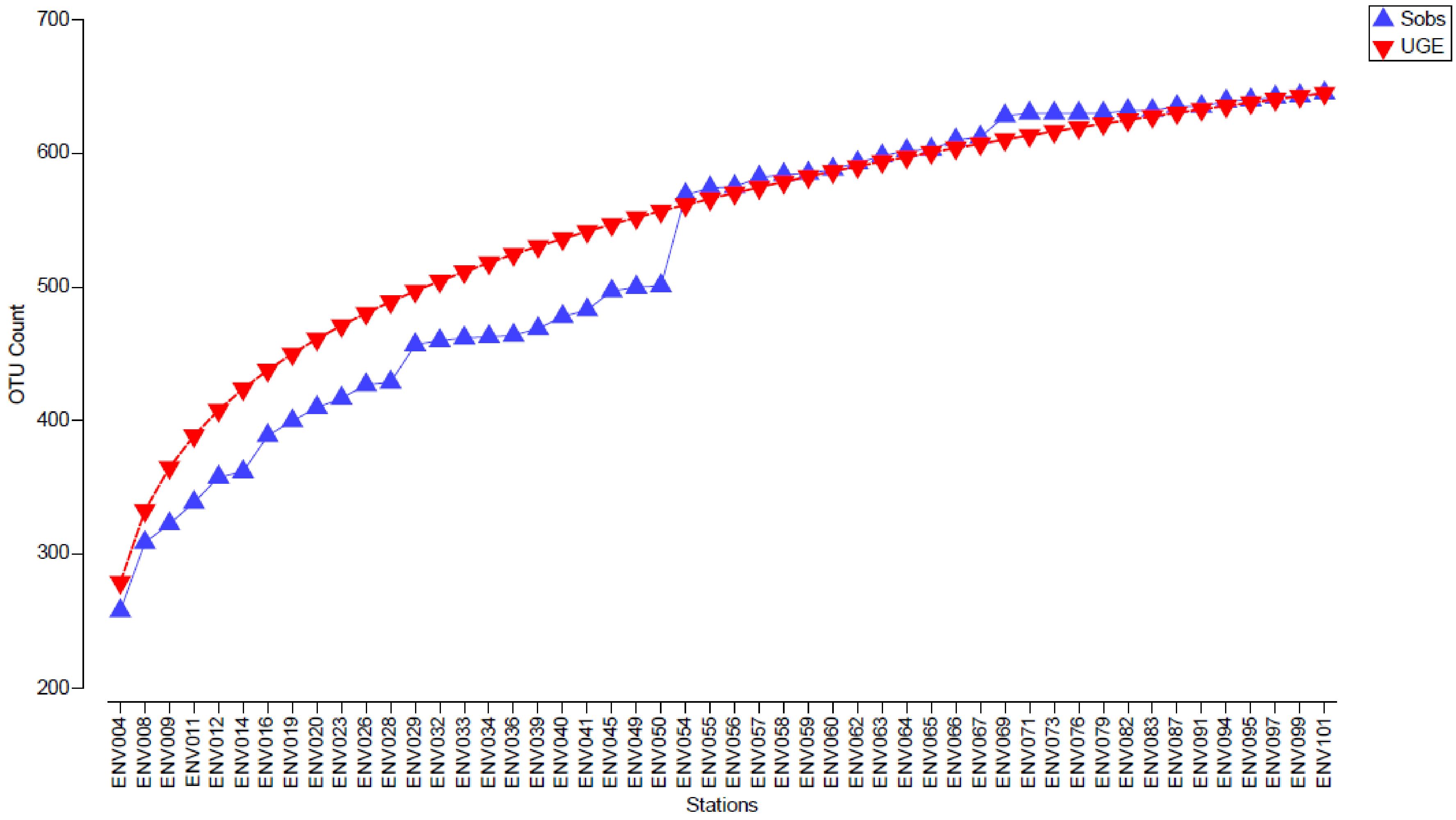

Figure E. 4: Bacterial OTU Accumulation Curve

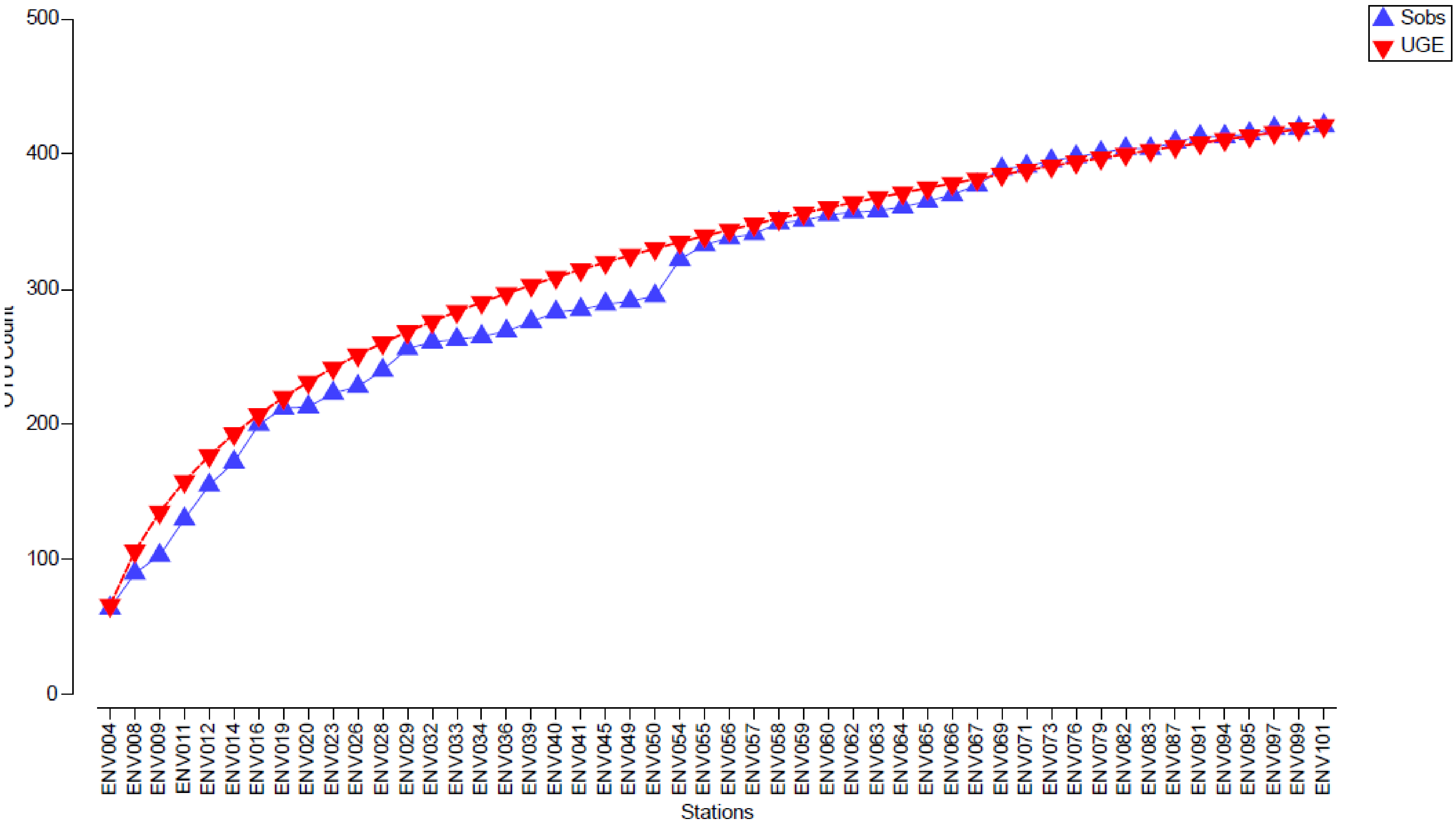

Figure E. 5: Infaunal OTU Accumulation Curve

E.1.2 Diversity using Univariate Statistics

7.1.1.18 By using reads as a proxy for abundance or biomass, the univariate statistics for the sediment bacterial and infaunal data sets are summarised in Table E. 7 and Table E. 8. The eDNA data sets for the Survey Area were analysed to provide the total number of reads and OTUs, Shannon-Weiner diversity index (H') calculated using logarithm base 2 (Shannon & Weaver, 1949), Pielou's evenness (J), Simpson's dominance (λ), Margalef's richness (d) and rarefaction (ES(n)). Increasing values of the Shannon-Weiner diversity correspond to increasing diversity of the community. Values for the Simpson's dominance index and Pielou's both range from 0 to 1, with 1 indicating a dominated community for the former and an even community for the latter. Margalef's index takes account of the number of OTUs present for a given number of reads. Rarefaction (ES(n)) estimates the number of OTUs that would be present if a specified number of reads were detected (n), with the value of n representing the lowest recorded reads across the stations, allowing comparison across all stations in the current survey.

7.1.1.19 Univariate bacterial statistics (Table E. 7) largely followed the trends seen in number of OTUs and relative dominance of Bacteria IM-3ND1 reads across the stations with lowest Shannon-Weiner diversity, Margalef's richness and ES(n) values recorded at the deepest Station ENV057, whereas the shallowest and sandy gravel Station ENV054 recorded the greatest Shannon-Weiner diversity, Margalef's richness and ES(n) values as well as the most even (highest J) and least dominated (lowest λ) bacterial community.

Table E. 7: Summary of sediment bacterial eDNA univariate statistics

Statistic	No. of Operational Taxonomic Units	Margalef's richness (d)	Simpson's dominance (λ)	Pielou's evenness (J')	Shannon-Wiener diversity (H'log2)	Rarification (ES) (28013)
Minimum	252	28013	23.4	0.01	0.77	6.24
At Station	ENV057	ENV063	ENV057	ENV054	ENV063	ENV057
Maximum	341	52797	31.9	0.07	0.86	7.27
At Station	ENV054	ENV094	ENV054	ENV091	ENV054	ENV054
Mean	279	44720	26.0	0.05	0.80	6.53
SD	17	5114	1.7	0.01	0.02	0.20

7.1.1.20 Univariate infaunal statistics (Table E. 8) also largely followed the trends seen in number of OTUs across the stations with lowest Shannon-Weiner diversity, Margalef's richness, ES(n) and Pielou's evenness (J) values recorded at Station ENV020, whereas a range of stations recorded the greatest Shannon-Weiner diversity (ENV039), ES(n) and Margalef's richness (ENV055), Pielou's evenness (ENV101) values, consistent with a varied community structure across the Survey Area.

Table E. 8: Summary of sediment infaunal eDNA univariate statistics

Statistic	No. of Operational Taxonomic Units	Margalef's richness (d)	Simpson's dominance (λ)	Pielou's evenness (J')	Shannon-Wiener diversity (H'log2)	Rarification (ES) (28013)
Minimum	26	12680	2.6	0.04	0.19	0.91
At Station	ENV020	ENV036	ENV020	ENV101	ENV020	ENV020
Maximum	91	75693	8.5	0.80	0.84	5.43
At Station	ENV055	ENV091	ENV055	ENV020	ENV101	ENV039
Mean	66	41398	6.2	0.13	0.71	4.27
SD	14	12532	1.3	0.13	0.12	0.83

OTU Community Structure using Multivariate Analyses

7.1.1.21 Bray-Curtis similarity matrices were produced from the standardised data using Primer v7 (Plymouth Marine Laboratories). Rather than applying the conservative approach of presence-absence, the standardized reads were used as a proxy for relative abundance to maximise use of the available data. A SIMPROF permutation test was conducted in conjunction with CLUSTER analysis and the results illustrated on a dendrogram. Red lines join samples that are statistically indistinguishable, whilst black lines join samples which are distinct from one another. A nMDS routine was also run. The results of the CLUSTER analysis including SIMPROF analysis in the form of a Bray-Curtis similarity dendrogram and nMDS plot for the sediment bacteria samples are displayed in Figure E. 6 and Figure E. 7, while results of the same analysis on the infaunal data is presented in Figure E. 8 and Figure E. 9.

Bacteria

7.1.1.22 The CLUSTER analysis and resulting dendrogram for the Survey Area sediment bacterial OTU data set (Figure E. 6) identified 27 SIMPROF groups, and with the exception of SIMPROF aa (comprising Stations ENV054 and ENV069), all stations were more similar than dissimilar to one another (i.e. Bray-Curtis similarity of >50%). Four SIMPROF groups (SIMPROF a-c and aa) were less than 59% similar, while the remaining stations could be split into two broad groups at a Bray-Curtis similarity of 60%. The key OTUs and classes responsible for the multivariate pattern in the bacterial eDNA data set are displayed in Table E. 9, based on SIMPER analysis and a review of the raw data.

7.1.1.23 Numerous OTUs each made a small contribution towards the separation of the groups from the remaining stations. This may be due to the bacterial communities being far richer than equivalent metazoan communities and less discriminately bound to the sediment given their established variation with both overlying water quality along with direct sediment physico-chemistry (Allison & Martiny, 2008; Frühe *et al*., 2021). However, they still provide a suitable sensitive receptor to environmental pressures for monitoring impacts (Horton *et al*., 2019).

7.1.1.24 The nMDS ordination of the Survey Area sediment bacterial sample data set (Table E. 5) revealed a similar pattern to the CLUSTER analysis and with a stress level of 0.14, this can be considered a useful two-dimensional representation of rank dis(similarities) and overall pattern observed in the data set.

Infauna

7.1.1.25 Cluster analysis and resulting dendrogram for the Survey Area sediment infaunal OTU data set (Table E. 6) identified eighteen groups, all of which were more dissimilar than similar (i.e. Bray-Curtis similarity of <50%). Four SIMPROF groups (SIMPROF a-c and f) were less than 10% similar, while the remaining stations could be split into two broad groups at a Bray-Curtis similarity of >10%. The key OTUs and classes responsible for the multivariate pattern in the infaunal eDNA data set are displayed in Table E. 10, based on SIMPER analysis and a review of the raw data.

7.1.1.26 Compared with the bacterial data set, each OTUs made a larger contribution towards the separation of the groups from the remaining stations, including those from the top ten in some cases.

7.1.1.27 The nMDS ordination of the Survey Area sediment infaunal sample data set (Figure E. 8) revealed a similar pattern to the CLUSTER analysis and with a stress level of 0.25, the nMDS ordination should be treated with caution as a two dimensional representation of rank dis(similarities) and overall pattern observed in the data set.

Table E. 9: Taxa influencing sediment bacterial Operational Taxonomic Units SIMPROF variation

Stations	SIMPROF	Similarity (Bray-Curtis %)	Operational Taxonomic Units and Groups influencing sample separation
ENV054 and ENV069	SIMPROF aa vs a-z	42.00	Unique presence of 66 OTUs (43 at Station ENV054, 12 at ENV069 and 11 at both stations), accounting for 26% of the OTUs across the survey area. Higher reads of 106 OTUs including 24 Gammaproteobacteria OTUs (e.g. Marinobacter IM-7QOK42), 37 Other Bacteria OTUs (e.g. Bacteria IM-Q5O3I1), 12 Alphaproteobacteria OTUs (e.g. Rhodospirillaceae IM-SL8I74) and 12 Planctomycetes OTUs (e.g. Planctomycetales IM-L507EP). No reads of 3 OTUs including Actinobacteriota IM-ID4M60 at Station ENV054. Fewer reads of 3 OTUs including Gammaproteobacteria IM-65MO9C
ENV063	SIMPROF a vs b-z	53.90	Unique presence of 4 OTUs including 2 Gammaproteobacteria OTUs (Colwellia IM-CP3684 and Alteromonadaceae IM-S3JR77) and 2 Other Bacteria OTUs (Verrucomicrobiota IM-U7G862 and Bacteria IM-572ZXH). Higher reads of 36 OTUs including 18 Other Bacteria OTUs No reads of 32 OTUs including 14 Other Bacteria OTUs and 8 Planctomycetes OTUs. Fewer reads of 67 OTUs including Actinobacteriota IM-ID4M60,

Stations	SIMPROF	Similarity (Bray-Curtis %)	Operational Taxonomic Units and Groups influencing sample separation
			Alphaproteobacteria IM-72K6VM and Acidobacteriaceae IM-P87B3X.
ENV045, ENV057 and ENV087	SIMPROF b vs c-z	58.12	Unique presence of 20 OTUs including 9 Other Bacteria OTUs. Higher reads of 79 OTUs including 44 Other Bacteria OTUs No reads of 8 OTUs Fewer reads of 32 OTUs including Gammaproteobacteria IM-9QCQ08
ENV004 and ENV011	SIMPROF c vs d-z	58.77	Unique presence of 20 OTUs including 9 Other Bacteria OTUs. Higher reads of 67 OTUs including Flavobacteriaceae IM-598GJS No reads of 21 OTUs including 13 Other Bacteria OTUs Fewer reads of 22 OTUs including 11 Other Bacteria OTUs
ENV029, ENV082 and ENV101	Broad Group 1 (SIMPROF d-e) vs Broad Group 2 (SIMPROF f-z)	59.70	Unique presence of 11 OTUs. Higher reads of 90 OTUs including 33 Other Bacteria OTUs, 14 Planctomycetes OTUs and 12 Gammaproteobacteria OTUs. No reads of 13 OTUs including 8 Other Bacteria OTUs Fewer reads of 39 OTUs including Gammaproteobacteria IM-8QS7N5
ENV054 and ENV069	SIMPROF aa vs a-z	42.00	Unique presence of 66 OTUs (43 at Station ENV054, 12 at ENV069 and 11 at both stations), accounting for 26% of the OTUs across the survey area.

Stations	SIMPROF	Similarity (Bray-Curtis %)	Operational Taxonomic Units and Groups influencing sample separation
			Higher reads of 106 OTUs including 24 Gammaproteobacteria OTUs (e.g. Marinobacter IM-7QOK42), 37 Other Bacteria OTUs (e.g. Bacteria IM-Q5O3I1), 12 Alphaproteobacteria OTUs (e.g. Rhodospirillaceae IM-SL8I74) and 12 Planctomycetes OTUs (e.g. Planctomycetales IM-L507EP). No reads of 3 OTUs including Actinobacteriota IM-ID4M60 at Station ENV054. Fewer reads of 3 OTUs including Gammaproteobacteria IM-65MO9C

Table E. 10: Taxa Influencing Sediment Infaunal Operational Taxonomic Units SIMPROF Variation

Stations	SIMPROF	Similarity (Bray-Curtis)	Operational Taxonomic Units and groups influencing sample separation
ENV054	SIMPROF a vs b-r	2.84	Unique presence of 18 OTUs including 1 Annelida (Terebellidae IM-44US22), 11 Nematoda, 3 Arthropoda, 1 Chordata, 1 Gastrotricha and 1 Sipuncula Higher reads of 5 OTUs including Annelida (Terebellidae IM-K5XE4D), Nemertea, Arthropoda, Rotifera and Cnidaria.
ENV062	SIMPROF b vs c-r	7.40	Unique presence of 2 Nematoda OTUs Higher reads of 18 OTUs

Stations	SIMPROF	Similarity (Bray-Curtis)	Operational Taxonomic Units and groups influencing sample separation
			Absence of 6 OTUs including Nematoda Lauratonematidae IM-8TAQB0 Fewer reads of 7 OTUs including Nematoda Leptonemella IM-49Q94K, Microlaimidae IM-761UIS and Desmodorella IM-30F4AS
ENV020 and ENV049	SIMPROF c vs d-r	8.13	Unique presence of 2 OTUs. Higher reads of 13 OTUs including Annelida Nephtyidae IM-V80QNW No reads of 17 OTUs Fewer reads of 34 OTUs including 8 of the top ten
ENV029, ENV069 and ENV082	Broad Group 1 (SIMPROF d-e) vs f-r	8.99	Unique presence of 16 OTUs. Higher reads of 41 OTUs including Nematoda Lauratonematidae IM-8TAQB0 Fewer reads of 6 OTUs including Nematoda Leptonemella IM-49Q94K, Desmodorella IM-30F4AS and Microlaimidae IM-761UIS
ENV066	SIMPROF f vs Broad Group 2 (SIMPROF g-r)	9.45	Unique presence of 6 OTUs. Higher reads of 19 OTUs including Nematoda Oncholaimidae IM-86N6VA

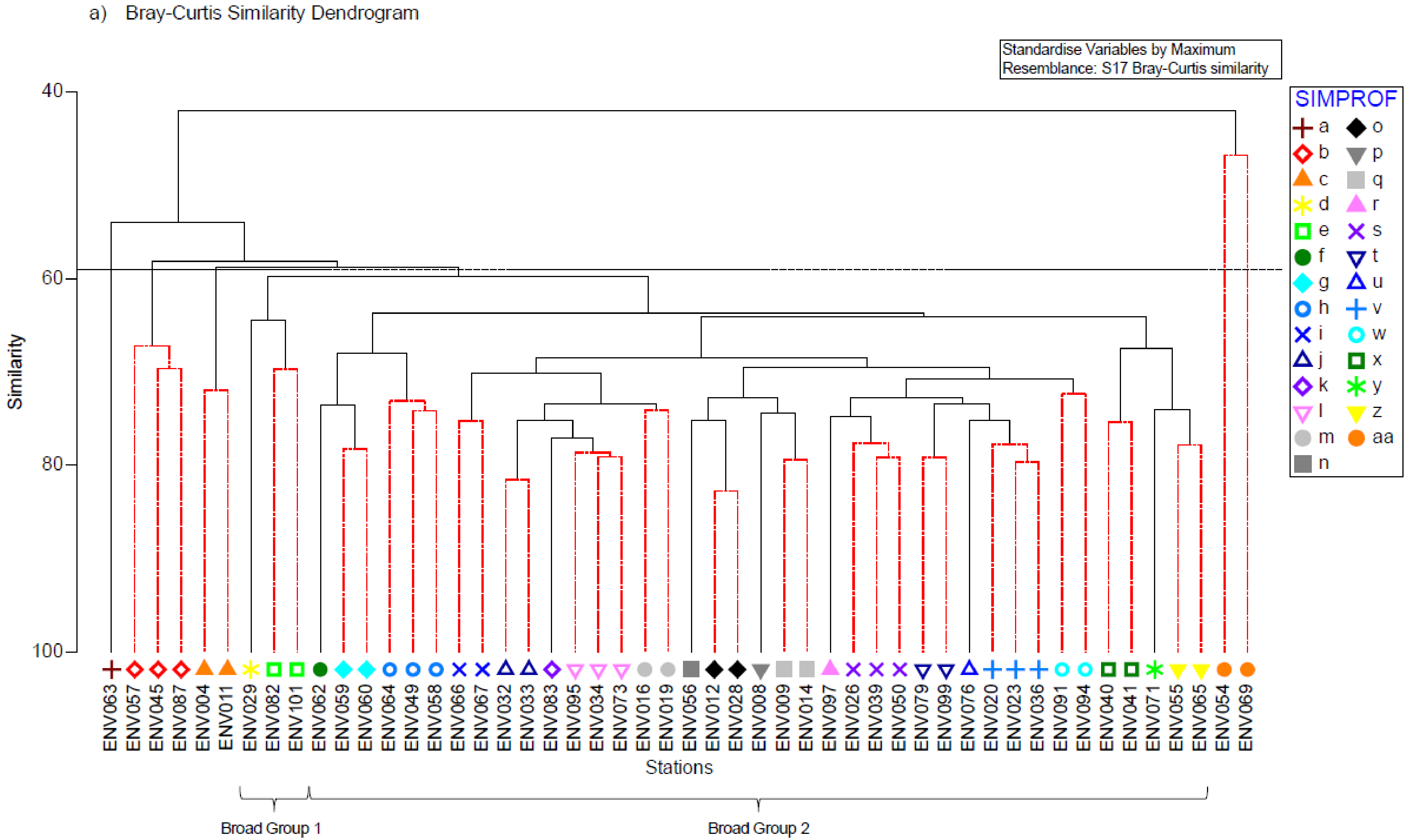

Figure E. 6: Multivariate analysis of Sediment Bacterial OTU Data by Station dendrogram

b) MDS Ordination

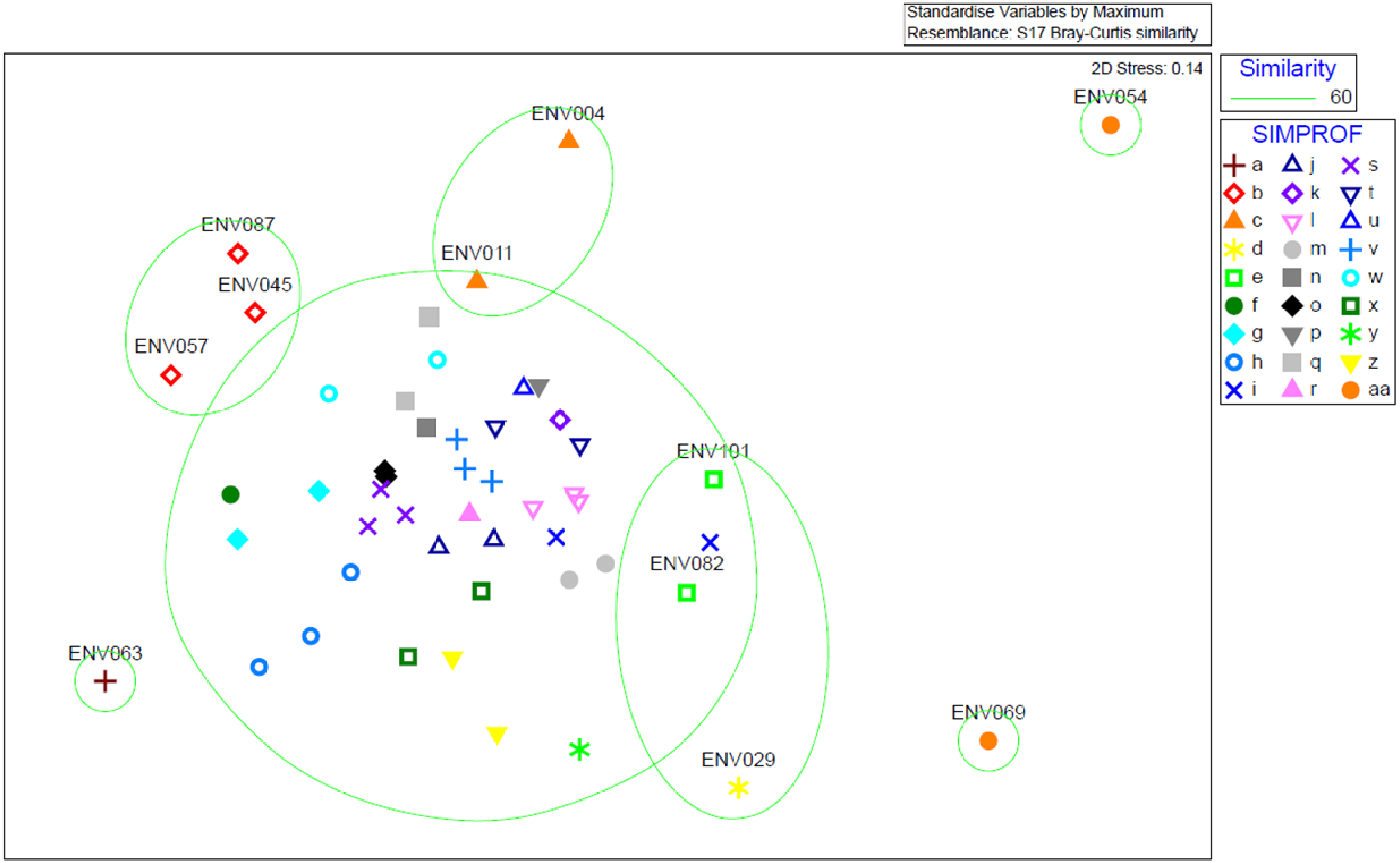

Figure E. 7: Multivariate analysis of Sediment Bacterial Operational Taxonomic Units Data by Station MDS plot

a) Bray-Curtis Similarity Dendrogram

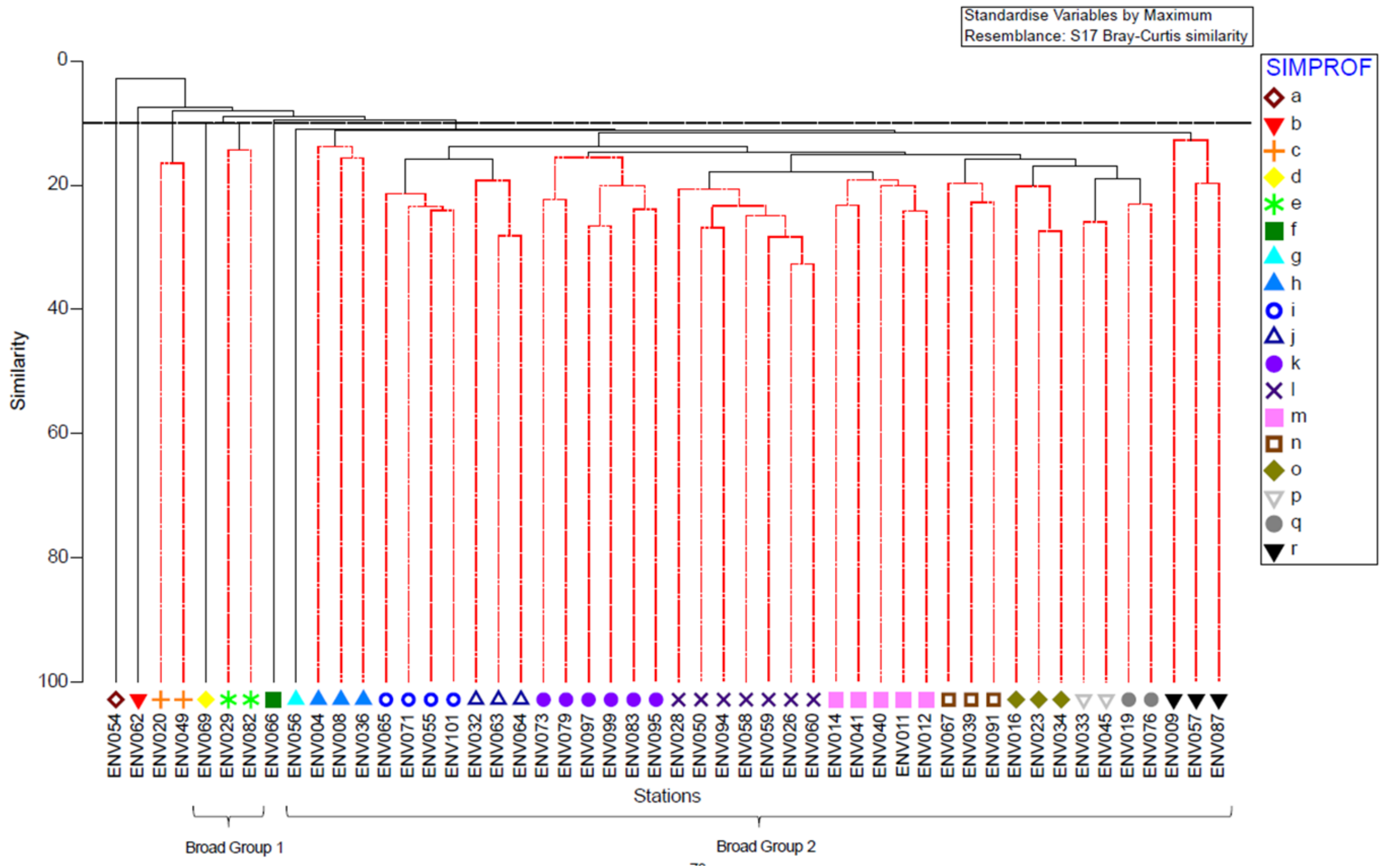

Figure E. 8: Multivariate analysis of Sediment Infaunal OTU Data by Station MDS plot

b) MDS Ordination

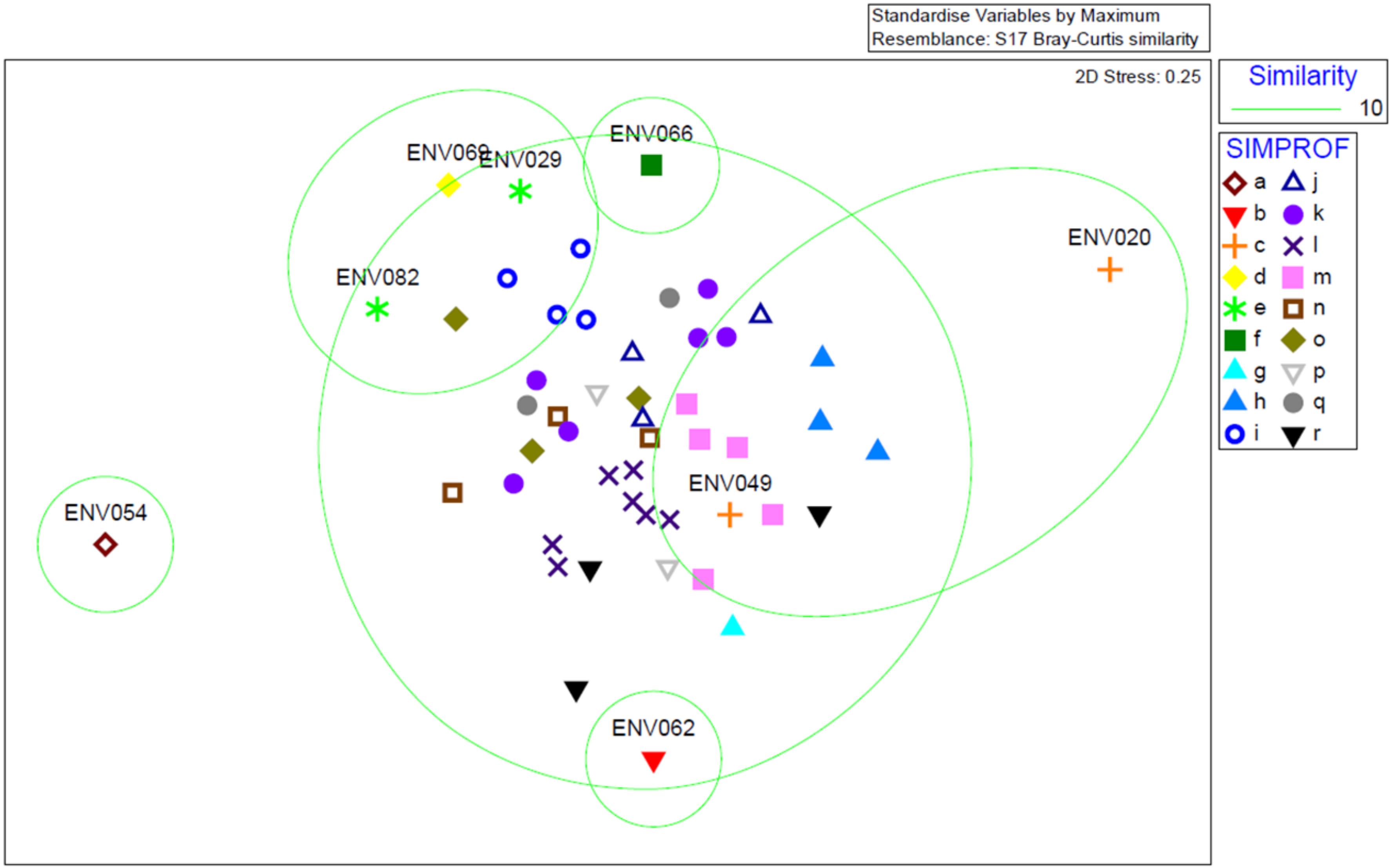

Figure E. 9: Multivariate analysis of Sediment Infaunal Operational Taxonomic Units Data by Station MDS plot

E.1.3 Multivariate Comparison of Metabarcoding Results to Physico-chemical Data

7.1.1.28 The bacterial and infaunal DNA multivariate patterns were compared to the physico-chemical data to determine if any patterns correlated. All the 50 stations analysed for sediment DNA also had sediment characteristics analysed, but only 24 stations had the full suite of physico-chemistry analysed.

7.1.1.29 A RELATE analysis identified only a 46% correlation between the sediment bacteria DNA multivariate pattern and that of the physico-chemical variables. BV STEP analyses further identified a sub-set of five physico-chemical variables (fines, TOC, Fe, V, n-alkanes) which showed a 70% correlation with the sediment bacteria DNA multivariate pattern. When all 50 stations were compared with the PSA results, fines and sand showed a 58% correlation with the sediment bacteria DNA multivariate pattern.

7.1.1.30 A RELATE analysis identified only a 42% correlation between the sediment infauna DNA multivariate pattern and that of the physico-chemical variables. BV STEP analyses further identified a sub-set of five physico-chemical variables (mean diameter, TOC, Cu, Fe and PAH) which showed a 56% correlation with the sediment infauna DNA multivariate pattern. When all 50 stations were compared with the PSA results, mean diameter and fines and sand showed a 44% correlation with the sediment infauna DNA multivariate pattern.

7.1.1.31 An analysis of similarity (ANOSIM) was conducted on both the bacterial and infaunal DNA data sets to investigate the influence of depth (rounded down to nearest 5m LAT). This revealed a significant but low-level impact on the bacteria DNA data set ($r=0.184$, $p<0.05$) and infauna DNA data set ($r=0.176$, $p<0.05$).